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ENTOMOLOGICAL NEWS

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Vol. 80 JANUARY, 1969 No. 1

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EPIZOIC SYMBIOSIS[1]

J. L. Gressitt[2]

During the past few years an interesting ecological association has come to light, involving cryptogamic plants, oribatid mites, rotifers, nematodes and microorganisms living together on the backs of beetles, primarily weevils. To date this phenomenon has apparently only been noted in the mountains of New Guinea, above 1,200 meters altitude, and primarily between 2,000 and 3,600 meters altitude.

There are indications that mutualistic symbiosis is involved, although this may be debated.

In the course of joint and separate field work over a period of several years, J. J. H. Szent-Ivany, J. Sedlacek and myself collected weevils with plant growth on their backs (Gressitt, Sedlacek & Szent-Ivany, 1965). At first algae, fungi, liverworts and lichens were observed, but more recently mosses and a fern gametophyte were found on weevils (Gressitt, Samuelson & Vitt, 1968). Lichen growth was also found on a colydiid beetle (Gressitt, 1966a, b; Samuelson, 1966). Living in the plants on the beetles, at least on the larger weevils, are oribatid mites (Aoki, 1966), which feed on the fungi or massed algae and fungi and lichenized fungi, and lichens. Also, under the matted plant growth are nematodes and microorganisms. On the exposed dorsal surfaces of the weevils, or on the plant growth, are sessile rotifers, which are pink when desiccated, but nearly colorless when wet and active.

The cryptogamic plants noted to date represent a large number of species of 13 or more families, but only one species each of phytophagous mite, nematode and rotifer have been noted for certain.

It would seem rather surprising if such an ecological association had developed only in New Guinea, since the Papuan area is only one of the several major humid tropical areas of the earth, and one of the least of these from the standpoint of area and range of latitude (not quite touching the equator). The development of this phenomenon has been found between 3° and 6° South latitude, but the moss growth has only been noted between 3° and 4° South latitude.

It is obvious that such a development could only occur under circumstances of prevailing high humidity. The appropriate environment is typical of much of the mountainous terrain of New Guinea. It consists of rain forest or moss forest, generally on upper slopes, ridges and peaks, where

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[1] Partial results of a grant to Bishop Museum from the National Science Foundation (GB-3245, GB-5864).

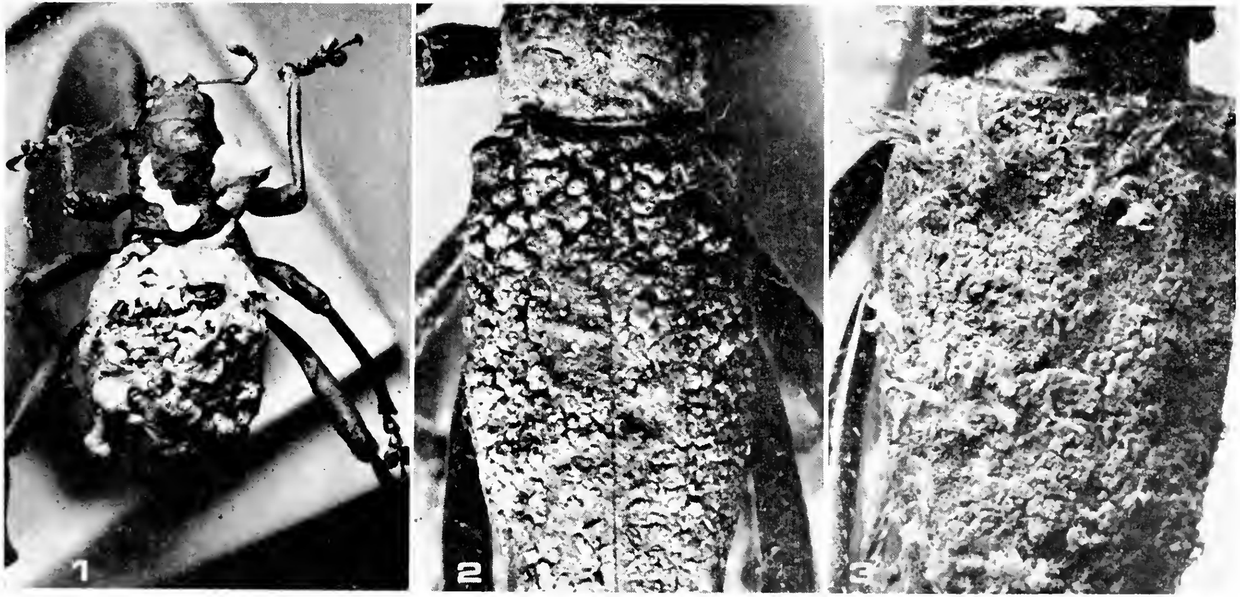
[2] Bishop Museum, Honolulu, Hawaii 96819.

fog is common. Summits over 3,300 meters altitude in New Guinea are generally bare of forest, and support tussock grassland of a somewhat marshy nature, with shrubs in more protected areas. The host weevils feeding on trees and shrubs, may occur on these isolated or fringing shrubs in the 3,300–3,700 meter zone, to the mountain summits (if within this range).

The host animals of this association belong primarily to weevils of three subfamilies: Leptopiinae, Brachyderinae (Fig. 1) and Cryptorhynchinae. The full association has only been noted among the Leptopiine weevils of the genus *Gymnopholus*. This genus is restricted to the mainland of New Guinea, above the altitude of 900 meters. It is represented by two subgenera, of about 25 known species each (Gressitt, 1966a; Gressitt & Sedlacek, 1967). The typical subgenus *Gymnopholus* consists largely of smooth species (with or without flat scales), which as a rule do not bear plant growth, and which primarily inhabit the 900–3,000 meter zone. The other subgenus, *Symbiopholus*, consists of species which are specialized in several respects, and in almost every case carry the complex association (Figs. 2–5). They occur almost exclusively above 2,000 meters in altitude.

The structural specializations of *Symbiopholus* include various modifications which appear to be developed for the encouragement and protection of the plants. These involve various large depressed areas or pits or grooves which permit plants and their associates to live undisturbed. Or, there may be tubercles or ridges which to some extent serve the same function. In addition, there are scales or setae modified in several peculiar fashions to serve as attachments or protective devices for the plants. Some of these are scales which at first are horizontal and then become erect, turning at right angles, with one or more processes. Some dorsal areas, on certain species, have peculiar fine hairs like fur, and it is on these, as on the above scales, where the plants make their start. Some setae are modified into stout, erect peg-like structures, with or without a rosette of smaller pegs or scales, which are located in areas where they make the plant-protecting ridges higher, or are interspaced with softer hairs on which plants grow, and provide protection to prevent the plants from being scraped off.

The behavior of the weevils is also such as to cause minimum disturbance to the plant association. The weevils, particularly *Gymnopholus*, are quite sedentary, often remaining on the same branches for a few days at a time. They are leaf-feeders, chewing on the outer borders of leaves while placing their feet on the two sides of the leaf, or on an adjacent stem. Since they move slowly and deliberately, there is minimum abrasion of the dorsum,

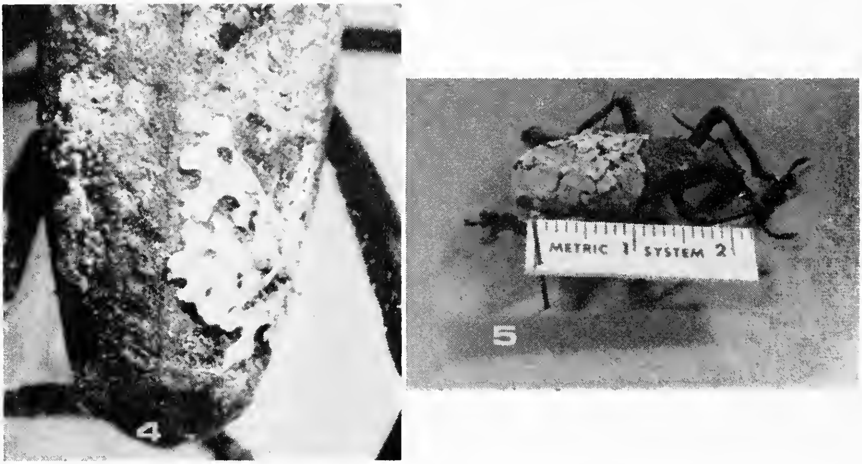


FIGS. 1–3; FIG. 1. *Pantorhytes lichenifer* Gressitt, Mt. Kaindi, Northeast New Guinea, L. Gressitt, with extensive growth of *Parmelia* lichen. FIG. 2. *Gymnopholus carolynae* Gressitt & Sedlacek, Kubor Range, Carolyn Gressitt, with dense mat of fungi, algae, incipient lichen and young moss. On side of prothorax there are peculiar yellow hairs bearing wax and resembling fungi. FIG. 3. *Gymnopholus fungifer* Gressitt, Huon Peninsula, G. A. Samuelson, bearing fungi, algae, moss (*Daltonia*) and 3 genera of liverworts.

where the plants grow (sometimes also on outer and upper sides of femora). There appears to be a minimum of erosion of plants on backs of females during mating, particularly because most species have one or two tubercles on each elytron at the top of its posterior declivity, with often also the suture being ridged in that area.

The weevils are to some extent polyphagous, and perhaps extensively so. Known hosts may span several plant families for one weevil species. As far as known, all species feed upon woody dicots. Among the known hosts are *Nothofagus*, and members of the Urticaceae, Rutaceae, Euryaceae, Rosaceae and other families.

The weevils appear to have few predators, so that the assumed protective resemblance to plants or plant-covered leaves or bark may be difficult to explain from the standpoint of evolution of the structures on the weevils. However, not enough is known of the biology of the weevils, as yet. The weevils often climb to the top shoots of shrubs and young trees, to rest for long periods, even at night, and particularly when it is foggy. In sunny weather they generally move to undersides of leaves, again favoring the growth of the cryptogams. Only one case of evidence of possible predation was observed on a log at night. The predator was possibly a mammal and had only removed the weevil's abdomen.



FIGS. 4–5; FIG. 4. *Gymnopholus lichenifer* Gressitt, Mt. Kaindi, with lichen and fungal growth. FIG. 5. *Gymnopholus lichenifer* Gressitt, Mt. Kaindi; elytra entirely covered with *Parmelia* lichen.

A prerequisite to the development of extensive lichen growth on the weevils is long life, because of the slow growth of the plants (Fig. 5). At the start of our long-term experiments, we stressed the marking and releasing of weevils on a mountain top (Kaindi, 2,350 meters) near the Bishop Museum Field Station in Northeast New Guinea. By now we have observed several individuals one year after marking, and one nearly two years after release. Most of the many recoveries have been in the immediat area of release, but one was one kilometer away. Usually the weevils will remain for hours or days on the bush they are released on, but sometimes they will drop or climb down to the ground and walk away in a fairly consistent course, but in different directions for different individuals, to disappear in the forest.

It is fairly certain that the plants that grow on the weevils are the same as those on leaves and bark in the same environment. As yet the animal associates of these plants have only been noted on the weevils, but studies have not progressed far enough for certainly on this point. There is remarkable local speciation in the weevils, but this is not the case with the plants and their associates.

Much remains to be learned of this fascinating association.

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An Army Ant Attacking the "Guaiá" Crab in Brazil[1]

Karol Lenko[2]

A good synopsis of the feeding habits of *Labidus coecus* (Latr., 1802) (Hymenoptera: Formicidae) appears in Borgmeier's classical work (1955) and another, more recently, was published by Rettenmeyer (1963). After an analysis of the data collected by these authors, I concluded that most of the references on the subject do not specify precisely the victims of the predatory activities of *L. coecus*. Many authors furnish very vague information, stating only that these ants are predatory on insects and arthropods in general. This paper is an account of one of our field observations of an attack of *L. coecus* on a fresh water crab commonly known in Brazil as "guaiá" *Trichodactylus argentinianus* Rathbun, 1906 (Crustacea: Patomonidae), kindly identified by my colleague Gustavo Augusto S. de Mello.

At 10 A.M., the 20th of June, 1965, on the left bank of the Jacaré-Guaçu river, on the lands of the Itaquarê Ranch, Municipality of Bôa Esperança do Sul, State of São Paulo, Brazil, I observed an agglomeration and great activity of workers of *L. coecus* circling a hole in the ground. This hole was the entrance of the burrow of the "guaiá" crab. Shortly the crab came to the surface with dozens of ants attached to its body. The ants were small and medium sized workers. The behavior of the crab seemed strange to me, for instead of striking for the river, only 1.20 m from its burrow, it took the opposite direction penetrating deeply into the ciliary second growth vegetation.

The crab was captured and found to have a great number of ants attached to it, principally to the maxillipeds, the insertions of the schizopodites, the basipodites, and also around the abdomen. A further examination verified the lack of antennae and the partial destruction of the antennules. The organs of the abdominal cavity had been partially destroyed. The specimen was an adult female with a carapace 42 mm in length by 46 mm in width. This nocturnal crab was resting in its burrow where it has the habit of day hiding, when it was attacked by the ants. The burrow extended 40 cm into the ground.

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Rettenmeyer, C. W. 1963. Behavioral studies of army ants. Univ. Kansas Sci. Bull. 44 (9): 281–465, 23 fig.

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[1] Accepted for publication April 8, 1968.

[2] Department of Zoology, Secretaria da Agricultura, São Paulo, Brazil.

Review of Arenophilus and Key to All Species[1, 2]

R. E. Crabill, Jr.[3]

In presenting a new species of *Arenophilus* I have taken the opportunity of reviewing aspects of the genus, its important diagnostic criteria, its known species, its distribution, its relationships and categorical position, for since its inception it has for most students occupied a kind of systematic limbo. Chamberlin, who proposed *Arenophilus* and described three of its five species, contented himself only with species descriptions, and Attems in his ordinal monograph of 1929 (*vide infra*), relying upon a scanty and misleading literature alone, mislocated it within his system.

Arenophilus Chamberlin

Arenophilus Chamberlin, Bull. Mus. Comp. Zool. Harvard, 54, p. 416, 1912.
Zygomerium Chamberlin, Proc. Biol. Soc. Wash., 56, p. 100, 1943. (New Synonymy).[4]

Type-species: *Geophilus unaster* Chamberlin, 1909 [= *Arenophilus unaster* (Chamberlin)]. Original designation.

The tuberculate ultimate pretarsus, the incomplete pleurograms, and the abortive pleuroprosternal sutures will readily identify the genus within Geophilidae.

Generic Diagnosis. Cephalic plate at least 1.3 times longer than wide; transverse suture very indistinct. Antennae: long, at least 4 times longer than cephalic plate. Clypeus: without plagulae; with a single anterocentral fenestra with inclusive setae. Labrum: Midpiece narrowly separating the sidepieces or overlapped by them, the latter with long hyaline filaments. First maxillae: with long telopodite and coxosternal lappets. Second maxillae: isthmus anteroposteriorly relatively deep, areolate, not suturate; telopodite first article notably shorter than the others, apical claw long, simple, both basal condyles present; statuminia and parastatuminial sutures absent, post-maxillary sclerites absent. Prehensorial segment: prosternum with prominent virtually complete pleurograms; pleuroprosternal sutures strongly oblique, anteriorly terminating at less than half the distance to anterior margin. Sternites: deeply punctured, medially often fossulate; ventral porefields appearing in subcircular, longitudinally or transversely subelliptical configurations. Ultimate pedal segment: sternite broader than

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[1] Accepted for publication June 6, 1968.

[2] Chilopoda, Geophilomorpha, Geophilidae.

[3] United States National Museum, Smithsonian Institution, Washington, D. C. 20560. Undertaken with the aid of a grant from the National Science Foundation.

[4] By original designation the type-species of *Zygomerium* is *Z. euphanum* Chamberlin, which in turn is conspecific with *Arenophilus watsingus* Chamberlin; accordingly, *Zygomerium* is a junior subjective synonym of *Arenophilus*. The original description of *euphanum*, whose holotype I have studied, is in error.

long; coxopleural pores opening into two subsurface cavities on each coxopleuron; pretarsus tuberculate; tarsalia two.

KEY TO KNOWN ARENOPHILUS SPECIES

1. Ventral porefields subelliptical to lanceolate, their long axes anteroposterior.............................**unaster** (Chamberlin)
   Ventral porefields subtriangular to subcircular, their long axes transverse...2
2. Ventral porefields subcircular, about as long as wide...**watsingus** Chamberlin
   Ventral porefields subtriangular, much wider than long..............3
3. Prehensorial first article without mesodistal denticle...**iugans** Chamberlin
   Prehensorial first article with mesodistal denticle...................4
4. Anterior legs ventrally very densely setose. Dorsum typically with a dark geminate band..................**bipuncticeps** (Wood)
   Anterior legs ventrally very sparsely setose. Dorsum without geminate dark band........................**psednus,** new species

Systematic Notes. This genus and the European *Necrophloeophagus* occupy a position intermediate between Geophilidae and Chilenophilidae,[5] and their assignment to the one or the other poses a problem that is at once interesting and refractory. In *Arenophilus* the long, robust prehensors, the distinct fenestra, the nearly eclipsed labral midpiece, and the dolichocephalic head all suggest Chilenophilidae. On the other hand the oblique pleuroprosternal sutures, the prominent pleurograms and, very compellingly, the whole habitus of the first and second maxillae are more characteristic of Geophilidae. And hence the horns of the dilemma, for one can marshal convincing reasons for assigning the genus to each family. Tentatively I shall assign it to Geophilidae because it keys out handily to that family, but I must confess that I have the feeling that it is a chilenophilid masquerading as a geophilid.

All of the above features, particularly the abortive pleuroprosternal sutures, clearly indicate close kinship between *Arenophilus* and *Necrophloeophagus*, both occupying an annectant position between the aforementioned taxa.

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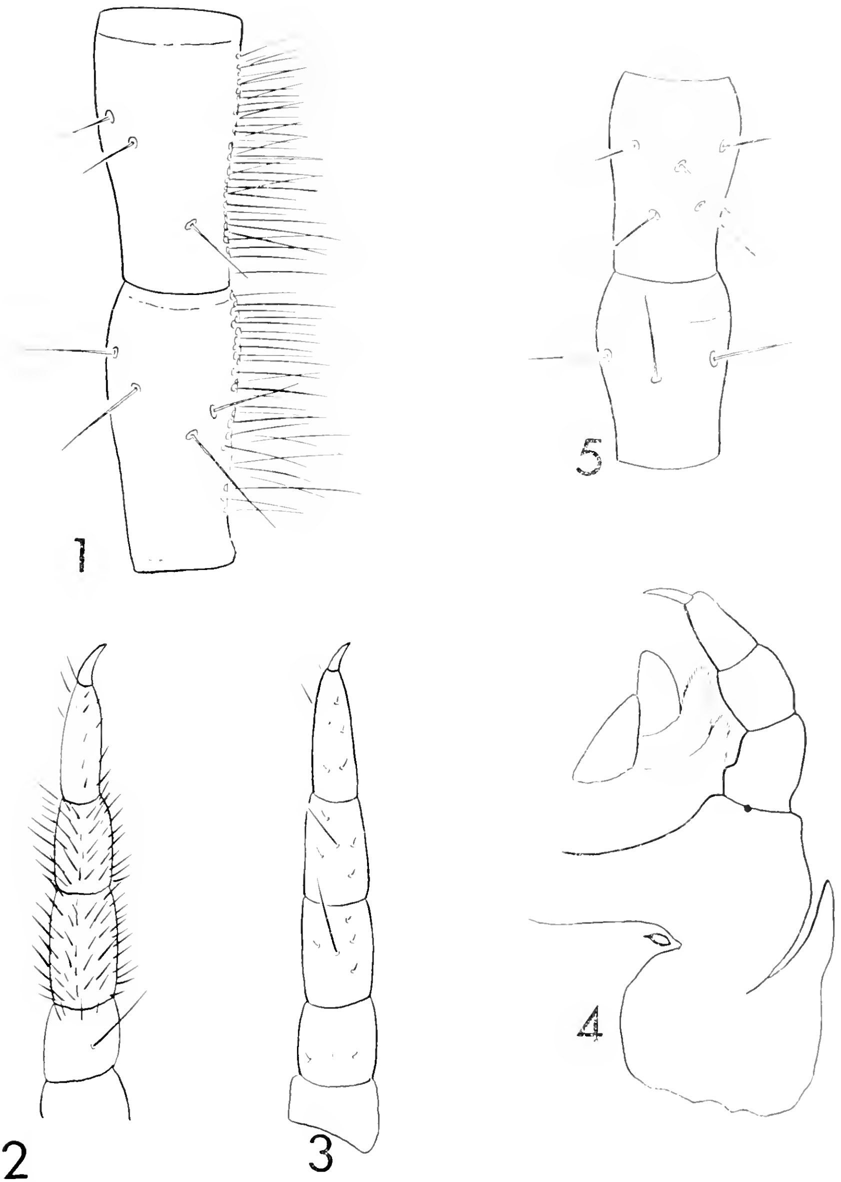
[5] Attems in various publications including his great ordinal monograph, Das Tierreich, Lief. 52, 1929, erroneously located the, to him unknown, *Arenophilus* within Geophilinae, p. 158, even though if one uses its true characteristics in conjunction with his key to subfamilies, p. 157, it would plainly key out to Pachymeriinae. Of course, never having seen a specimen by 1929, he was misled by descriptions and lacunae in the literature. In the present discussion I do not follow Attems' division of Geophilidae into Pachymeriinae and Chilenophilinae, but instead am in accord with Chamberlin's view that sees in the latter two subfamilies a single family, Chilenophilidae, which is distinct from Geophilidae.



FIGURES 1–5: *Arenophilus bipuncticeps* (Wood): 1, 2. *A. psednus*, holotype 3, 4, 5. FIG. 1. Antennal articles 3 and 4; left ventral. All setae shown. FIG. 2 Left fifth leg; ventral. All setae shown. FIG. 3. Left fifth leg; ventral. All setae shown. FIG. 4. First and second maxillae; left side, ventral. Setae deleted. FIG. 5. Antennal articles 3 and 4; left ventral. All setae shown.

So far as is known, *Arenophilus* occurs only in extreme northern Mexico and in all but the most northern of the United States. Its two most widespread species are *bipuncticeps* (Wood) and *watsingus* Chamberlin, which throughout their range tend to replace the species of *Geophilus*. Of all North American geophilids *bipuncticeps* appears to be the most widespread and, within its range, the most prevalent. It is possible, however, that some records attributed to the Wood species were actually based upon very similar but different species, such as the new one described below.

Arenophilus psednus, NEW SPECIES

The new species most closely resembles *bipuncticeps* (Wood) but differs from it most conspicuously as follows. In *bipucticeps:* (1) antennal articles each very long; width of each uniform; ectally with dense, long setae. (2) Anterior legs ventrally very densely setose. (3) Telopodite lappets longer than telopodites. (4) Dorsal geminate band present, dark. (5) Ultimate pretarsal tubercle typically short and hyaline. In *psednus:* (1) antennal articles each shorter; in each greatest width at distal end; ectally, sparsely setose. (3) Telopodite lappets shorter than telopodites. (4) Dorsum without geminate dark band. (5) Ultimate pretarsal tubercle longer, fulvous.

Holotype: female. Kentucky, Boyle County, Lawrence Cave at the southwest edge of Perryville. June 23, 1967; T. C. Barr, Jr., leg.

GENERAL. Length, 45 mm. Leg pairs, 59. Shape: anteriorly slightly, gradually attenuate; ultimate ten segments strongly attenuate. Color: brownish yellow, without dorsal midlongitudinal geminate band.

ANTENNAE. Length to head length, 4:1. Each article except first longer than wide; article 2 slightly geniculate. Vestiture: articles 1–5 each with 1–2 circlets of setae; articles 6–14 each with many circlets of shorter setae; in general setae of the more distal articles shorter and more numerous. CEPHALIC PLATE. Length to width, 12:10. Cephalic suture weakly indicated. With two paramedian sutures. Sides slightly excurved; rear straight. CLYPEUS. Wider than greatest length. Anterocentrally with a prominent white clypeal fenestra with two stout inclusive setae. Remaining setae minute, sparse. Plagulae absent. Paraclypeal sutures strong, complete. LABRUM. Midpiece very narrowly separating sidepieces. Each fulcrum short, robust, transverse, about $\frac{1}{5}$ as long as one sidepiece. FIRST MAXILLAE. Telopodites: biarticular; lappets robust, distally blunt, shorter than telopodite. Coxosternal lappets reaching half the height of the telopodite lappets. SECOND MAXILLAE. Basal article of first article with an inner protuberance; claw long and curved.

PREHENSORS. Trochanteroprefemur with low, weakly pigmented denticle; claw with basal denticle. Tarsungula: blade smooth, not serrate. PROSTERNUM. Pleurograms prominent, essentially complete to the condyles. Pleuroprosternal sutures oblique, incomplete, terminating laterally at a point half distant to anterior margin.

TERGITES. Sparsely, shortly setose. Subsurface dark geminate band absent. STERNITES. Without *carpophagus*-structures; on anterior body third each with a slight anterocentral fovea. Porefields: single on 1–19, broadly transverse, weakly triangular, the very obtuse apex posterior, without anterior extension; 20 through penult each double, each subelliptic to subcircular. Intersternites of anterior body half medially weakly divided, the division not apparent on posterior body half. LEGS. Vestiture very sparse, not dense as in *bipuncticeps*. Tibiae and femora of all legs ventrally with a single exceptionally long seta.

ULTIMATE PEDAL SEGMENT. Pretergite laterally not fissate, fused with its pleurites. Tergite: greatest width to length, 13:10. Presternite anteroposteriorly deep, without midlongitudinal suture or division. Sternite: much wider than greatest length, 9:6. Rear margin very slightly embayed; sides on anterior half parallel, on posterior half slightly convergent. Coxopleuron: with two heterogeneous glandular cavities, their walls convoluted and minutely papillate. Telopodite: notably longer than penult, not crassate. Distotarsus longer than proximotarsus, 6:5. Pretarsus tuberculate, pigmented, hispidate.

POSTPEDAL SEGMENTS. Female gonopods medially fused without suture or divison, uniarticular. Anal pores large heterogeneous, walls convoluted and minutely papillate.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

ECOLOGY OF APHIDOPHAGOUS INSECTS

Edited by Ivo Hodek and M. L. Dutkowa. 1966. Dr. W. Junk, Publishers, The Hague, The Netherlands, 360 pp. + 10 plates. Cloth, approx. $14.00.

The proceedings of a symposium held September 27 to October 1, 1966, in Liblic (Near Prague), Czechoslovakia, are presented as summaries of the 75 papers given during the 5-day meeting, participated in by 86 research workers from many countries. The papers are grouped into 6 sections: I. food ecology of aphidophagous insects, 17; II. voltinism and arrest of development in aphidophagous insects, 4; III. behavior of aphidophagous insects and aphids, 14; IV. distribution of aphidophagous insects in habitats, 13; V. population dynamics of aphids and their natural enemies, 17; and VI. aphidophagous insects in biological and integrated control, 10. The first paper of each section is a review of previously published information, and the closing paper of each (except II which had none) summarizes the papers presented with a general discussion of them in an attempt to compensate for their subjective approaches.

This book contains a wealth of basic background information for entomologists, especially those interested in or concerned with biological control of aphids. It will be an essential working tool for those in research with aphids as well as for teachers and students of entomology, both at the graduate and undergraduate levels. However, one may differ with the scientific editor's conclusions that "The conception, working methods and conclusions," contained in the summarized papers, "are valid not only for predators and parasites of aphids, but also for natural enemies generally." Nevertheless, while more of the research included relates to predators of aphids, the book represents a landmark in that it summarizes much of the more outstanding progress from past and current research activity basic to some applied aspects of biological control of aphids.—W. A. SHANDS, *U. S. Dep't. Agric., Orono, Maine.*

EVOLUTIONARY BIOLOGY, volume 2.

Edited by TH. DOBZHANSKY, M. K. HECHT, and W. C. STEERE, 1968. Appleton, Century, Crofts, New York. xi + 452 pp. Cloth, $15.00.

Prompt publication of important new concepts in well digested form coupled with a thorough survey of the recent literature that lead to the synthesis of these concepts is one way to serve the struggling biologist in his attempt to keep up with his field. The present volume is of interest to entomologists for the general evolutionary concepts presented, and in particular through three articles: "Cave ecology and the evolution of Troglobites" by Thomas C. Barr, Jr.; "Evolutionary implications of sexual behavior in Drosophila" by Herman T. Spieth, and "Suture-zones of hybrid interaction between recently joined biotos" by Charles L. Remington.

The Remington article proposes, defines, and describes the concept of *suture-zones*, a term used as a refinement of "hybrid belts" and other terms loosely used by previous authors. This concept will be exceedingly useful in the interpretation of the origin and dispersal of our biota for it will explain many of the confusing species concepts, some of the variation noted in museum specimens from these zones, as well as calling attention to geographical areas needing further and intensive study. The lucid exposition of the theory presented in simple and logical steps, not only shows the clear understanding of the author, but his writing skill as well, and assures the firm establishment of the concept and the term in our biological literature at all levels.—R. H. A.

INSECTS OF NORTH CAROLINA, 3rd supplement.

By DAVID L. WRAY. North Carolina Dep't. Agric., 1967. 181 pp.

Since the original list, published in 1938, two supplements have appeared, but this supplement, the 3rd, combines 1 and 2, as well as adding the new information gathered since 1950, the date of the 2nd supplement. This thankless job is extremely well done. —R. H. A.*

METAMORPHOSIS

Edited by WILLIAM ETKIN and LAWRENCE I. GILBERT, 1968. Appleton, Century, Crofts, New York. xii + 459 pp. $14.50 cloth.

Pages 43–219 deal with insect metamorphosis in many aspects including a review of the most recent literature (only about 30% of the hundreds of references were published prior to 1960, and most every reference appeared since 1950). Reading this section alone will be a quick way for teachers to get up-to-date on this subject. Most of the rest of the book deals with vertebrates, a much different world than that of the insects.—R. H. A.

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* In the opinion of this editor, each state would contribute immensely to our science if they were to produce such a list as the above, in spite of possible misidentifications. The available data could then be used by the specialist, supplemented and corrected if need be, working toward that time when our insect fauna will be well enough known to more easily permit accurate ecological, behavioral, and genetic (population) studies.—R. H. A.

Notes on the Food of Tanypodinae Larvae[1]

Selwyn S. Roback[2,3,4]

The larvae of the Tanypodinae often have been reported as being predaceous (Leathers, 1922; Wesenberg-Lund, 1943; Morgan, 1949; Belyaskaya and Konstantinov, 1956). Leathers mentions the ability of these larvae to suck fluid from their prey. This permits their predation on organisms too large to swallow whole. Morgan discusses the mechanism enabling these larvae to ingest whole organisms and also notes their capability of using algae as food. Armitage (1968) considered that for smaller larvae, *Procladius choreus*, *Pr. nudipennis* and *Ablabesmyia monilis*, size group 2 (4–7 mm) algae was the most important food during the spring and autumn while detritus was the most important food under ice cover. For larger larvae *Pr. signatus*, *Pr. nigriventris* and *Pr. flavifrons*, size group 1 (7–11 mm), faunal and detritus food was preferred earlier and detritus was most common under ice cover. As Armitage mentions, more work is needed to test the significance of algae as food for the Tanypodinae.

Much work on the precise feeding of Tanypodinae larvae has been done by the Russian workers, Konstantinov and Luferov. Unfortunately all their work has been done only on the species of the genera *Procladius* and *Ablabesmyia*. Konstantinov (1961) lists chironomids, oligochaetes and plankton crustacea, in that order, as the preferred food for both genera. The results here indicate that Cladocera and chironomids, in that order, are the most important for *Procladius* spp. and chironomids and Cladocera for *Ablabesmyia* spp. The results of Luferov (1957, 1958, 1961) are more in accord with the results here. He lists for *Procladius* spp.: 7 species of Tendipedidae, 11 Entomostraca, 3 Oligochaeta; for *Ablabesmyia* spp.: 9 species of Tendipedidae, 5 Entomostraca, 1 Oligochaeta and 1 mite. Entomostraca as used by Luferov includes Cyclopoid Copepoda, Ostracoda and Cladocera.

This report is based on the slide mounted specimens in the collection of the Academy of Natural Sciences of Philadelphia. In all, the intestinal contents of about 310 specimens from over 10 genera of Tanypodinae were examined. The Tanypodini are not included but are discussed in another paper now in press.

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[1] Diptera, Chironomidae.

[2] Accepted for publication June 10, 1968.

[3] Curator, Department of Limnology, Academy of Natural Sciences of Philadelphia, Pa. 19103.

[4] The support of the National Science Foundation (GB [illegible]) is gratefully acknowledged. I am indebted to Dr. Clyde Goulden of the Academy of Natural Sciences for the determination of the Arthropoda other than insects.

In the lists that follow, the number in boldface after each genus or species gives the number of specimens examined. The boldface numbers after the food categories give the number of specimens in which the particular food species or genus was found, while the number preceding this indicates the number of specimens of the particular food species or category which were found. For example, in the Coelotanypodini, 15 specimens of *Coelotanypus* sp. were examined, 5 of these contained 7 specimens of Chironomidae and 2 of these 5 contained 3 specimens of *Polypedilum*. No attempt was made to count the numbers of diatoms or desmids and a count of the Oligochaeta was impossible. The classification of invertebrates used is as in 2nd Edition of "Fresh Water Biology" (Edmondson, 1959).

THE FOOD OF TANYPODINAE LARVAE

Diatomaceae.—Almost all genera examined contained diatoms, in varying concentrations, in their digestive tracts. Some evidence indicates these are an important food component (Armitage, 1968) but in the specimens examined there was no way to be sure that they were alive when ingested. Some may be taken along with debris as the larvae browses through the bottom or over vegetation in search of food. Their concentration might depend on whether the larva was living in shallower water where conditions for diatom growth were good or was moving through an area of frustule deposition. The species of the genus *Procladius* had the greatest percentage of larvae with diatoms (95%), while the species, Pentaneurini sp. E with 23%, was lowest. Both centric and pennate diatoms were present.

Desmidaceae.—The comments under diatoms apply equally well here. Specimens from pond situations had a greater concentration of desmids in their digestive tracts.

Protozoa.—Only the case forming Testacea were observed. They were of sporadic occurrence and cannot be considered significant as food.

Rotifera.—These are normally quite abundant in slower water and may be more significant as food than the meager records would indicate. The body parts are probably ground up by the diatoms and sand in the digestive tracts of the Tanypodinae larvae and cannot be distinguished. A loricate rotifer, *Monostyla*, was the only one found.

Tardigrada.—Only one specimen was found (at best these are rare animals), tentatively identified as a tardigrade.

Oligochaeta.—The presence of these worms in the digestive tracts was indicated by concentrations of body setae. It was impossible to count the number of individual worms involved. As far as could be determined from these setae, most of the worms present belonged to the genera *Limnodrilus* or *Tubifex*. Except for the species of genera *Coelotanypus* and *Clino-*

tanypus, where from 33–50% of the specimens examined contained worms, these did not seem to be an important component of the food of the Tanypodinae.

Cladocera.—The cladoceran fauna of the digestive tracts of the Tanypodinae is large and varied. Over 16 species representing 10 or more genera were identifiable. There were undoubtedly many more whose remains were broken up or were hidden by debris and could not be identified. Most of the species found belonged to the Chydoridae. This family and corresponding superfamily are, according to Brooks (1959), bottom feeders on particulate matter, thus they would be readily available as food for Tanypodinae larvae. A few head shields of *Bosmina* sp. were found in the larvae examined but I have not included these in the lists. *Bosmina* sp. is primarily a planktonic filter feeder and the head shields were probably of dead specimens picked up with bottom debris. *Procladius* sp. larvae appear to be the most voracious Cladocera predators. Thirteen specimens contained 21 Cladocera with 9 species and 7 genera represented.

Ostracoda.—Most of the shattered ostracod remains were beyond identification due to the grinding action of the debris in the digestive tracts of the larvae. Only occasionally the shells were intact. Morgan (1949) says: "the contents of the midgut are churned up by vigorous muscular movements of the walls." The Ostracoda seem to form an important part of Tanypodinae food and were found in the species of all genera except *Coelotanypus*. At times they seem to have been eaten in great numbers, e.g., 10 specimens were found in the digestive tract of one larva of a species of the *Thienemannimyia* group.

Copepoda.—The copepods were used very sporadically as food of the species of Tanypodinae and cannot be considered an important component. Both the Cyclopoida and Harpacticoida were represented, but not the Calanoida.

Insecta.—The lists show that chironomid larvae form an important part of the food species of Tanypodinae. A total of 15 recognizable genera were found in the digestive tracts of the larvae of Tanypodinae and many specimens were so broken or debris covered that they could be identified only to subfamily or tribe. Members of the Tanytarsini and *Polypedilum* spp. were the most common with the other genera randomly distributed. There is no evidence of any specific or generic preference. Members of the *Thienemannimyia* group of genera seemed to be the most voracious feeders on chironomid larvae with 26 of the specimens examined containing 38 larvae.

Non-chironomid insects as food were scarce. Only a few early instar Trichoptera, one questionable lepidopteran, and one ceratopogonid larva were found. Morgan (1949) mentions that ceratopogonid larvae are seldom eaten.

Acarina.—The mites, though very numerous in pond type aquatic environments, were not abundant as food of the Tanypodinae larvae examined. Only 5 mites were found in all the specimens seen.

Miscellaneous.—In addition to the aforementioned categories, the digestive tracts of the Tanypodinae larvae contained an assemblage of detritus, gravel, plant parts, unidentifiable eggs, turbellarian egg cocoons, sponge spicules and unidentifiable chitinous fragments. Undoubtedly a great many additional organisms are present in the digestive tracts of the larvae examined but due to the amount of debris and gravel it is not always possible either to find or to identity these. I have found algae (other than Diatoms and Desmids) sporadically and in most cases they were unidentifiable.

Food of Tanypodinae

COELOTANYPODINI

- **Coelotanypus** sp. **15**
  - Diatomaceae **2**
  - Oligochaeta
    - *Limnodrilus* or *Tubifex* sp. **5**
  - Cladocera
    - non-Chydoridae sp. **2—2**
  - Insecta, Diptera, Chironomidae **7—5**
    - sp. **1—1**
    - *Polypedilum* sp. **3—2**
    - *Chironomus* sp. **2—2**
    - Tanytarsini sp. **1—1**
- **Coelotanypus tricolor** (Loew) **5**
  - Diatomaceae **1**
  - Oligochaeta
    - *Limnodrilus* or *Tubifex* sp. **1**
  - Insecta, Diptera, Chironomidae
    - sp. **1—1**
- **Coelotanypus concinnus** (Coq.) **32**
  - Diatomaceae **10**
  - Oligochaeta
    - *Limnodrilus* or *Tubifex* sp. **11**
  - Insecta, Diptera, Chironomidae **4—2**
    - spp. **3—1**
    - *Psectrocladius* sp. **1—1**
- **Clinotanypus** prob. **pinguis** (Loew) **24**
  - Diatomaceae **6**
  - Oligochaeta
    - *Limnodrilus* or *Tubifex* sp. **12**
  - Ostracoda
    - sp. **1—1**
  - Insecta, Diptera, Chironomidae **3—2**
    - sp. **1—1**
    - *Sergentia* sp. **1—1**
    - *Chironomus* sp. **1—1**

MACROPELOPIINI

- **Psectrotanypus dyari** (Coq.) **13**
  - Diatomaceae **11**
  - Desmidaceae **4**
  - Cladocera **2—2**
    - *Chydoras* sp. **1—1**
    - *Chydoras sphericus* Müller **1—1**
  - Insecta, Diptera, Chironomidae **2—2**
    - *Tanypodinae* **1—1**
    - *Trichocladius* sp. **1—1**
- **Natarsia** prob. **baltimoreus** (Macq.) **16**
  - Diatomaceae **13**
  - Cladocera
    - *Alonella excisa* (Fischer) **1—1**
  - Ostracoda
    - sp. **4—2**
  - Copepoda
    - Harpacticoida **1—1**
  - Insecta, Diptera, Chironomidae **2—2**
    - sp. **1—1**
    - Ploypedilum sp. **1—1**
- **Procladius bellus** (Loew) **5**
  - Diatomaceae **5**
  - Cladocera
    - *Alona* sp. **2—2**

- Copepoda
  - sp. 1—1
  - Harpacticoida 2—1
- Ostracoda
  - sp. 1—1
- Insecta, Diptera, Ceratopogonidae
  - sp. 1—1
- Acarina
  - sp. 1—1

Procladius spp. (prob. *denticulatus* and *freemani* Sublette) 40
- Diatomaceae 38
- Desmidaceae 1
- Protozoa
  - *Arcella* sp. 1—1
  - *Difflugia* sp. 3—2

PENTANEURINI

Thienemannimyia Reihe Fittkau 66
- Diatomaceae 23
- Desmidaceae 2
- Protozoa
  - Testacea sp. 1—1
- Tardigrada ?
  - sp. 1—1
- Cladocera 6—3
  - *Alonella hamulata* (Birge) 2—1
  - *Alona* sp. 2—2
  - *Chydorus* prob. *ovalis* Kurz 1—1
- Ostracoda
  - sp. 21—8
- Insecta, Diptera, Chironomidae 38—26
  - undet. spp. 10—8
  - *Zavrelimyia* sp. 1—1
  - *Labrundinia* sp. 1—1
  - *Rheorthocladius* ? sp. 1—1
  - *Trichocladius* sp. 2—2
  - *Psectrocladius* sp. 2—2
  - Orthocladiinae sp. 2—2
  - *Thienemanniella* sp. 1—1
  - *Polypedilum* sp. 2—2
  - *Chironomus* sp. 2—1
  - *Glyptotendipes senilis* ? (Joh.) 1—1
  - Tendipedini spp. 4—2
  - Tanytarsini spp. 5—5
- Trichoptera
  - spp. 3—3
- Lepidoptera
  - poss *Parargyractis* sp. 1—1

Zavrelimyia sp. 7
- Diatomaceae 5
- Desmidaceae 1
- Oligochaeta
  - *Limnodrilus* or *Tubifex* sp. 1
- Ostracoda
  - sp. 2—1
- Insecta, Diptera, Chironomidae 3—1
  - sp. 1—1
  - *Thienemanniella* sp. 1—1
  - *Dicrotendipes* ? sp. 1—1
- Trichoptera
  - sp. 1—1

Labrundinia sp. 17
- Diatomaceae 7
- Oligochaeta
  - *Limnodrilus* or *Tubifex* sp. 2
- Cladocera
  - sp. nr. *Sida* 1—1
- Ostracoda
  - sp. 1—1

Ablabesmyia mallochi (Walley) 12
- Diatomaceae 5
- Rotifers
  - *Monostyla* sp. 1—1
- Oligochaeta
  - *Limnodrilus* or *Tubifex* sp. 5
  - sp. 1
- Cladocera 7—4
  - Chydoridae sp. 2—1
  - *Chydorus sphericus* Müller 1—1
  - *Alona* sp. 1—1
  - *Alonella hamulata* (Birge) 1—1
  - *Camptocercus rectirostris* Schodler 1—1
  - *Pleuroxus denticulatus* Birge 1—1
- Ostracoda
  - sp. 2—2
- Insecta, Diptera, Chironomidae 6—4
  - *Harnischia* sp. 1—1
  - *Dicrotendipes* sp. 1—1
  - *Polypedilum* sp. 1—1
  - *Rheotanytarsus* sp. 1—1
  - *Calopsectra* sp. 2—2
- Acarina
  - sp. 1—1

Ablabesmyia monilis ? (L.) 23
- Diatomaceae 7
- Desmidaceae 1
- Rotifers
  - *Monostyla* sp. 2—1
- Oligochaeta
  - *Limnodrilus* or *Tubifex* sp. 3

Cladocera 6—**3**
Leydigia leydigi (Schødler) 1—**2**
Chydoras sphericus Müller 1—**1**
Alonella excisa (Fischer) 1—**1**
Eurycercus lamelatus Müller 1—**1**
sp. 1—**1**
Alona affinis (Leydig) 1—**1**
Ostracoda
sp. 5—**5**
Copepoda
sp. 1—**1**
Insecta, Diptera, Chironomidae 18—**11**
spp. 2—**2**
Zavrelimyia sp. 2—**2**
Orthocladiinae 2—**1**
Harnischia sp. 1—**1**
Microtendipes sp. 1—**1**
Polypedilum scalaenum (Schrank) 1—**1**
Tanytarsini spp. 6—**3**
Calopsectra sp.? 3—**2**
Trichoptera
sp. 1—**1**
Acarina
sp. 1—**1**

Ablabesmyia peleensis (Walley) **22**
Diatomaceae **15**
Desmidaceae **1**
Oligochaeta
Limnodrilus or *Tubifex* sp. **1**
Cladocera 14—**10**
Alona sp. 1, 4—**3**
Alona sp. 2, 1—**1**
Alona circumfimbriata (Megard) 1—**1**
Chydoras sphericus (Müller) 7—**6**
Chydoridae sp. 1—**1**
Ostracoda
sp. 14—**6**
Copepoda
Cyclopoidea 1—**1**
Insecta, Diptera, Chironomidae 20—**9**
undet. spp. 5—**4**
Thienemanniella sp. 3—**1**
Cricotopus bicinctus ? (Meig.) 3—**1**
Orthocladius nr. *nivoriundus* (Joh.) 1—**1**
Orthocladiinae sp. 1—**1**
Dicrotendipes sp. 2—**2**
Polypedilum illinoense (Mall.) 3—**1**
Tanytarsini sp. 2—**2**
Ablabesmyia monilis ? (L.) 1—**1**

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New Species of Krombeinia Pate and Neotiphia Malloch (Hymenoptera: Tiphiidae)[1, 2]

Harry W. Allen[3]

Abstract

Since the genera *Krombeinia* and *Neotiphia*, uncommon North American wasps of the family Tiphiidae, were revised in 1964, the author has examined more than twice as many as were then available. Three new species of *Krombeinia* and two of *Neotiphia* have been identified and are described in this paper. They are *Krombeinia hurdi*, *K. oaxacae*, *K. sculleni*, *Neotiphia latirostrata*, and *N. aurisaetae*.

The revision of the two genera of uncommon wasps, *Krombeinia* and *Neotiphia*, published in 1964 was based on a study of about 350 specimens. In this small number of specimens Allen and Krombein recognized 19 species of *Krombeinia*, of which 15 were new to science, and 19 species of *Neotiphia*, of which 9 were new to science, a total in the two genera of 38 species of which 24 were new to science. This has since been reduced by synonymy (Allen, 1965) to 35 species of which 22 were new to science.

Since the publication of the 1964 revision, the author has examined an additional 880 specimens, or more than twice as many as were available in 1964. Among these only 5 new species have been recognized, all from Mexico, of which 3 are *Krombeinia* and 2 *Neotiphia*. It would thus appear that future collecting will result in the discovery of relatively few new species. However, it should make it possible to recognize both sexes for numerous species now known in only one sex. All illustrations in this paper are by Mary H. Fuges.

This study was made possible by the loan of material from the following institutions:

American Museum of Natural History [AMNH] through Dr. J. G. Rosen, Jr.; California Academy of Sciences [CAS] through Mr. Hugh B. Leech; Cornell University [CU] through Dr. L. L. Pechuman; Museum of Comparative Zoology [MCZ] through Dr. Howard E. Evans; Oregon State University [OreSU] through Dr. Paul W. Oman; University of California, Berkeley [UCB] through Dr. P. D. Hurd, Jr.; University of California, Davis [UCD] through Mr. A. T. McClay; University of California, Riverside [UCR] through Dr. Saul Frommer; University of Kansas [UK] through Dr. G. W. Byers; United States National Museum [USNM] through Dr. K. V. Krombein. Holotypes of *Krombeinia oaxacae*, *K. sculleni*, and *Neotiphia auri*

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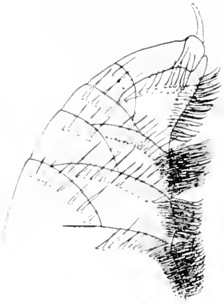
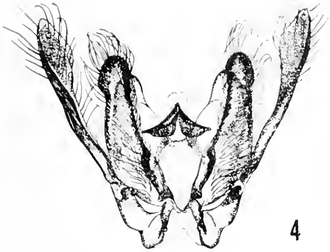
[1] This is the tenth paper by the author (the first as co-author with K. V. Krombein) prepared under National Science Foundation Grants GB 1240 and GB 5171

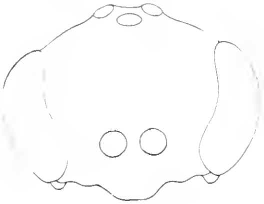
[2] Accepted for publication October 10, 1968.

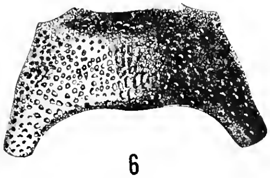
[3] Research Fellow in Entomology, Academy of Natural Sciences of Philadelphia and Collaborator, Entomology Research Division, Agricultural Research Service, United States Department of Agriculture, Moorestown, New Jersey.

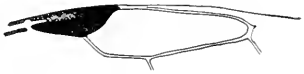
saetae (all new species) have been presented to the U. S. National Museum by the Entomology Department of Oregon State University.











FIGS. 1–4. *Krombeinia hurdi* n. sp., male, from 16 mi W of San Cristobal, Chiapas Mexico. 1, hind basitarsus. 2, left tegula. 3, abdomen showing tufts of hairs on sterna. 4, male genitalia. FIGS. 5–7. *Krombeinia oaxacae* n. sp., male, from 12 mi SE of Oaxaca, Mexico. 5, head outline. 6, dorsal pronotum. 7, section of forewing.

Krombeinia hurdi NEW SPECIES

(Figs. 1, 2, 3, 4)

Diagnosis.—Male. A large species with tegula only slightly longer than wide, which differs from other described species in possessing conspicuous erect tufts of fine hairs on sterna 3, 4, and 5, and fine carinae on inside of hind basitarsus.

Male.—Front with primary punctures of first-degree density to above level of lowest ocellus except band as wide as an ocellus, with scattered secondaries on lower half. Antennal flagellum slender, 1.8 times as long as wide (3 measured were 1.77, 1.82, 1.92), with all joints but first much longer than wide. Cheek slightly wider than an antennal fossa. Head width 1.7 times least distance between eyes (3 measured were 1.7, 1.7, 1.7). Mandible without preapical denticle.

Dorsal pronotum without transverse carina; chiefly shagreened, with closely contiguous primary punctures; impunctate apex very narrow, scarcely one-sixth as long as punctate part. Lateral pronotum with its disc flat and bearing about 10 short, parallel rugulae in ventral corner; without anterior process. Mesopleuron with primary punctures small, and over much of outer disc separated by distances greater than their average diameter; micropunctures everywhere much more numerous than primaries. Hind tibia on inner face with a large, sunken, clavate sensorial area. Hind basitarsus (Fig. 1) on inner face with a thin (sometimes 2 parallel) carinae extending almost entire length of joint. Tegula (Fig. 2) broadly shagreened, orbicular on outer margin, without marginal grooves, 1.1 times as long as middle width. Forewing with infumated membrane; radius 1 contiguous to costal margin for much more than half its length.

Dorsal propodeum outside areola faintly shagreened and finely aciculate, with a low, inconspicuous transverse carina. Areola only slightly tapered, with recurved sides; length about one and one-half times apical width. Tergum 1 with a well-developed transverse carina; punctures very numerous, rather uniformly distributed and not differing in size or distribution from those of tergum 2. Terga 2 to 6 with punctures numerous, of moderate size and fairly uniform in distribution without impunctate areas. Sternum 2 with a strong anterior transverse carina acutely pointed on median line. Sterna 3, 4, and 5 (Fig. 3) each with a median brush of dense, very long, fine, erect hairs. Sternum 6 not furcate apically, with a relatively narrow vitta slightly tapered toward apex, obscurely carinate, without bordering grooves; basally a low transverse carina which terminates laterally in a deep, longitudinally oriented incision. Genitalia (Fig. 4).

Length, 12 to 14.5 mm.

Female.—Unknown.

Holotype.—♂; 16 mi W of San Cristobal de las Casas, Chiapas, Mexico, 6–VII–57 (P. D. Hurd) [UCB].

Paratypes.—1; same data as holotype [UCB]. 1; 35 mi E of San Cristobal, Chiapas, Mexico, 26–VII–57 (J. A. Chemsak & B. J. Rannells) [UCB].

Discussion.—*Krombeinia hurdi* runs in the key (Allen & Krombein, 1964) to *tegularis* in couplet 8.

Krombeinia oaxacae NEW SPECIES

(Figs. 5, 6, 7)

Diagnosis.—Dorsal pronotum and tergum 1 without trace of transverse carina. Sternum 2 with a weak, anterior transverse carina. Sternum 6 with a median triangular carinate vitta terminating in a broad U-shaped transverse carina.

Male.—Front with closely contiguous punctures to above level of lowest ocellus except for a very small area below lowest ocellus; with secondary punctures on less than lower half; without median carina. Antennal flagellum 1.5 times as long as head width (2 measured were 1.55, 1.42). Head (Fig. 5) 2.0 times as wide as least distance between eyes (2 measured were 2.0, 2.0). Cheek slightly wider than an antennal fossa. Mandible with rudimentary preapical denticle.

Dorsal pronotum (Fig. 6) without transverse carina; punctate part with very fine, closely contiguous punctures except in a small medioapical area; impunctate apex scarcely one-eighth length of punctate part. Lateral pronotum puncto-rugulose above, finely rugulose on ventral half, without groove across disc; anterior process low but sharp-crested almost to ventral corner. Mesopleuron with coarse, shallow primary punctures of first-degree density on outer disc; minute secondaries everywhere much more numerous than primaries. Hind tibia with usual sunken clavate sensorial area which is continued basad of middle as a strong ridge terminating near base of joint. Tegula strongly shagreened; 1.35 times as long as middle width; outer margin broadly curved without marginal grooves. Forewing (Fig. 7) with radius 1 distinctly diverging from costal margin on more than half its length.

Dorsal propodeum polished rugulose at sides, near areola strongly reticulate over fine shagreening; transverse carina low, crooked. Areola with recurved sides, concave near apex, not enclosed apically, about one and one-half times as long as apical width. Posterior aspect of propodeum not concave; with median carina on lower two-thirds. Tergum 1 with anterior face normally declivous; with a small median patch of dense minute punctures; without trace of transverse carina; dorsum uniformly set with median-sized punctures except for a preapical band of smaller punctures about 3 punctures wide. Terga 3, 4, and 5 densely set with punctures of moderate and nearly uniform size; hairs of abdominal terga yellow. Sternum 2 with a faint, crooked transverse carina. Sternum 6 notched on side; apex not furcate; vitta at apex with median and lateral carinae, expanded basally into a slender triangle and ending at a broad, U-shaped transverse carina.

Length, 10 mm.

Female.—Unknown.

Holotype.—♂; 12 mi SE of Oaxaca, Hidalgo, Mexico, 22–VIII–63, 5,350 ft. (Scullen & Bolinger) [USNM].

Discussion.—Known only from holotype specimen. This species is exceptional in having no trace of dorsal pronotal carina or transverse carina on tergum 1. This species runs in Allen & Krombein's key to *robusta* in couplet 8.

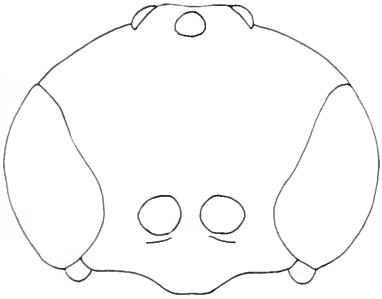
Krombeinia sculleni NEW SPECIES

(Figs. 8, 9, 10)

Diagnosis.—Male. A small, *Tiphia*-like species with two transverse carinae on tergum 1, the posterior one low, crooked, and bordering a broad preapical area of shallow and very irregular punctures of many sizes and shapes.

Male.—Front with punctures chiefly of first-degree density, thinning out at level of lowest ocellus; without secondary punctures. Antennal flagellum slender, all joints except first much longer than wide, 1.5 times as long as head width (4 measured were 1.52, 1.39, 1.56, 1.44). Head (Fig. 8) 2.2 times as wide as least distance between eyes. (5 measured were 2.2, 2.3, 2.2, 2.2, 2.1.) Cheek slightly narrower than an antennal fossa. Mandible without perapical denticle.

Dorsal pronotum with complete, sharp-crested transverse carina, densely punctate except for a narrow lateral and crescent-shaped median impunctate apex, with numerous secondaries laterally. Lateral pronotum usually with a series of obscure rugulae across disc; anterior process low, and rounded except at humeral angle. Mesopleuron with primary punctures on outer disc separated in all directions by much more than their average diameter; minute secondaries much more numerous



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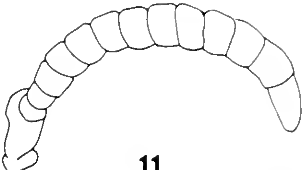

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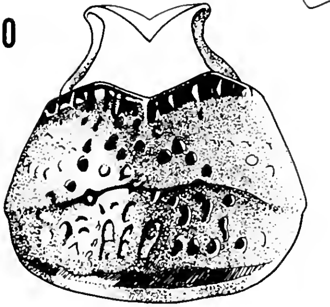

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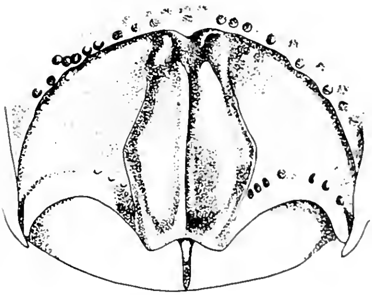

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Figs. 8–9. *Krombeinia scullcni* n. sp., male, from 5 mi SE of Oaxaca, Mexico. 8, head outline. 9, left tegula. Fig. 10. *K. sculleni* n. sp., male from Oaxaca, Mexico, tergum 1. Figs. 11–12. *Neotiphia latirostrata* n. sp., male from 3 mi W of Pachuca, Hidalgo, Mexico. 11, antenna. 12, sternum 6 showing longitudinal and transverse carinae.

than primaries except on ventral aspect. Hind tibia with sensorial area relatively small, clavate, not sunken. Tegula (Fig. 9) orbicular on outside, 1.2 times as long as middle width. Forewing with radius 1 attaining costal margin one-half distance from apex of radial cell.

Dorsal propodeum with transverse carina very high; area beside areola without punctures. Areola rectangular, almost twice as long as wide, with median carina short and buttressing posterior transverse carina. Tergum (Fig. 10) with a high, anterior, transverse carina buttressed by a regular series of short ridges; posterior dorsum on lower two-fifths with coarse, shallow punctures very irregular in size and shape and limited anteriorly by a crooked, transverse ridge. Intermediate terga with numerous, rather fine shallow punctures, more numerous anteriorly and in a row just cephalad of the broad impunctate apices. Pygidium with punctate part bordered by lateral groove and bordering carinae. Sternum 2 without anterior transverse carina. Sternum 6 with its lateral edge moderately notched; its apex broadly furcate; median vitta with low, bordering carinae; without basal transverse carina.

Length, 5.5 to 7 mm.

Female.—Unknown.

Holotype.—♂; Oaxaca, Oaxaca, Mexico, 5,068 ft, 24–VIII–57 (H. A. Scullen) [USNM].

Paratypes.—4: same data as holotype (one lacks a head and another an abdomen) [OreSU]. 3; 3 mi N of Huajuapan de Leon, Oaxaca, Mexico, 8–IX–59 (R. H. & E. M. Painter) [UK]. 1: 5 mi S of Oaxaca, Mexico, 6,150 ft, 21–VIII–63 (Scullen & Bolinger) [OreSU].

Discussion.—This species more closely resembles a *Tiphia* than any *Krombeinia* so far discovered. The polished apical bands of the terga are *Tiphia*-like. However, the male possesses the notched margin of sternum 6, a vitta of sternum 6 bordered by carinae, and a radial cell with radius 1 only gradually sloped from its apex to the costal margin, all distinctive *Krombeinia* characters. *K. sculleni* runs in key (Allen & Krombein, 1964) to couplet 6. In size, it is intermediate between *parva* of 5 mm or less and the species of large or moderate size.

Neotiphia latirostrata NEW SPECIES

(Figs. 11, 12)

Diagnosis.—Male. Flagellum of antenna short, about as long as width of head. Clypeus with a black, broad-tipped clypeal beak. Median depression of sternum 6 terminating basally at a long transverse carina which is not invaginated at middle.

Male.—Front with punctures of first-degree density except for an area below ocellar triangle and about as large where they are of second-degree density; without secondaries; with an obscure, narrow, median carina. Antennal flagellum (Fig. 11) short and stubby, 1.1 times as long as width of head (4 measured were 0.98, 1.09, 1.11, 1.05). Cheek much wider than an antennal fossa. Head width 1.65 times least diameter between eyes (4 measured were 1.68, 1.62, 1.65, 1.65). Clypeus produced in a conspicuous beak with its apex black, about as wide as an antennal fossa, its disc concave, its base much broader than antennal base line; lateral pit exceptionally enlarged, deep, as broad as mandible. Mandible without preapical cusp. Area bordering oral cavity with numerous small secondary punctures but without dense pubescence. Occiputal carina without projections.

Dorsal pronotum with complete transverse carina; punctate part ranging from first- to third-degree density, without secondaries, about as long as impunctate part.

Lateral pronotum with scattered punctures on upper half, obscure rugulae in ventral corner; with a short inconspicuous groove on middle disc; anterior process low with rounded crest. Mesopleuron with coarse punctures everywhere of first-degree density, without interspersed secondaries; with abundant long fine hair. Hind tibia on inner face with usual sunken, clavate sensorial area on distal half. Hind basitarsus 5.5 times as long as middle width. Tegula broader than long with a groove about its apical margin. Forewing with its membrane moderately infuscated.

Dorsal propodeum with a high transverse carina; area beside areola obscurely coarse reticulate. Areola strongly tapered, length slightly greater than basal width and one and one-half times apical width. Tergum 1 with anterior aspect almost perpendicular to dorsum; transverse carina strong with numerous buttressing ridges; dorsum with many medium-sized punctures, on sides of first-degree density. Intermediate terga with medium-sized punctures of fairly uniform distribution; with white hairs. Tip of escutcheon of sternum 1 not spine-like. Sternum 2 without anterior transverse carina. Sternum 6 (Fig. 12) with median depression deep, with strong, narrow median keel, broadly flaired at middle, terminating at a long transverse carina which is not invaginated medially.

Length, 9 to 11.5 mm.

Female.—Unknown.

Holotype.—♂: 3 mi W of Pachuca, Hidalgo, Mexico, 24–VI–53, on pepper tree [UK].

Paratypes.—3; same data as holotype [UK].

Discussion.—*Neotiphia latirostrata* runs in key (Allen & Krombein, 1964) to *barbata* in couplet 4. It appears related to *rostrata* Allen and *barbata* Allen & Krombein. It differs from both in having a broader beak which is black at its tip. It lacks the coarse spines on the occipital carina of *rostrata*, and the abruptly invaginated transverse carina of the sixth sternum found in both *rostrata* and *barbata*.

Neotiphia aurisaetae, NEW SPECIES

Diagnosis.—Female. *Neotiphia aurisaetae* runs in key (Allen & Krombein, 1964) to *waltoni* in couplet 25, from which it differs in lacking a series of pits on lateral pronotum parallel to its posterior margin, in having golden hairs and bristles on dorsal pronotum and abdominal terga, and in having the elevated part of the pygidium acutely pointed and not obtusely rounded at apex.

Female.—Vertex without minute punctures. Front without interspaces wider than an ocellus; median carina very short but high enough to be visible in profile. Dorsum of pronotum with transverse carina weak but complete; punctures everywhere of first-degree density; bristly hairs golden. Side of pronotum with parallel rugulae on more than lower half; without a series of pits parallel to posterior margin. Hind tibia on inside with sensorial area a minute oval pit, its length much less than half width of micropunctate band. Tegula broader than long, posterior edge without a vertical face. Forewing with a flavous membrane. Abdominal terga with golden hairs and bristles, apical rows brilliantly golden. Pygidium with punctate part abruptly elevated on posterior border, its apex extended in an acute point.

Length, 11 mm.

Male.—Unknown.

Holotype.—♀; 15 mi S of Puebla, Puebla, Mexico, 5,200 ft, 6-IX-57 (H. A. Scullen) [USNM].

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The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

The Garden Centiped at London, Ontario.—Two garden centipeds, *Scutigerella immaculata*, were found in May, 1964, one on a hillside and the other in a greenhouse.

During the summer of 1964 a study of terrestrial non-insect arthropods was conducted in the vicinity of London, Ontario, based upon collections made at twenty-six localities. Eleven species of sowbugs were collected and a report on their distribution is given by Judd (1965, Canadian Field-Naturalist, 79(3): 197-202). Twenty species of millipeds were found and are reported on by Judd (1967, loc. cit., 81(3): 189-196). Both these reports include a map showing the twenty-six localities, A to Z, at which the collections were made. The sowbugs and millipeds were found by removing bark from logs and stumps and by turning over logs, boards, stones, piles of trash and other objects on the ground. In and around greenhouses a search was made beneath pots, potting benches and seed flats. Two symphylans were found, one on May 13 beneath sticks on a hillside at locality C which is "The Coves," a plain surrounded by a backwater of the Thames River, and the other on May 25 beneath a stick inside a greenhouse, locality K, on Riverside Drive. They were both identified as the garden centiped, *Scutigerella immaculata* (Newport) by Dr. C. E. Williams, Wabash College, Crawfordsville, Indiana. The specimen collected on May 13 is in the collection of Dr. Williams and that collected on May 25 is mounted on a slide numbered E32.4 in the collection of the Department of Zoology, University of Western Ontario. The finding of only two specimens of *S. immaculata* among the many specimens of sowbugs and millipeds indicates that this species is comparatively rare in the London area. Waterhouse (1967, Canadian Ent., 99(7): 696-702) shows that this species can produce large populations when it infests root crops. Michelbacher (1938, Hilgardia 11(3): 55-148) records that it occurs on all continents but Australia and that it may be present from the surface to as deep as four feet down into the soil and may build up large populations in farming country, doing much damage to crops.—William W. Judd, *Department of Zoology, University of Western Ontario, London, Ontario, Canada.*

A Problem in the Diagnosis of Head Lice[1,3]

Frederick W. Kutz[2]

Each year at the opening of schools in rural areas, it is not uncommon to find several children in elementary grades infested with head lice. Public schools in Rossville, Clinton County, Indiana, were closed on October 5 and 6, 1967, because of reports of a heavy infestation of the head louse, *Pediculus humanus capitis* DeGeer (Phthiraptera: Pediculidae). According to Buxton (1947), rarely do these parasites reach the high levels characteristic of their close relative, the body louse, *Pediculus humanus humanus* L.

During the first few days of October, the school nurse at Rossville discovered several children in the elementary grades infested with mature head lice. As a routine measure, school authorities notified the Clinton County Board of Health. A joint inspection of students and staff by school and board of health officials uncovered no new infestations of mature lice, but found an alarmingly high rate of students and a few staff members infested with objects they believed to be nits, with the highest incidence among senior high school students. Believing that these were louse eggs and that an outbreak of epidemic proportions had developed, board of health officials closed the school.

An inspection station was set up at the school for students; residents of Rossville were also urged to be inspected. Public health nurses conducted the inspections during the first few days of operation and, thereafter, volunteer parents performed this function.

An entomologist from Purdue University visited the inspection station on its second day of operation and encouraged the inspectors to collect and preserve specimens of any stage of this louse for identification. Only two specimens were collected on this date and both were identified as the egg of the head louse.

Over a period of one week, school and public health authorities collected approximately fifty specimens for identification. Examination of these specimens revealed that they were not nits, but minute pieces of human scalp which had been glued around the hair. These closely resembled nits so that magnifications of 40 to 50 × had to be used to distinguish their identity.

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[1] Journal Paper No. 3482 of the Purdue University Agricultural Experiment Station.

[2] Department of Entomology, Purdue University, Lafayette, Indiana 47907

[3] Accepted for publication October 17, 1968.

These pieces of scalp were probably dislodged during shampooing and the glueing agent may have been hair spray or any other of a number of grooming aids on the market today. Barnes and Keh (1959) noted that among objects mistaken for nits have been particles of scabby tissue attached to hairs (probably due to some other scalp condition) and globules of solidified hair net spray.

In addition to mistaking objects in the hair for nits, aphids and psocids were also mistaken for mature lice by some residents of the community. In this particular situation, cold weather was immobilizing large numbers of aphids on trees and some of these aphids would fall from trees landing on heads of people walking or working under them. Also psocid populations build up in the humid summer in closed schools. This resulted in some popular confusion over possible louse-plant relationships.

In summary, a few suggestions are offered to public health officials when faced with a head louse problem.

1. Obtain the services of a competent entomologist at the first signs of an infestation of this insect. Usually, a state university or the state board of health will have an entomologist to assist with the entomological aspects of the problem.

2. Retain all specimens collected for identification. Specimens should be preserved in 70% ethanol.

3. Keep an up-to-date library containing references to aid with insect problems. The literature cited at the end of this paper is very useful.

Two important conclusions can be drawn from this situation: (1) The entomologist must continue to play an important, active part on the public health team, and (2) public health officials must continue to participate in entomological training sessions. These training courses need to be intensified to include not only biology, identification and control of medically important insects, but also the epidemiology and dynamics of insect outbreaks.

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The **December Issue** was mailed January 10, 1969

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REARING MANTISPA VIRIDIS WALKER IN THE LABORATORY (NEUROPTERA, MANTISPIDAE)[1]

John A. Davidson[2, 3]

Few detailed biological observations of the genus *Mantispa* have been recorded in the literature. Brauer (1869), studying *Mantispa styriaca* Poda, was among the first to publish such on the hypermetamorphosis of mantispids. McKeown and Mincham (1948) presented a comprehensive account of the biology of *M. vittata* Guerin in Australia. In contrast to the work reported herein they were unable to rear larvae found in the fall, while larvae found in the spring could be reared. They found egg incubation varied from 16–40 days. Lucchese (1955, 1956) detailed the biology of *M. perla* Pallas along with descriptions of the first instar and adult. Peterson (1951) presented a dorsal view of *M. interrupta* Say without setae. Parfin (1958) gave a host record synopsis for the Mantispidae along with longevity notes including 81 days for one female *M. viridis* Walker.

On 4 October one female *Mantispa viridis* was collected by sweeping at Carderock, Maryland. Although kept in a glass vial at room temperature with neither food nor water she produced 528 stalked eggs six days later. Of this total 46 eggs never showed signs of embryonic development, 28 developed embryos which failed to hatch, and 453 eclosed 10 days later: an 86% hatch. For several hours following eclosion the majority of the first instar larvae remained motionless among the cluster of eggs. No instances of egg destruction or canabalism were noted in this stage.

Rearing was begun with 24 first instar *M. viridis* larvae (Fig. 3) which were placed in glass covered microsyracuse dishes to which food was added as needed. Before feeding began they were extremely active in their search for food. After feeding began they became highly distended and soon mobility was lost allowing easy manipulation. Two cases of canabalism were noted, shortly after the appearance of the second instars. Thereafter each larva was reared separately.

The first food presented consisted of spider eggs removed from the egg case of a species of Theridiidae. Although well developed spiderlings could be seen within the choria, the first instar larvae soon attached themselves and began feeding. Each larva first penetrated the egg chorion and then

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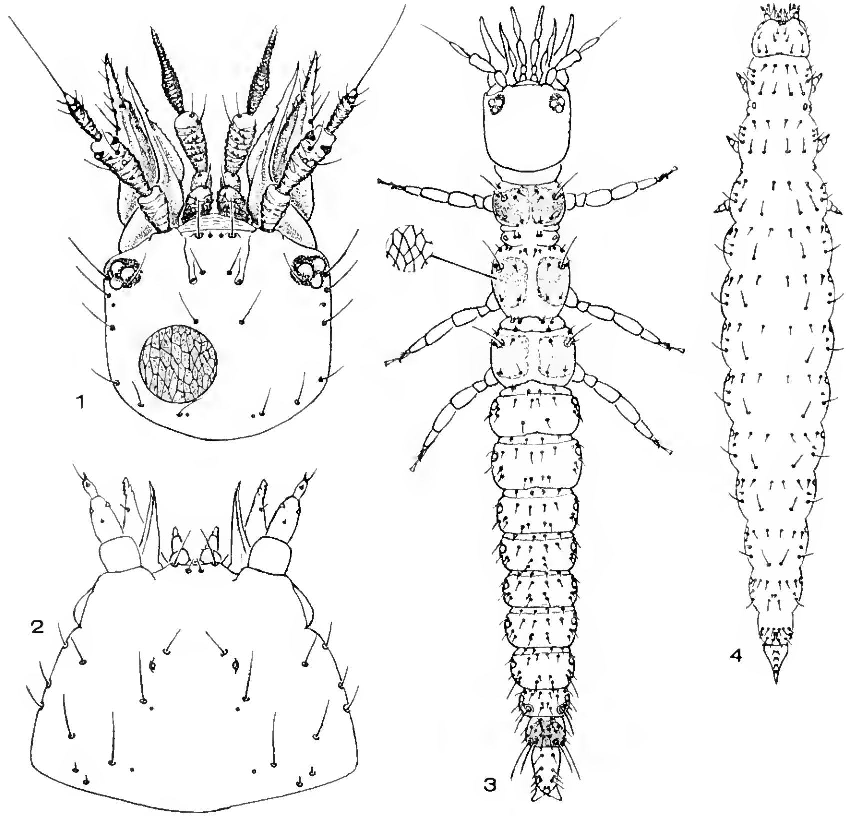
[1] Scientific Article No. A1481, Contribution No. 4119, of the Maryland Agricultural Experiment Station, Department of Entomology.

[2] Department of Entomology, University of Maryland, College Park, Maryland 20742.

[3] I wish to thank Mr. F. E. Wood and Mr. D. O. Cordts for providing spider eggs and Dr. E. G. MacLeod for his suggestions concerning the foreign literature.

the abdomen of the spiderling. Each larva remained attached for one or more hours until all available body fluids had been sucked from the unborn host. At the end of the first instar each larva was distended approximately three times its original size.



FIGS. 1–4. *Mantispa viridis* Walker: 1, dorsal view of first instar head; 2, dorsal view of second instar head; 3, dorsal view of first instar larva; 4, dorsal view of fourth instar larva.

Second instar larvae (Fig. 4) appeared six days after eclosion. There was a notable reduction in the length of the head and its appendages, particularly the labial palps, between the first instar (Fig. 1) and the second instar (Fig. 2). In addition the eyes and sclerotized areas were lost and the legs much reduced. The body of the second instar was also much thicker and ended in a point. The second instar larvae were fed eggs of the long-bodied cellar spider, *Pholcus phalangioides* (Fuesslin), Pholcidae.

Third instar larvae resemble second instar larvae in general appearance. Pupation occurs within the exuvium of the third instar which is shed in fragments. Third instar larvae were also fed spider eggs (*P. phalangioides*) but not enough eggs were available to satisfy the requirements of the mantispid larvae. A search was begun for a substitute food.

The third instar larvae remained unfed for four days following their last feeding of spider eggs. On the fifth day each larva was given a second instar cabbage looper which had been reared on artificial media. It was necessary to crush the looper's head to render it motionless. While the mantispids probed the looper larvae with their mouthparts, they appeared unable to penetrate the cuticle. Therefore each looper was pierced with a probe and the wound presented to a mantispid larva. Feeding began immediately and continued for two or more hours until the loopers appeared dehydrated. Two days later loopers were again fed to the mantispids in the same manner.

The major drawback of this procedure lies in the fact that escaping body fluids dry and tend to cement the looper to the head of the mantispid larva. The looper must then be carefully cut away from the mantispid.

Shortly after the second feeding of loopers the mantispids began cocoon spinning, with the pure white silk issuing from the anus. At this time the head and thoracic regions of the larvae appeared greatly enlarged. The flimsy cocoons were all completed in less than six hours. The cocoons were then removed so that pupation could be observed. Eight pupae were produced from the original 24 larvae but only three adults emerged. It is believed dehydration caused the death of the remaining pupae.

The average life cycle in the laboratory at room temperature from egg to adult required 50 days and may be summarized as follows:

Incubation period, 10 days; first instar, 5–7 days; second instar, 5–9 days; third instar, 11–13 days; pupal period, 15 days.

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Treehoppers of Certain Mississippi River Islands (Homoptera, Membracidae)[1]

Clifford J. Dennis[2]

During 1968 a study was made to determine the treehopper species, their hosts and seasonal incidences on the islands of the Mississippi River between miles 621 and 623 on the Corps of Engineers Navigation Chart. This is eight to ten miles below the point where the Wisconsin River flows into the Mississippi. The work was supported in part by a research grant from the Board of Regents of Wisconsin State Universities. To the Board and to my wife, Maxine, who aided in collections I wish to express my appreciation.

The precise number of islands varied somewhat, depending on water level, but for most of 1968 these numbered 52. They range in size from about six by three feet to slightly over a mile in length by about one-sixteenth of a mile in width. Most are rather long, slender and of alluvial formation. All of them are low-lying and subject to periodic flooding. The usual spring flood did not occur in 1968. However, there was an atypical moderate flooding during late June and the first half of July.

Considering the islands as a whole, the dominant tree species are silver maple and American elm. However, the conditions described by Curtis (1959) with reference to the wet segment of Wisconsin southern lowland forests prevail: "The average values in Table VIII—1 tend to obscure the fact that several different combinations of species are included within the wet segment. On pioneer sites along sand bars, mud flats, and other open places of recent soil disturbance near the water's edge, the usual forest is dominated by black willow (*Salix nigra*) and cottonwood (*Populus deltoides*). On open sites near the upland edge of the wet ground, river birch and swamp white oak (*Quercus bicolor*) are the usual dominants. As both of these types mature, they are invaded by silver maple (*Acer saccharinum*) and American elm (*Ulmus americana*), thus accounting for the high values attained by these species in the averages." The shrubs are few, but there is a growth of lianas, principally poison ivy, woodbine and grape. Poison ivy in its low-lying form is the prevalent ground cover over many of the islands, particularly those which have progressed beyond the black willow–cottonwood stage.

Weekly observations and collections were made from mid-May through September and twice in October. Records were obtained by direct observa-

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[1] Accepted for publication October 26, 1968.

[2] Wisconsin State University, Whitewater, Wisconsin 53190.

tion, by collecting from a boat with a net at the end of fifteen foot pole and by net while walkng on the islands. (Yes, I fell out of the boat once.)

Of the 52 islands, 17 yielded treehoppers, all of which were collected from swamp white oak only. Adult *Cyrtolobus discoidalis* (Emmons) and *C. maculifrontis* (Emmons) were found throughout June; *C. helena* Woodruff and *C. querci* (Fitch) throughout June and early July; *C. pallidifrontis* (Emmons) throughout June, July and early August. One adult specimen of *Xantholobus muticus* (Fabricius) was collected on June 23. A single nymph of *Telamona* Fitch *sp.* was found on July 28. In both Wisconsin (Dennis and Dicke, 1953) and Oklahoma (Dennis, 1963) males of *Cyrtolobus* and *Xantholobus* were found on the same trees as the females. However, while all species known from these islands are represented by females, only *C. helena* Woodruff and *C. pallidifrontis* (Emmons) also included males.

The seven kinds of treehoppers known to inhabit these islands compare with the 45 species I have found on adjacent bluffs and farmlands in Wisconsin. Plants such as red oak, bitternut hickory, American elm, basswood, haw, stinging nettle, woodbine and grape which have produced adult treehoppers in mainland areas are growing on the islands but are devoid of membracids. The only nymphs noted were those of *Cyrtolobus sp.* and the one telamon, all of which were found on swamp white oak only; none were noted on groundlayer herbaceous plants. Since some treehoppers utilize herbaceous hosts as nymphs and trees as adults it would appear that only those which may inhabit swamp white oak as both nymphs and adults are present.

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Life History, Habitat, and Taxonomic Characters of the Larva of Mochlonyx fuliginosus [1, 2]

Robert W. Lake [3, 4]

Cook (1956) describes three species of *Mochlonyx* in the Nearctic area: *Mochlonyx cinctipes* (Coquillett), *M. fuliginosus* (Felt) and *M. velutinus* (Ruthe). The adults are mosquito-like in appearance with short mouthparts. They are not known to bite, hence they and other members of the Chaoboridae have often been called non-biting mosquitoes. The larvae are predaceous to some degree upon mosquito larvae, as well as other aquatic life such as cladocerans, ostracods, copepods and protozoa. Investigations by O'Connor (1959) in Ohio on *M. cinctipes* and James (1957) in Ontario on *M. velutinus* indicated that larvae of these species were not very efficient in reducing the population of pest mosquito larvae in their respective study areas.

M. fuliginosus (Felt, 1905) was first described from a single female collected at Nassau, New York. The male was later described by Dyar and Shannon (1924). To date no detailed description of the larva or pupa has been published. *M. fuliginosus* is apparently very rare in collections but this may be due, in part, to the lack of information about the biology and habitat of the species. Available records of collections indicate the following distribution in North America: New Jersey, New York, Rhode Island, Massachusetts, Quebec and Ontario. The author's observations on this species were made in Passaic County, New Jersey and Bristol County, Massachusetts.

Habitat.—The collecting and observation site for this species in Passaic County, New Jersey was a cold, sphagnum bog, heavily shaded by hemlock (*Tsuga canadensis* (L.) Carr), white pine (*Pinus strobus* L.) and rhododendron (*Rhododendron maximum* L.). Many hummocks were present on which blueberry (*Vaccinium* sp.) and swamp laurel (*Kalmia polifolia* Wang.) predominated. In Massachusetts, blueberry swamps and white cedar (*Chamaecyparis thyoides* (L.) BSP.) swamps proved to be the preferred habitat. These swamps generally had a dense cover of sphagnum

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[2] Diptera, Chaoboridae. The present paper follows the usage by Stone (1956) of according family rank to the group of insects formerly limited to the subfamily Chaoborinae of the Culicidae.

[3] Research Associate, Department of Entomology and Applied Ecology, University of Delaware.

[4] Accepted for publication June 5, 1968.

moss (*Sphagnum* spp.) and were interspersed with small hummocks. In one instance a pool produced by the overflow of a small stream and partly protected by a large rock, contained a number of larvae and pupae. This pool was shaded by a dense growth of Alder (Alnus sp.).

Life Cycle.—Egg: No eggs were seen or collected during these observations but it is probable, that the overwintering eggs, are oviposited in the leaf litter and debris of dry swamps and bogs similar to those of other *Mochlonyx* species (James, 1957, O'Connor, 1959).

Larva: During May and June, *M. fuliginosus* larvae are often associated with *M. cinctipes* and *M. velutinus* but unlike these two species it is multivoltine, a number of generations being present throughout the summer and fall. In the two areas studied *Mochlonyx* larvae collected after the middle of June were almost certain to be *M. fuliginosus*. Larvae have been collected in all months from May to December. Earliest collections were made on May 23 and the latest on December 1.

The greatest number of larvae and pupae were collected in dark protected holes under hummocks present in the bog or swamp habitat. *Culiseta melanura* (Coquillet) also prefers such an environment and was present in many of the *M. fuliginosus* collections. In the laboratory *M. fuliginosus* larvae readily feed on *C. melanura* larvae and undoubtedly, in nature, first and second instar *C. melanura* larvae are consumed. Cannibalism was noted on one occasion with specimens confined in a small jar.

In addition to *C. melanura* larvae, other mosquito larvae found associated with *M. fuliginosus* were *Culex territans* Walker, *Aedes c. canadensis* (Theobald) and *Culiseta morsitans dyari* (Coquillett).

Pupa: The pupa, unlike pupae of the closely related Culicidae, remains below the water surface until eclosion is imminent. The length of pupal period in specimens reared in the laboratory was three or four days.

Adult: Adults were observed adjacent to the breeding holes. They were often flushed from dark recesses under roots and stones in close proximity to the emergence sites. On one occasion, viz. December 1, 1955 in Passaic County, New Jersey, a female was observed emerging from a pupa at the water's surface. The temperature of the water at this time was close to the freezing point.

Taxonomic Notes.—Edwards (1930) first synonomized *M. martinii* with the species Martini (1929) described as *M. velutinus* (Ruthe) and stated his reasons as follows: "I consider that a new name should be given to the species described by Martini as *M. velutinus* because Ruthe's description appears to fit the common *M. culiciformis* better and because the British Museum possesses German specimens named by Ruthe himself which are certainly *M. culiciformis*." Cook (1956) suggested that the

European *M. martinii* (Edwards) was possibly synonymous with *M. fuligosus* (Felt). Freeman (1962) confirmed this claim by examination of British and Finnish material of *M. martinii* and by comparing adults with figures and descriptions of American specimens and stated "*M. fuliginosus* now has a Holarctic distribution." The author has also examined larvae and pupae labeled *M. martinii* from Abisko, Sweden in the British Museum collection and found that these stages agree very closely with American specimens of *M. fuliginosus* and descriptions and figures of Martini (1929) and further substantiates the synonymy.

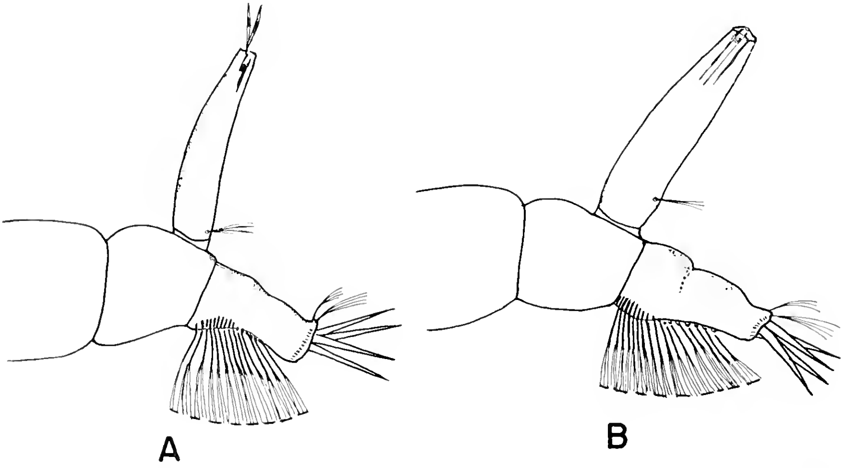

FIG. 1. Terminal segments of larvae of *Mochlonyx*: A. *Mochlonyx fuliginosus* showing paired structures at distal end of siphon. B. *Mochlonyx cinctipes.*

Description of Larva: Martini (1929) provides a very brief description and figures the head and its appendages as well as the end of the siphon of *M. velutinus* (= *M. fuliginosus*). He states that the breathing tube has a pair of feathered hairs at the end. Specimens of *M. fuliginosus* examined by the author had paired structures at the distal end of the siphon but these were solid in character and never appeared as feathered hairs. Third and fourth instar larvae of *M. fuliginosus* can be separated readily from *M. cinctipes* and *M. velutinus* by the shape of the siphon and the presence of the paired structures at the distal end of the siphon (Fig. 1). The second instar of *M. fuliginosus* can also be separated from these other species by the paired structures at the end of the siphon, but the siphon is shorter and stouter similar to *M. cinctipes* and *M. velutinus* and is not a good separating diagnostic character in this stage.

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The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

The Salt Marsh Habitat: A special project of the Pacific Coast Entomological Society, was begun at a meeting in 1967 following a lecture on the ecology of the mud flat–salt marsh habitat. A number of the members expressed concern regarding the rapid disappearance of this habitat due to commercial development. Subsequently, a salt marsh habitat committee was appointed to stimulate studies in central California. The Society is now sponsoring publication of notes and observations on salt marsh insects (and other terrestrial arthropods) for publications in the Pan-Pacific Entomologist. Articles should be submitted to the editor of the Journal, California Academy of Sciences, San Francisco, California 94118. An annoted bibliography of California species of salt marsh insects will appear in Volume 44, No. 4, 1968. It is our hope that entomological societies in other geographic locations will undertake a similar interest and sponsorship of articles on the salt marsh habitat.—Joel F. Gustafson, Professor of Ecology and Systematics, San Francisco State College, Chairman, Salt Marsh Habitat Committee, Pacific Coast Entomological Society.

(Continued on p. 43)

Revisionary Conspectus of Neogeophilidae with Thoughts on a Phylogeny[1,2]

R. E. Crabill, Jr.[3,4]

The most distinctive and phylogenetically revealing structures of the Neogeophilidae are, I believe, their absolutely unique first maxillae, their filamentous second maxillary claws, and their pedal fibulungues.[5]

The neogeophilid first maxillae are unique among those of all Geophilomorpha, for in no other family are medial lobes suppressed, and only in the unrelated Mecistocephalidae is the coxosternum cleft in exactly the same manner. (The coxosternal cleavage must have developed independently in the two taxa.) As useful as the neogeophilid first maxillae are for defining the family, they fail to disclose affinity with any other group.[6]

Fibulungues occur uncommonly within the Order, so far as I know, only in *Bothriogaster* (Himantariidae), in *Eucratonyx* and *Sogophagus* (Gonibregmatidae, *s.l.*), and in all Neogeophilidae. They are of three types: (1) both anterior and posterior parungues are hypertrophied, without plantar tooth (*Bothriogaster*); (2) only the anterior parungues are hypertrophied, without plantar tooth (*Eucratonyx* and *Sogophagus*); (3) only the anterior parungues are hypertrophied, with plantar tooth (Neogeophilidae). Considering their structure, it is tempting to suppose that they have arisen independently at least twice, once in the himantariids and again in ancestors common to the neogeophilids and to *Eucratonyx*-*Sogophagus*.

The evident kinship linking the neogeophilids with certain gonibregmatids is furthermore compellingly reflected in what I take to be the most

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[2] Chilopoda, Geophilomorpha, Neogeophilidae.

[3] United States National Museum, Smithsonian Institution, Washington, D. C. 20560.

[4] Undertaken with aid of a grant from the National Science Foundation. I am indebted to Dr. G. Owen Evans for his kindness in permitting me to study specimens in the British Museum (Natural History). I should also like to thank Dr. G. E. Ball and Mr. D. R. Whitehead of the University of Alberta, Dr. W. T. Keeton of Cornell University, and Dr. B. D. Valentine of The Ohio State University. Their unstinting efforts over the years have provided me with the bulk of the material that I have seen.

[5] Fibulunguis (-gues) = fibula + unguis. A new term to describe those pretarsi which by virtue of their enormously hypertrophied, remarkably modified parungues and massive decumbent ungues have become clasplike hold-fast or anchoring devices.

[6] Silvestri in 1919, p. 100, fig. 25(3) erred in showing the first maxillary coxosternum of *Himantosoma typicum* Pocock as being midlongitudinally cleft. It is cleft neither in the British Museum type, which I have studied, nor in any other *Himantosoma* specimens that I have examined.

revealing, though subtle, characteristic of all, their common possession of *filamentous* second maxillary claws.

This and other evidence suggest to me that although the Neogeophilidae and Gonibregmatidae are not obviously closely allied (as are, for instance, the Himantariidae and Schendylidae), they are more closely related to each other than either is to any other extant taxon.

For a fuller, though less conclusive, discussion the reader is referred to my 1961 study, pp. 182–187.

At this time I consider the family to be divisible into two genera and four species, all from Mexico and Guatemala. All are summarized below; a key to the genera and species is presented; a new *Neogeophilus* is described.

Evallogeophilus Silvestri

Evallogeophilus Silvestri, 1917, p. 355.

Diagnostic features: (1) Ultimate pretergite in effect absent, i.e., indistinguishably amalgamated with its tergite. (2) Female pregenital and genital sternites indistinguishably amalgamated without intervening demarcation. (3) At least eight subultimate sternites indistinguishably amalgamated with their subcoxae. (4) Prominent prosternal denticles present. (5) Two or three subultimate sternites with numerous scattered pores (but without formed pore*fields*).

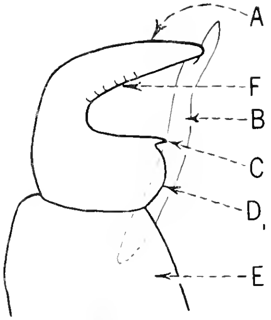
Known species: *E. mexicanus* Silvestri, 1917, p. 357. Mexico, Veracruz: Jalapa Enriquez. Oaxaca: 22.2 miles south of Tuchatengo at 5,800′; 5.4 miles south of Suchixtopec at 8,100′.

Neogeophilus Silvestri

Neogeophilus Silvestri, 1917, p. 352.
Cryptostrigla Crabill, 1961, p. 156. (New Synonymy.)

Diagnostic features: (1) Ultimate pretergite and tergite separate, not amalgamated, the former plainly distinguishable. (2) Female pregenital and genital sternites separate, their intervening demarcation plainly evident. (3) All sternites separate from their subcoxae. (4) Prosternal denticles present or absent. (5) Sternital pores absent.

Remarks. When I proposed *Cryptostrigla*, I relied heavily upon Silvestri's 1917 text and figures, for I had no direct knowledge of *Evallogeophilus*, and I had never seen a specimen of *N. primus*. Now having seen material representing all taxa, and particularly impressed with the distinctiveness of *Evallogeophilus*, I feel that better balance is achieved by submerging my genus beneath *Neogeophilus*.



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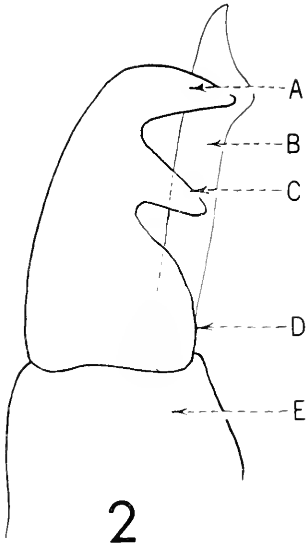

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FIG. 1. *Neogeophilus ixion*, paratype. 11th right pretarsus, posterior aspect. A = claw proper. B = hypertrophied anterior parunguis. C = ventral tooth. D = fundus. E = tarsus. F = striations (absent on *N. primus*).

FIG. 2. *Neogeophilus primus* Silvestri. 11th right pretarsus, posterior aspect. A = claw proper. B = hypertrophied anterior parunguis. C = ventral tooth. D = fundus. E = tarsus.

Known species: *N. primus* Silvestri, 1917, p. 354, Mexico, Morelos: Cuernavaca. San Luis Potosi: 2.7 miles west of Santa Catarina at 3,500′. Tamaulipas: 83.2 miles north of Manuel at 500′; 2.8 miles south of Ciudad Victoria. Oaxaca: 21.8 miles north of Tuchatengo.

N. silvestri (Crabill), 1961, p. 177, Guatemala, Alta Verapaz: Semococh. Mexico, San Luis Potosi: 3.6 miles west of El Naranjo at 1200′. Tamaulipas: 20.6 miles east of Villa de Casas. Veracruz: Vulcan San Martin north of San Andres Tuxtla.

N. ixion, new species, q.v.

The new species presented below is clearly most like *silvestri* (Crabill) but differs strikingly from it in the nature of the fibulunguis. In *silvestri* the ventral or plantar tooth is very large and located upon the unguis, not upon the fundus; in *ixion* the ventral tooth is much smaller and is situated upon the fundus, not upon the unguis.

Neogeophilus ixion,[7] new species

Holotype: female. Mexico, Veracruz: north of San Andres Tuxtla, on slope of Vulcan San Martin at 3,300′–3,500′. July 20–August 1, 1959. W. T. Keeton and B. D. Valentine, legg.

[7] In mythology a Thessalonian king celebrated for sin and murder.

GENERAL. Length, about 33 mm. Pedal segments, 75. Body shape: dorsoventrally notably flattened; width essentially uniform. Color, pale yellowish white. ANTENNAE. Short, length to head length, 19:7; dorsoventrally slightly flattened, distally not notably attenuate; articles 2–5 slightly longer than wide, articles 6–13 slightly wider than long, submoniliform. Article 14 with an ectal and a mesal patch of short, flat special setae, these situated slightly distal to midlength. CEPHALIC PLATE. Wider than long, 8:7. Anteriorly pointed; sides strongly excurved; rear straight. Frontal suture absent. CLYPEUS. Much wider than long. Paraclypeal sutures oblique, straight, meeting labral fulcra at their extreme mesal ends. Anterior fenestra and posterior plagulae absent. Anteriorly with some 20 short setae, posteriorly glabrous. LABRUM. Consisting of one undivided hyaline piece, armed posteriorly with short, delicate, hyaline filaments. Fulcra short, transverse, not oblique. FIRST MAXILLAE. Coxosternum completely divided medially, lappets absent. Discrete medial lobes absent. Telopodites without lappets. SECOND MAXILLAE. Isthmus anteroposteriorly shallow, transversely wide; areolate, not suturate, not divided. Postmaxillary sclerites absent. Statuminia absent. Telopodite: of three discrete parts; dorsal and ventral basal condyles absent; apical claw with a few minute terminal and mesal bristles.

PREHENSORS. Flexed, not surpassing anterior head margin. Denticles absent. Tarsungula: only slightly curved; dorsoventrally strongly flattened, bladelike; posterior edge deeply dissected forming about 16 coarsely regular serrations. Poison apparatus: calyx in upper trochanteroprefemur, subcordiform; gland terminating dorsal to prosternum. PROSTERNUM. Broad. Pleuroprosternal sutures strongly oblique, complete, teminating dorsolaterally. Pleurograms concursive with pleuroprosternal sutures, not extending to or toward condyles, hence in effect absent. Anterocentral condyles present.

PLEURITES. Spiracles weakly horizontally elliptical. Paratergites absent. LEGS. The first slightly shorter than the second. All including the more posterior notably robust and short. PRETARSI. Each fundamentally consisting of a basal fundus and an emergent unguis flanked by two parungues. Ungues: on most anterior legs only slightly curved, thereafter becoming very strongly bent, thereafter becoming slightly curved again; each fundus ventrally with a small tooth; each ventrally shortly and minutely serrate. Posterior parungues: minute and present on all ungues. Anterior parungues: on most anterior legs nearly as long as ungues, thin, spiniform; on legs of middle body longer than ungues, distally expanded, flat, hyaline; on rear legs as on most anterior legs, very long and spiniform. STERNITES. All slightly wider than long. Sulci, sutures, depressions, *carpophagus*-structures, single pores and porefields absent. Setae sparse and short. Intersternites: on anterior body medially divided; on posterior body larger and undivided.

ULTIMATE PEDAL SEGMENT. Pretergite and tergite discrete; unfused, pretergital lateroposterior corners angularly extended; laterally not fissate. Tergite: longer than wide, sides weakly convergent, rear pointed obtusely. Presternite and sternite discrete, unfused. Sternite: wider than long, sides subparallel, posterolateral corners extended. Coxopleuron: moderately inflated; ventrally, laterally, and dorsally pierced with numerous freely-opening pores; setae short and sparse. Telopodite: thinner and much longer than penult; with two discrete (unfused) tarsalia, these equal; pretarsus absent.

POSTPEDAL SEGMENTS. Pregenital and genital sternites discrete, unfused. Genopods only basally adnate, otherwise separated, each uniarticular. Anal pores present, simple, not composite.

Paratype A. Same locality and date as holotype.

Paratype B. Veracruz: San Andres Mountains, 2.5 km west of Sontrecompan at 0–100′. September 18–21, 1965. G. E. Ball and D. R. Whitehead, legg.

Both paratypes are males: A, 77 leg pairs, 28 mm; B, 75 leg pairs, 30 mm. They are in substantial agreement with the holotype, except for the following secondary sexual features. The male coxopleura are posteromesally slightly extended. The gonopods are widely separated, nowhere adnate, and prominently biarticular. The ultimate legs are longer and much more swollen than those of the female, and the male tarsalia are manifest as two entirely discrete, unfused articles.

KEY TO KNOWN NEOGEOPHILIDAE

1a. Ultimate pretergite entirely amalgamated with its tergite. Pregenital and genital sternites of female amalgamated without trace of demarcation. On at least six subultimate segments in both sexes the sternites entirely amalgamated with the subcoxae without trace of demarcation............................... ....*Evallogeophilus* Silvestri......*E. mexicanus* Silvestri

1b. Ultimate pretergite discernible, i.e., not amalgamated with its tergite. Female pregenital and genital sternites separated and individually discernible. All sternites clearly separate from subcoxae, their intervening margins clearly discernible................. ....*Neogeophilus* Silvestri......2

2a. Prosternal denticles entirely absent. Ungular serrations essentially absent. Pretarsal ventral teeth large and well removed from the fundus..............................*N. primus* Silvestri

2b. Prosternal denticles present. Ungular serrations clearly present, coarse 3
3a. Pretarsal ventral teeth large and well removed from the fundus . . . . N. *silvestri* (Crabill)
3b. Pretarsal ventral teeth very small, located upon the fundus . . . . N. *ixion* sp. n.

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(ENTOMOLOGIST'S RECORD, continued from p. 37)

Recent Gifts to the Cornell University Insect Collection: During the past 18 months, three rather substantial insect collections have been added to the Cornell University collection.

In October 1967, Dr. Mortimer D. Leonard of Washington, D. C., presented Cornell with his entire collection of Aphididae (Homoptera). This collection of nearly 17,000 slides, representing about 500 species was the result of a life time interest in the group. A number of papers by Dr. Leonard are based on this collection. Since the aphid collection at Cornell, previous to Dr. Leonard's gift, consisted largely of material assembled by the late Miss Grace H. Griswold, the Cornell collection of aphids has been designated, "The Griswold-Leonard Collection of Aphididae."

Dr. W. Wayne Boyle, recently of the Pennsylvania State University, gave his collection of exotic Erotylidae (Coleoptera) to Cornell in November 1967. The nearly 3,000 specimens comprising this collection are beautifully mounted and in superb condition. Only a portion of the specimens are determined and it is anticipated that the collection will serve as a fertile source of material for workers engaged in revisional studies of this family.

In September 1968, Mr. Roy Latham of Orient, New York, turned over to Cornell his entire collection of insects which he had built up over a period of approximately 60 years. No complete inventory has been made but the collection was housed in the equivalent of 325 Schmitt boxes. All the insects are from eastern Long Island and probably represent the largest single collection of specimens from this area. All orders found on Long Island are represented and most of the specimens have been determined by authorities in the various groups. A cursory examination of this collection indicates that it contains a number of species not previously known to occur in New York. —L. L. PECHUMAN, Department of Entomology, Cornell University, Ithaca, N. Y. 14850.

(Continued on p. 53)

Revision of the Termitophilous Subfamily Trichopseniinae (Coleoptera, Staphylinidae)

I. The genus *Schizelythron* Kemner [1, 2]

David H. Kistner [3]

The subfamily Trichopseniinae was proposed by Seevers (1941) to include what was then a small group (6 genera and 7 species) of termitophilous Staphylinidae with rather remarkably modified bodies. Although various authors thought they were related to Tachyporinae, Aleocharinae, Paederinae, and Staphylininae at various times, Seevers held that they were rather isolated from all other subfamilies and placed them by themselves. Presently the subfamily contains 9 genera and 17 species, and new ones will doubtless increase our understanding of the group.

On a recent collecting trip to the Orient, Professor A. E. Emerson, University of Chicago, and his wife collected some new species of this subfamily. To describe each one of these, it will probably be necessary to revise the rest. This paper then is the beginning of this series of revisions. So far as I know, Emerson's capture of 3 species of *Schizelythron* represents the first recapture of the genus since the original specimens were captured by Kemner in 1920.

GENUS **SCHIZELYTHRON** KEMNER

Schizelythron Kemner, 1925: 110; Seevers, 1957: 280

Type Species: *Schizelythron javanicum* Kemner (Blackwelder 1952: 345).

A highly distinctive genus that has no very close relatives and is easily distinguished from all the other genera of the subfamily by its split and physogastric elytra. It appears most closely related to *Rhinotermitopsenius* Seevers through the leg structure and the long metasternum but it is hoped that closer relatives may be captured in the future. *Rhinotermitopsenius* also shows some evidence of the expansion of the apical portion of the elytra but is definitely a more primitive genus and immediately distinguishable by its facies from *Schizelythron*.

Overall appearance as in Figs. 21–26. Head capsule more or less oval in shape (Fig. 2). Dorsal appearance of the head capsule without distinction. Antennae in-

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[1] This study was financed in part by the National Science Foundation (Grant No. GB-6284).

[2] Accepted for publication July 9, 1968.

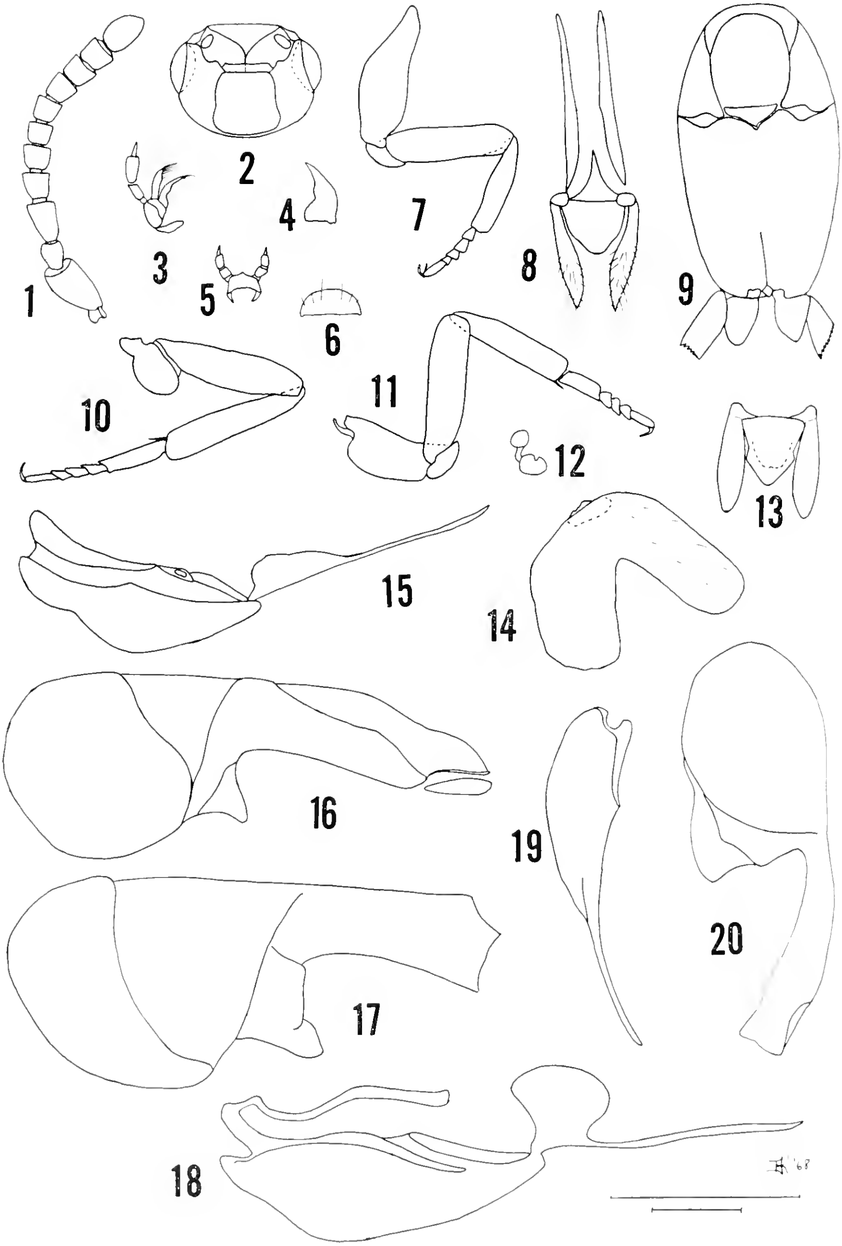
[3] The Shinner Institute for the Study of Interrelated Insects, Department of Biology, Chico State College, Chico, California 95926.

serted at the corners of the vertex medial to the eyes. Anterior arms of the tentorium insert slightly anterior and medial to the antennal insertion. Antennae 11-segmented, shaped as in Fig. 1, apparently constant in shape for the entire genus. Ventral features of the head capsule shown in Fig. 2, with the gula reduced to a very small sclerite and the foramen magnum greatly enlarged. The head is attached by a large membrane to the thorax which is filled with expanded tissue. Thus the head can be said to be physogastric. The first, second, and last segments of the antennae also appear to contain expanded tissue. Mandibles very small, with only a vestige of a median tooth, shaped as in Fig. 4. Maxillae shaped as in Fig. 3, palpi 4-segmented. Labium shaped as in Fig. 5, palpi 3-segmented. Labrum simple and semicircular in shape as in Fig. 6. Eyes present and well developed, oval in lateral outline.

Pronotum shape variable by species but always expanded posteriorly with a heavily sclerotized extension (see Fig. 21). Dorsal surface characteristics also variable by species. Prosternum greatly reduced in size and evenly rounded medially. Mesothoracic peritremes entirely membranous except for a small sclerotized circle about each spiracle. Prothoracic coxal cavities closed behind by narrow pieces of the prosternum. The prothorax is connected to the meso- and metathorax by enlarged membranes containing expanded tissue, thus the thorax can also be said to be physogastric.

Mesothorax greatly reduced such that the basisternum is reduced to a very small subtriangular sclerite which together with the epimera and the metasternum closes the mesothoracic coxal cavities (see Fig. 9). The space where the basisternum should be provides a large expansion of the anterior mesothoracic foramen which connects by expanded membrane to the prothorax. Metasternum extremely long with the peculiar coxal articulation processes characteristic of the subfamily (Fig. 9). Elytra shape variable by species but always with a deep cleft. Instead of being flat, they are lobe-like in appearance with expanded tissue in the center. Each seta on the elytra is surrounded by a hyaline area (Fig. 14), and there appear to be pores in these regions to the exterior of the elytron. Legs are all relatively long. Prothoracic leg shaped as in Fig. 7. Mesothoracic leg shaped as in Fig. 11. Metathoracic leg shaped as in Fig. 10; note the complete absence of the coxa, articulation is achieved through the use of the large condyle of the trochanter. This codyle bears a faint fusion line and may be homologous to the coxa. Tarsal formula 5–5–5.

This description of the abdomen applies only to fully mature physogastric specimens. Overall abdominal shape as in Figs. 21–26. Tergite II modified into half-ring shaped sclerite that is practically in a vertical position due to expansion of the membrane and the tergites behind it. Tergite III greatly enlarged but separated by membrane from sternite III. Tergite IV greatly enlarged but smaller than tergite III; whether it fuses with sternite IV or not is variable by species. Tergites V–VII progressively smaller than IV but fuse with their corresponding sternites. Tergite VIII generalized with no modification. Segment IX greatly modified with long valvulae in both the male and female and with extremely long anterior apodemes in the male which are absent in the female (Figs. 8 and 13). There are no paratergites and the abdominal spiracles are very small. Sternite III is basically ring-shaped but has extensive secondary sclerotization which may articulate to tergite II but does not articulate with tergite III. Sternites IV with secondary sclerotization which may articulate with tergite IV or not depending on the species. Sternites IV–VII all with secondary sclerotization which fuses laterally to tergites V–VII. Membranes between segments II–VII extremely enlarged and filled with tissue, hence the abdomen also



Figs. 1–20.

is physogastric. Male genitalia bulbous, shape variable by species. Spermatheca present and sclerotized but apparently not variable in the 2 species where it is known.

KEY TO SPECIES

1\. Maximum length of the outer part of the elytron more than 1.5 × the maximum length of the inner part 2
Maximum length of the outer part of the elytron less than 1.5 × the maximum length of the inner part 3
2\. Lateral lobe of male genitalia shaped as in Fig. 15; median lobe of the male genitalia shaped as in Fig. 16 .... **S. eleanorae** n. sp.
Lateral lobe of male genitalia shaped as in Fig. 18; median lobe of the male genitalia shaped as in Fig. 17 ..... **S. sarawakensis** n. sp.
3\. Pronotum with distinct lateral depressions; posterior projection of the pronotum relatively broad and flat ...... **S. javanicum** Kenner
Pronotum fairly smooth with just a hint of lateral depressions on some specimens; posterior projection of the pronotum bent strongly in a ventral direction (Figs. 21 and 22) .. **S. emersoni** n. sp.

Schizelythron eleanorae NEW SPECIES

(Figs. 12, 13, 15, 16, 23 and 26)

Most closely related to *S. sarawakensis* n. sp. from which it is distinguished by the shapes of the lateral and median lobes of the male genitalia. It is also a somewhat smaller species and has less secondary sclerotization of its abdomen.

Color of sclerotized parts yellowish brown throughout except for eyes and the borders of the pronotum which are much darker, approaching black. Membranous parts white. Dorsal shape as in Fig. 23. Lateral shape as in Fig. 26. Pronotum with 2 lateral depressions. Posterior projection of the pronotum broad and flat. Secondary sclerotization of sternite III not quite reaching tergite II. Secondary sclerotization of sternite IV not quite reaching tergite IV. Lateral lobe of the male genitalia shaped as in Fig. 15. Median lobe of the male genitalia shaped as in Fig. 16. Spermatheca shaped as in Fig. 12.

Measurements: Pronotum length, without projection, 0.28–0.30 mm; maximum length of the inner part of the elytron, 0.40–0.45 mm; maximum length of the outer

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FIGS. 1–20. *Schizelythron emersoni* n. sp.: 1, Antenna; 2, Head, ventral; 3, Maxilla; 4, Mandible; 5, Labium; 6, Labrum; 7, Proleg; 8, Abdominal segment IX with the long apodemes characteristic of the male; 9, Meso- and metasterna showing the metatrochanter insert characteristic of the Trichopseniinae; 10, Metaleg; 11, Mesoleg; 14, Elytron, setae placed only on the outer part in figure; 19, Lateral lobe of the male genitalia; 20, Median lobe of the male genitalia. *S. eleanorae* n. sp.: 12, Spermatheca; 13, Abdominal segment IX of female; 15, Lateral lobe of the male genitalia; 16, Median lobe of the male genitalia. *S. sarawakensis* n. sp.: 17, Median lobe of the male genitalia; 18, Lateral lobe of the male genitalia. Large scale refers to Figs. 15–20. Small scale refers to all other figures. Both scales represent 0.25 mm.

21

22

23

24

25

26

Figs. 21–26.

part of the elytron, 0.72–0.74 mm; length of posterior projection of the pronotum, 0.10–0.12 mm; head length, 0.26–0.28 mm. Number measured, 6.

Holotype: Male, No. 13090, Sarawak, 1°38′N, 113°35′E, 7 February 1963, Coll. W. King, A. Emerson, and Eleanor Emerson. In the collection of the author.

Paratypes: 5, same data as the holotype (D. K.).

Notes: The host was determined as *Schedorhinotermes* sp. A by Dr. A. E. Emerson. The colony was found in a deserted nest of *Prohamitermes mirabilis* (Haviland). The host colony is the type colony of a probable new species and is located in the Emerson collection of the American Museum of Natural History, New York. The species is named for Eleanor Emerson.

Schizelythron sarawakensis NEW SPECIES

(Figs. 17 and 18)

Most closely related to *S. eleanorae* n. sp. from which it is distinguished by the shapes of the lateral and median lobes of the male genitalia. It is also a larger species with somewhat larger elytra and has more secondary sclerotization of its abdomen.

Color of sclerotized parts yellowish brown throughout except for the eyes and the borders of the pronotum which are much darker, approaching black. Membranous parts white. Overall shape of the species very similar to *S. eleanorae*. Pronotum with 2 lateral depressions. Posterior projection of the pronotum broad and flat. Secondary sclerotization of sternite III reaches and articulates with tergite II. Secondary sclerotization of sternite IV not quite reaching tergite IV, though it comes closer than *S. eleanorae*. Lateral lobe of the male genitalia shaped as in Fig. 18. Median lobe of the male genitalia shaped as in Fig. 17. Female unknown.

Measurements: Pronotum length without projection, 0.32 mm; maximum length of the inner part of the elytron, 0.47 mm; maximum length of the outer part of the elytron, 0.80 mm; length of the posterior projection of the pronotum, 0.08 mm; head length, 0.28 mm. Number measured, 1.

Holotype: Male, No. 13091, Sarawak, 1°38′N., 113°34′E., 11 February 1963, Coll. A. and Eleanor Emerson. In the collection of the author.

Notes: The host was determined as *Schedorhinotermes brevialatus* (Haviland) by Dr. A. E. Emerson and is in the Emerson collection of the American Museum of Natural History, New York.

FIGS. 21–26. *Schizelythron emersoni* n. sp.: 21, Lateral view of fully physogastric form; 24, Dorsal view of fully physogastric form; 22, Lateral view of partially callow form; 25, Dorsal view of partially callow form. *S. eleanorae* n. sp.: 23, Lateral view; 26, Dorsal view. Scale arbitrary except that the dorsal and lateral views were taken of the same specimen in each instance and given the same degree of enlargement. See descriptions for measurements.

Schizelythron javanicum Kenner

Schizelythron javanicum Kenner, 1925: 119 (Figs. 1–3, Pl. III), Java, near Buitenzorg, 28 November 1920, with *Rhinotermes (Schedorhinotermes) longirostris* Brauer in a fallen log; Seevers, 1957: 281 (listed; changed host name upon advice of Emerson to *Schedorhinotermes javanicus* Kenner).

This species was not available for study and the facts given here have been taken from Kenner's excellent paper. The form of the elytra resembles that of *S. eleanorae* and *S. sarawakensis* more than that of *S. emersoni* because of the slender nature of the outer part. However, the length of the outer part is only about ⅓ longer than the inner part, which readily distinguishes it from all the other species herein. Both sternites III and IV form complete abdominal rings with tergites II and IV, respectively, which distinguishes it from *S. eleanorae* and *S. sarawakensis* and would indicate relationship with *S. emersoni.*

Color of the sclerotized parts brown with the pronotum and last abdominal segments somewhat darker. Membranous parts white. Overall shape of the species given in Kenner's paper. Pronotum with 2 distinct lateral impressions. Posterior projection of the pronotum broad and flat. Secondary sclerotization of sternite III reaches and articulates with tergite II. Secondary sclerotization of sternite IV reaches and is fused with tergite IV. Genitalia unknown.

Measurements: Pronotum length, without projection, 0.51 mm; maximum length of the inner part of the elytron, 0.86 mm; maximum length of the outer part of the elytron, 1.03 mm; length of the posterior projection of the pronotum, 0.09 mm; head length not given or derivable. These measurements were either taken from Kenner's paper or derived by proportioning out known measurements from the figures contained therein.

Notes: While Kenner's description makes this species sound darker than the rest herein, I would not be inclined to take this too seriously. Color interpretation, unless the differences are great, is a very subjective business and depends on the quality of the light source, the amount of light, and the magnification, all of which are unknown with respect to Kenner's study.

Schizelythron emersoni NEW SPECIES

(Figs. 1–11, 14, 19–22, 24 and 25)

The most distinctive species of the genus which is readily distinguished from all the others by the hook-shaped extension to the pronotum, the almost equal length of the inner and outer parts of the elytra, as well as the shape of the lateral and median lobes of the male genitalia.

Color of the sclerotized parts yellowish brown throughout except for the eyes and the borders of the pronotum which are much darker, approaching black. The posterior projection of the pronotum is especially dark. Membranous parts white. Dorsal shape of mature adult as in Fig. 24. Lateral shape of mature adult as in Fig. 21.

Figs. 22 and 25 are of a callow specimen which will be discussed later. Pronotum usually without lateral depressions, but 2 specimens show just a faint hint of depressions in that area. Posterior projection of the pronotum extremely long and bent in a ventral direction (hook-shaped). Secondary sclerotization of abdominal sternite III reaching and articulating with tergite II. Secondary sclerotization of abdominal sternite IV reaching and fused with tergite IV. Lateral lobe of the male genitalia shaped as in Fig. 19. Median lobe of the male genitalia shaped as in Fig. 20. Spermatheca as shown for *S. eleanorae* (Fig. 12) but somewhat larger.

Measurements: Pronotum length without projection, 0.35–0.40 mm; maximum length of the inner part of the elytron, 0.42–0.43 mm; maximum length of the outer part of the elytron 0.42–0.46 mm; length of the posterior projection of the pronotum, 0.22–0.24 mm; head length, 0.30–0.32 mm. Number measured, 10.

Holotype: male, No. 13089, Sarawak, 1°38′N, 113°35′E, 7 February 1963, Coll. W. King, A. Emerson, and Eleanor Emerson. In the collection of the author.

Paratypes: 11, same data as the holotype (D. K.), 1 male, Malaya, Bukit Belata forest preserve, 3°42′N, 101°28′E, 13 March 1963, Coll. A. Emerson and C. M. Low (D. K.).

Notes: Both host colonies were determined by Dr. A. Emerson as *Schedorhinotermes* sp. A. The Sarawak colony was found in a deserted nest of *Prohamitermes mirabilis* (Haviland) and is the type colony of a probable new species. The Malaya colony was determined as the same species and is a paratype colony. All host specimens are in the Emerson collection of the American Museum of Natural History, New York. This species is named for Dr. Alfred E. Emerson in honor of his 72nd birthday, December 31, 1968.

POST-IMAGINAL GROWTH

One of the specimens of *S. emersoni* is a callow which provides us with some insight into the process of the post-imaginal growth of physogastry in this genus. It is illustrated in Figs. 22 and 25. It is not a completely stenogastric form but represents an intermediate stage. By comparing Figs. 24 and 25, it will be noted abdominal tergites III–VII are narrower and not as long in the immature adult and also not as wide. Each tergite is composed of 2 parts and though most of the secondary sclerotization occurs in the posterior part, some also occurs in the anterior part. It will also be noted by comparing Figs. 21 and 22 that secondary sclerotization along the lateral bodies of the tergites and sternites ultimately produce the fused condition of segments IV–VII present in the mature adult. Thus secondary sclerotization occurs at all borders of the tergites and sternites to produce the fully expanded abdomen. The extent of the membrane increases mostly in the anterior end of the abdomen. The spiracles are placed well inside the lateral borders of the tergites and do not migrate outward as the abdomen expands.

BEHAVIOR

We are indebted to Kemner (op. cit.) for our knowledge of the behavior of this genus, meager though it might be. *Schizelytron javanicum* was captured twice in fallen logs which were being eaten by their termite hosts. Kemner definitely states that the logs did not contain the nests of the hosts which were deeper in the forest floor. Thus, the beetles were accompanying termite soldiers (both major and minor) and workers to their foraging area.

He kept 2 examples in the laboratory with a small *Schedorhinotermes* colony and was thus able to keep them alive for 6 days. He did not see the termites feed the beetles but often saw the termite workers licking them. When being licked, the beetles preferentially presented the tip of the abdomen, the abdominal segments, the elytra, particularly the outer part or in general those parts which exhibit the greatest amount of physogastry.

Kemner later showed that there were numerous pores in the chitinous parts of the beetles, namely in the hyaline area about the setae on the elytra and also on the abdominal tergites through which exudate could be excruded. These observations are herewith confirmed and in fact, there are hyaline areas around all dorsal major setae including those on the head and pronotum. These hyaline areas can be seen most clearly on the pronotum and head of *S. eleanorae* (Fig. 26). At 440 ×, these hyaline areas also exhibit pores. Several specimens of *S. emersoni* are in a good state of preservation and these will be sectioned for gland studies later.

RELATIONSHIPS OF THE SPECIES OF SCHIZELYTHRON AND THEIR HOSTS

It is my intention to analyze the relationships of all the species of the Trichopseniinae numerically eventually but it is hardly worthwhile to run a group of 4 species through the computer at this time as the relationships are quite apparent. *Schizelythron eleanorae* is most closely related to *S. sarawakensis.* These together would be more closely related to *S. javanicum* and finally this group of 3 would cluster out with *S. emersoni,* the most distinctive member of the genus.

All of these species are host specific at the species level of their termite hosts. If we assume that the pattern of speciation of the termitophiles parallels that of the termites, we would expect that *Schedorhinotermes* sp. A. would be more closely related to *S. brevialatus* than to *S. javanicus. Schedorhinotermes* sp. A has 2 species of *Schizelythron* found with it in the same colony. It is noteworthy that 1 of these species (*S. emersoni*) is highly distinctive and not very closely related to any of the others. This is a familiar pattern of speciation found not only among myrmecophiles and termitophiles but also among Staphylinidae of many other niches. It is explainable at present only by assuming that populations of termites and termitophiles became isolated and then this isolation later broke down, bringing evolutionarily divergent populations back together again.

ACKNOWLEDGMENTS

I want to thank Dr. A. E. Emerson for providing the specimens reported in this paper, for checking the host name of Kemner's species, for providing the host names for his captures, and for advice and reading of this manuscript. I also want to extend thanks to Mr. R. Gary Malin and Mr. Matthew Rees of Chico State College for technical assistance.

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(ENTOMOLOGIST'S RECORD, continued from p. 43)

Plastic microvial: Parts dissected from insects and other small organisms are frequently stored in a cotton-stoppered, glass microvial which is then placed in the larger vial with the rest of the specimen. These expensive microvials may damage the contents of the larger vial, the cotton frequently entangles the parts, and they are not readily obtainable. I have found a small, plastic, snap-cap vial (BEEM capsules made by Better Equipment for Electron Microscopy, Inc. (BEEM), P. O. Box 132, Jerome Ave. Station, Bronx, N. Y. 10468) which eliminates the undesirable cotton plug, and being much nearer the density of alcohol, damage to specimens is minimal. The microvials are slightly larger in diameter and not as easily removed from the vial as are the glass ones, but the cap hinge is easily grasped with fine forceps. They are not suitable for use as genitalia vials stored with specimens on pins. The capsules are translucent enough to see specimens contained within them. The two sizes available are conveniently suited for storage in 2 dram and 4 dram size patent-lip vials. The #1001 BEEM capsule fits into 4 dram vials only, while the #1001B BEEM capsule fits into 2 dram vials. The cost is considerably lower than glass microvials.—RICHARD W. KOSS, *Dep't. of Environmental Biology, University of Utah, Salt Lake City 84112.*

(Continued on p. 56)

Tanzania Bat Fleas, how they were secured.—It was mid January. I had been working with a staff of malaria specialists from the Malaria Institute where I was guest siphonapterist under N.S.F. grants and we had finished up at Same, Tanzania about 200 miles inland from the Indian Ocean. It was decided to go into the Ruvu (Pangani) river basin, about 20 miles by track, to continue work. At the point selected the basin was a flat, low piece of waste land which could easily become completely flooded by flash flood or continual rain. We were somewhat surprised to find on this flat land a deserted Masai village intact. Usually, because of the vermin therein these villages are burned to the ground when deserted.

After setting a string of 50 small box traps for the local mice attention was given to the Masai village. The Masai are a non-bantu people, tall, stately and copper colored who roam the plains of Kenya and Tanzania herding cattle by the thousands. They refuse to farm and bleed blood from their cattle to use for food.

When these tall, over six foot people build their houses, all within a corral, the roofs are only about 4 feet high with a foot of cattle manure atop and aside for insulation against heat and cold. Within the small huts are crude beds for the adults, cribs for the children and babies and enclosures for the dogs. In lion and leopard country the cattle are brought into the corral at night. The village in question was in perfect condition.

To explore the huts it was necessary to enter them on hands and knees or stooped Masai fashion. Hanging everywhere on the bed and crib uprights and the roof rafters were the Flying Foxes *Cardioderma cor.* They flew about one's head and out of the small doors in clouds.

The members of the party armed themselves with many branched switches and as the bats flew out of the doorways batted them down. One of the African assistants after critical examination of one of the bats came to the writer and exclaimed in swahili "dudu kidogo, buana, viraboto?" or "a small insect, sir, a flea?" and surely enough there was one of the smallest bodied, longest legged fleas I had ever seen. On return to the laboratory the fleas collected were found to be *Echidnophaga aethiops* J. and R. 1906, one of the smallest known fleas in the world and host positive for bats in East Africa.

In the tropics darkness settles in early so by 9 P.M. everyone had retired. At 10 P.M. a near hurricane and cloudburst hit the flat land blowing down the tents of the Africans who took refuge in the research truck and within minutes a foot of water was running swiftly under the camp beds of the senior staff members. In the morning the water was gone but the entire setup was marooned in a sea of mud. In spite of this setback the crew, sometimes in water to their wastes recovered 48 of the small box traps but because of the flood area not a mouse was taken. It was a day before the research truck with its load was with its wheels again on solid ground.

On the evening of January 10, 1966 (early summer) while reading in the lounge of the Institute resthouse at Muheza it was noticed that the bats flying about the building were terribly excited and were causing quite a racket with their squeaks. I was somewhat startled but greatly pleased when about 9 P.M. what should fall out of a hole in the ceiling right into my lap but a small young bat trying, but not quite able, to master the art of flight. I was very pleased to find small, light colored fleas on the young bat. For two nights the commotion lasted amongst the bats and during the two nights 4 other small bats, unable to fly, fell through the hole into the lounge. Then the bats were gone. Apparently the attic of the resthouse had been used for a nursery and those young bats which could not learn to fly fast enough were simply pushed out of the nursery and then deserted.

Upon my return to headquarters at Amani the bat fleas were found to be *Lagaropsylla consularis* Smit 1957, the host *Tadarida limbata*, the White-bellied Free-tailed Bat. This bat flea had not been before reported from Tanzania. It is host positive for East African bats.

Six months later the thatched roof of the resthouse was removed for a new one but not a bat was found in the attic.

Although the life history of a bat flea is no different from other fleas, that is, egg, larva, pupa, adult, it is hard to conceive how the adult emerging on the floor of the rookery ever finds its way to the bats hanging suspended above. So one can examine many bats without seeing a flea. In Baghdad, Iraq, some years ago 150 of these bats, all females and pregnant were examined and only 5 fleas were recovered from them.

One day at Moshi, Tanzania, in a 20 foot tree before the postoffice hundreds of Flying Foxes were almost breaking the tree down but a few examined carried no fleas. After a five year study only the two fleas mentioned above have been found on Tanzania bats.—C. Andresen Hubbard, *Tigard, Oregon 97223.*

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

General

COMMON NAMES OF BRITISH INSECTS AND OTHER PESTS

I. Thomas, H. W. Janson, and Audrey D. Aiken. Tech. Bull. no. 6, 2nd ed. Ministry of Agric., Fisheries, and Food. British Information Services, 845 3rd Ave., N. Y. 10022, iii + 72 pp., 1968. Paper $2.00 (including mailing).

"It is a paradox that in a list of common names, the scientific names are the more troublesome and the compilers are very conscious that the list is consulted as much for the latter as for the former. Great care has therefore been taken to bring the scientific names up to date." Preface.

THE OPTICS OF INSECT COMPOUND EYES

W. H. Miller, G. D. Bernard, and J. L. Allen. Science, 162: 760–767, 1968.

"Exner's classical theory of the function of compound eyes with crystalline tracts ignores the presence of the tracts for the dark-adapted eye. The tracts perform an optical function in the eyes of certain moths and skippers whether light- or dark-adapted. The lenslet of the corneal-crystalline cone focuses an image at the beginning of the tract. Although the image is not transmitted, theory predicts that some information about the image could be guided to the rhabdom. The tract and migrating pigment together also function as a longitudinal pupil.

"In addition, compound eyes contain dioptic components with characteristic dimensions smaller than a wavelength of light. Corneal nipples act as an anti-reflection coating that aids camouflage and may reduce ghosts. The specialized layering in corneas of certain dipterans probably serves a contrast-filtering function for vision. Tracheolar interference filters of lepidopterans act as tapeta that may enhance both sensitivity and the optical contrast of the retinal image." SUMMARY.

(ENTOMOLOGIST'S RECORD, continued from p. 43)

Additional notes on the food of Tanypodinae larvae (Diptera, Chironomidae).—Due to an error in retyping the typescript, the following data were omitted from my paper (ENT. NEWS, 80: 13–18). These additions are to be added to page 17:

—S. S. ROBACK, *Philadelphia Academy of Natural Sciences.*

Procladius spp. cont.
  Oligochaeta
    Limnodrilus or *Tubifex* sp. 4
  Cladocera 21—13
    Alona guttata Sars 2—2
    Alona circumfimbriata Megard 1—1
    Alona affinis (Leydig) 1—1
    Alona sp.
    Alonella hamulata (Birge) 1—1
    Chydoras sphericus (Müller) 1—1
    Leydigia sp. 2—2
    Camptocercus sp. 1—1
    Ilyocryptus sp. 3—3
    sp. 1—1
    Unk. gen. non-chydorid 1—1
  Ostracoda
    sp. 63—18
Copepoda
  Cyclopoida sp. 1—1
Insecta
Diptera
Chironomidae 14—10
  spp. 3—2
  Harnischia sp. 1—1
  Sergentia sp. 2—2
  Chironomus nr. *attenuatus* (Walk.) 3—2
  Tanytarsini sp. 2—2
  Calopsectra sp. 3—2
Trichoptera
  sp.? 1—1
Acarina
  sp. 1—1

PENTANEURINI

Pentaneurini sp. E. Roback 13
  Diatomaceae 3
  Oligochaeta
    Limnodrilus or *Tubifex* sp. 1
  Cladocera 4—2
    Alona sp. 2—1
    Alonella hamulata (Birge) 1—1
    Chydoridae sp. 1—1
  Ostracoda
    sp. 10—4
Copepoda
  Harpacticoida 1—1
Insecta
Diptera
Chironomidae 3—3
  Orthocladiinae sp. 1—1
  Psectrocladius sp. 1—1
  Tendipedini sp. 1—1
Acarina
  sp. 1—1

MEMOIRS OF THE AMERICAN ENTOMOLOGICAL SOCIETY

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For sale: Townsend's Manual of Myiology, 12 parts, complete, unbound; Ferris' Principles of Systematic Entomology, new condition; Creighton's Ants of North America, new condition; Ewing's Manual of External Parasites, excellent condition. Make offer. J. S. Wiseman, 152 E. Stenger, San Benito, Texas 78586.

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ENTOMOLOGICAL NEWS

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THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS

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A REVIEW OF HADRURUS SCORPIONS (VEJOVIDAE)[1]

Herbert L. Stahnke[2]

This taxon, the popularly designated giant hairy scorpions, belongs to Vejovinae of the Vejovidae. The characteristics of the subfamily are: First four caudal segments with paired inferior median keels or their vestiges, three pair of lateral eyes of which the third pair is always the smallest; median ocular tubercle located just anterior to the middle of carapace; distinct median claw (unguicular spine) on pretarsus; internal border of pedipalp tarsus with a single row of granules in non-overlapping rows, accompanied by widely spaced large granules on interior surface.

Hadrurus Thorell

Hadrurus Thorell, 1876, Ann. Mag. Nat. Hist., ser. 4, vol. 17, p. 11; Kraepelin, 1899, Das Tierreich, Scorpiones und Pedipalpi, no. 8, p. 187; Pocock, 1902, Biologia Centrali-Americana, Scorpiones, Pedipalpi, Solfugae, p. 5; Ewing, 1928, Proc. United States Natl. Mus., vol. 73, p. 7; Hoffman, 1931, An. Inst. Biol. Mexico, vol. 2, p. 334; Werner, 1934, in Bronn, Klassen und Ordnungen des Tierreichs, vol. 5, book 8, Pedipalpi, Scorpiones, p. 265; Stahnke, 1945, American Mus. Nov., No. 1298, 1945.

Scorpions of the genus *Hadrurus* have an abundance of bristles on legs and cauda; inferior border of movable finger armed with very large, darkly pigmented tooth; pedal spurs with denticulate spines, interior spurs with 3 to 4 teeth, exterior ones with 5 to 6; ratio of carapace length to posterior width 0.92–1.04; ratio of *distance* from anterior margin to anterior edge of median eyes to carapace length 0.46 to 0.50. Thus the carapace length approximates the posterior width and the median eyes are slightly forward of the middle of the carapace. Numerous (over 20) trichobothria on inferior edge of manus, ventral and exterior surfaces of pedipalp patella. Third marginal lamella longer than second.

KEY TO THE SPECIES OF HADRURUS

1 Trunk concolorous brownish yellow except for dark median ocular tubercle; other structures lighter yellow. One-half genital opercular with 4 large setae (Fig. 1) .... **Hadrurus concolorous** Stahnke
2 Trunk not concolorous..3
3 (2) Anterior portion of interocular triangle light yellow or slightly brownish..5
4 (2) Anterior portion of interocular triangle dark brown to black....11

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[1] Accepted for publication October 15, 1968.

[2] Poisonous Animals Research Laboratory, Arizona State University, Tempe, Arizona 85281.

5 (3) A crescentic, darkly pigmented region passing through median ocular tubercle with horns touching lateral eye clusters (faint or absent in poorly preserved specimens). One-half genital operculum with more than four bristles. Ratio of hand width to thickness greater than 1.55. Ratio of tarsus length to manus width less than 2.20.. **H. hirsutus** (Wood)

6 (3) Crescentic region indefinite or lacking with region posterior to it of very dark color......................................7

7 (6) Fingers and hand of pedipalp one color or fingers slightly darker...9

8 (6) Fingers and hand of pedipalp definitely of a darker color than hand.............................. **H. aztecus** Pocock

9 (7) Fifth caudal segment same yellowish color of other four. One-half of genital operculum with more than four large setae. Ratio of basal piece width to length over 1.60.. **H. arizonensis** Ewing

10 (7) Fifth caudal segment dark brown in toto or in part; other segments yellow. One-half of genital operculum with four large setae. Ratio of basal piece width to length not over 1.50 (Fig. 3)........................... **H. thayeri** Stahnke

11 (4) Cauda yellowish........................... **H. spadix** Stahnke

12 (4) Postabdomen dark brown; telson light yellow (Fig. 2).. **H. pinteri** Stahnke

Hadrurus arizonensis (Ewing)

Hadrurus hirsutus arizonensis Ewing, 1928, Proc. United States Natl. Mus., vol. 73, p. 9.

Hadrurus arizonensis Stahnke, 1945, American Mus. Novitates, No. 1298, pp. 6–8.

Differs from *H. hirsutus* in that it lacks a distinct interocular crescent. Horns of crescent present but body continuous with date-brown coloring of posterior part of carapace. Dorsum of trunk date-brown intermingled with gray and yellow. Recently preserved specimens lack the gray. Gray coloring due to dusty deposit between tergal granules. Living specimens with abdomen distended with food appear olive green banded with date brown. Change in appearance due to the now visible intersegmentary and pleural membranes. Lateral margins and anterior two-thirds of carapace, book lung area, cauda, legs and pedipalps light yellow. Fingers of pedipalps with reddish granules. Tarsus of pedipalp may be longer than, as long as, or shorter than carapace; more frequently longer than carapace on ♂ and shorter on ♀. Pectinal teeth: Arizona ♀ 25–34, av. 28.7; ♂ 29–39, av. 34.6. California ♀ 28–33, av. 30.2; ♂ 32–40, av. 36.8. Nevada ♀ 29–33, av. 31.2; ♂ 34–41, av. 38.0.

DISTRIBUTION.—Southern to northwestern Arizona; southern Utah; southern and central California; southern Nevada; northern Baja California, Mexico.

Hadrurus aztecus Pocock

Hadrurus aztecus Pocock, 1902, Biologia Centrali-Americana, Scorpiones, Pedipalpi, Solifugae, p. 7; Ewing, 1928, Proc. United States Natl. Mus., vol. 73, p. 9; Hoffman, 1931, An. Inst. Biol. Mexico, vol. 2, pp. 340–356; Stahnke, 1945, American Mus. Novitates, No. 1298, pp. 8–9.

Posterior two-thirds of carapace and terga black or blackish brown. Area anterior to median ocular tubercle light yellowish (similar to *H. arizonensis* and *H. hirsutus*). Cauda, pedipalps (except fingers) and legs also light yellow. Fingers reddish. Sternites of male more or less blackish, punctiform and with transverse wrinkles. Those of female lighter brown than terga. A double longitudinal series of denticles on inner face of femur of legs 1 to 4; well developed on 2 and 3, but incomplete and weak on 3 and 4. Tarsus of male same length or longer than carapace; female always shorter than carapace. Pectinal teeth: ♂ 37; ♀ 27–32.

DISTRIBUTION.—Mexico and extreme southern Arizona.

Hadrurus concolorous new species

(FIGURE 1)

TYPES.—*Holotype.*—♀, ASU 68–602, length 54 mm, fifty-four and two tenths miles north of La Paz, Baja California del Sur, Mexico. Under thin, dry cowdung in broad, flat burrow six inches long dug in very fine, powdery sand. June 14, 1968. L. L. and H. L. Stahnke. *Allotype.*—♂, ASU 56–175, length 37 mm (juvenile), Isla San Marcos, Baja California, Mexico. March 31, 1953. Fig-Hoblyn. Repository California Academy of Science.

FIG. 1, *H. concolorous* ♀, (ASU 68-602).

DIAGNOSIS.—Differs from *H. hirsutus* (Wood), 1863 as follows: Dark cresentic spot of interocular triangle lacking. A specimen of *H. hirsutus* of the same size would have a distinctly marked cresecent and the carapace would be a light rather than a reddish yellow. Genital operculum of *H. hirsutus* with more than four setae on each sclerite. Ratio of hand width to thickness over 1.55 in *H. hirsutus*; under 1.45 in *H. concolorous*. Ratio of distance between median eyes to diameter of median eyes over 1.45 on *H. hirsutus*; under 1.25 on *H. concolorous*. Ratio of tarsus length to manus width under 2.10 in *H. hirsutus*; over 2.40 in *H. concolorous*.

Description.—Trunk dorsally and ventrally concolorous brownish yellow except for dark brown median ocular tubercle; cauda and chelicera somewhat lighter yellow; telson, legs and pedipalps pale yellow. Storage in ethanol darkens all colors. Lightly granular over-all.

Prosoma.—*Carapace.*—Median anterior margin protruding. Hirsuteness and lateral eyes as in *H. thayeri.* Densely granular except area immediately around median ocular tubercle. Ratio of carapace length to posterior width over 1.00; length to anterior width over 1.60. Furrows as in *H. thayeri. Sternum.*—Like *H. thayeri. Pedipalps.*—Tarsus as in *H. thayeri. Tibia.*—Like *H. thayeri* but without row of granules on inner surface parallel to basal row of granules on cutting edge. *Manus.*—Like *H. thayeri.* Ratio of tibia length to tarsus length 1.47; of tarsus length to manus width ♀ 2.43, ♂ 292. *Patella.*—Like *H. thayeri* except inner surface lightly granular; ventral and exterior surface agranular. *Femur.*—Like *H. thayeri* but dorsal surface agranular except for cluster of five granules proximad; inner surface with about four or five large, scattered granules and about eight large setae; ventral surface agranular but for a cluster of granules proximad. *Walking legs* and femurs like *H. thayeri. Chelicera.*—Like *H. thayeri* except 5–6 bristles on superior surface; large tooth on inferior surface curved near distal one-third and basal two-thirds of inferior margin only moderately hirsute.

Opisthosoma.—*Mesosoma.*—Like *H. thayeri* but tergites agranular except for lateral and narrow posterior margins which are lightly to moderately granular. *Sternites.*—Like *H. thayeri. Genital operculum.* Like *H. thayeri* except that four bristles on each opercular sclerite not linearly arranged. Pectines.—Like *H. thayeri.* Teeth ♀ 29–30, ♂ 35–37. Metasoma.—Like *H. thayeri.*

Hadrurus histutus (Wood)

Buthus hirsutus Wood, 1863, Proc. Acad. Nat. Sci., Philadelphia, p. 108; Jour. Acad. Nat. Sci., Philadelphia, ser. 2, vol. 5, p. 367.

Buthus emarginaticeps Wood, 1863, Proc. Acad. Nat. Sci., Philadelphia, p. 109; 1863, Jour. Acad. Sci., Philadelphia, ser. 2, vol. 5, p. 367 (Anomally of *H. hirsutus*).

Hadrurus hirsutus Thorell, 1876, Ann. Mag. Nat. Hist., ser. 4, vol. 17, p. 11; Kraepelin, 1899, Das Tierreich, Scorpiones, Pedipalpi, No. 8, p. 188; Pocock, 1902, Biologia Centrali-Americana, Scorpiones, Pedipalpi, Solfugae, p. 6; Ewing 1928, Proc. United States Natl. Mus., vol. 73, p. 8; Hoffman, 1931, An. Inst. Biol., Mexico, vol. 2, pp. 335–340; Stahnke, 1945, American Mus. Novitates, No. 1298, pp. 5–6.

Carapace with dark, more or less crescent-shaped spot passing through median ocular tubercle with tips of crescent horns reaching lateral eyes. Entire body, except aculeus, light yellow. Sometimes dark crescent obliterated in preserved specimens and generally becomes less distinct in large (four inch and over) specimens. Crescent most distinct in young specimens which may occasionally also have faint, irregular dark spots on both carapace and dorsum of preabdomen. Posterior carapace and preabdomen of live specimens may have greenish hue. Live specimens have area over book lungs whitish yellow with rest of sternites greenish. Legs and pedipalps light yellow; fingers of pedipalps may have slight reddish tinge. Tarsus of pedipalps generally longer than carapace on both ♂ and ♀.

Pectinal teeth: Arizona ♀ 26–31, av. 28.7; ♂ 31–40, av. 34; California ♀ 27–31, av. 29.3, ♂ 34–40, av. 36.4.

DISTRIBUTION.—Southwestern Arizona; southern California; Mexico.

Hadrurus pinteri NEW SPECIES

(FIGURE 2)

TYPES.—*Holotype.*—♀, ASU 68–0090, length 63 mm, Puertocitos, Baja California del Norte, Mexico. On lightly volcanic ash. February 24, 1968. P. J. Pinter. *Allotype.*—♂, 68–1276, length 64 mm, Mission de Calamyget, Baja California, Mexico. Black volcanic banks of a ravine. April 16, 1962. E. L. Sleeper *via* W. D. Stockton. Repository California State College, Long Beach, California. *Paratypes.*—3 ♀s, ASU 56–0132, length 61 mm, ASU 56–0134, length 73 mm, Agua Verde Bay, Baja California, Mexico. March 26, 1953. J. R. Slevin; ASU 68–1277, length 83 mm, same as ASU 68–1276 above.

FIG. 2. *H. pinteri* ♀. (ASU 68–0090).

DIAGNOSIS.—Differs from *Hadrurus spadix* Stahnke, 1940 as follows: All caudal segments brown rather than concolorous yellow. Pedipalp chela brown rather than yellow with reddish fingers. Ratio of genital plate width to length for *H. pinteri* over 1.95; *H. spadix* under 1.80. Ratio of caudal segment III length to width for *H. pinteri* under 1.55; *H. spadix* over 1.65. Ratio of caudal segment IV length to width for *H. pinteri* under 1.80; *H. spadix* over 1.90. Ratio of caudal segment V depth to ampulla depth for *H. pinteri* over 1.00; *H. spadix* under 0.90.

DESCRIPTION. Entire dorsum of trunk date brown. Most specimens with distended preabdomens so that exposed intertergal connective tissue produces a banded appearance. All segments of postabdomen date brown but dorsum lighter. Sternite VII date brown; VI lightly invaded with brown and V lightly so. Chela of pedipalps date brown but lighter than trunk. Some brown pigment on distal portion of patella. Chelicera diffusely brown. Remainder of pedipalp patella and other segments, as well as legs, telson and other ventral structures a pale yellow in live specimens. This becomes a dark yellow after preservation in ethanol. Latero-distal terminus of femur and patella of all legs with reddish brown spot. Dorsum lightly granular and shiny.

PROSOMA.—*Carapace.*—Like *H. thayeri* except two setae anterior to median ocular; central area surrounding median ocular tubercle agranular. Ratio of carapace length to posterior width 0.99 to 1.08; length to anterior width 1.65 to 1.78. *Sternum* like *H. thayeri*. *Pedipalps, Tarsus.*—Like *H. thayeri* except that external surface has one longitudinal, continuous ridge. *Tibia.*—Like *H. thayeri* except that there is no row of granules on inner surface parallel to basal row of granules on cutting edge. *Manus.*—Like *H. thayeri.* Ratio of tibia length to tarsus length 1.44 to 1.50. *Patella.*—Like *H. thayeri* except that this exterior median keel is weakly developed and agranular and ventro-exterior keel is slightly granular; dorsal surface of ♂ agranular, of ♀ densely but inconspicuously granular on either part or entire surface; when entire surface is involved, granules distad are coarse. Also, ventral, inner and exterior surfaces agranular but inner surface with large setae. Numerous trichobothria as in *H. thayeri.* *Femur.*—Like *H. thayeri* except some granules on proximal end of ventro-exterior keel. Also surfaces differ as follows: Dorsal surface agranular except for inconspicuous, scattered granules; inner surface agranular except for a few large granules proximad; ventral surface agranular except for a few proximal granules. *Chelicera.*—Like *H. thayeri.* *Walking legs.*—Like *H. thayeri.*

OPISTHOSOMA.—*Mesosoma.*—Setae like *H. thayeri.* Tergites I–VI agranular and shiny except for lightly granular lateral areas and sparse granulation along posterior edge; VII coarsely but not densely granular and with pair of vestigial lateral keels. Other tergites keelless. *Sternites.*—Small cluster of setae just posterior to basal piece plus occasional setae on edges of sternites. Sternites I–VI keelless and agranular; VII with two pair of moderately developed lateral keels which may be distinctly granular on ♀ but indistinctly so on ♂. Stigma slit-like; lung book areas elevated above sternal surface. *Genital operculum.*—Divided and without genital papillae on both sexes. Five or more setae, irregularly arranged, on each opercular sclerite. *Pectines.*—Like *H. thayeri.* Teeth: ♀ 28–32, ♂ 37–39. *Metasoma.*—Like *H. thayeri* except inferior lateral and inferior median keels all well developed; those on caudal segment I agranular, II lightly granular and III–V strongly granular. Anal arch and anterior crest like *H. thayeri* but posterior crest with but few granules. *Telson.*—Like *H. thayeri.*

Hadrurus spadix Stahnke

Hadrurus spadix Stahnke, 1945, American Mus. Novitates, No. 1298, pp. 4–5.

Entire dorsum of trunk nearly uniform date brown color. Appendages light yellow except red pedipalp fingers; red color sometimes fades in preserved specimens; redness extends proximally along inner marginal and inner superior keels, sometimes to such an extent as to give entire superior surface of chela distinct reddish appearance. Tarsus of pedipalp definitely longer than carapace on ♂; may be as long as or longer on ♀. Pectinal teeth: ♀ 28–30; ♂ 32–39.

DISTRIBUTION.—Northern Arizona; Idaho, Utah and Nevada.

Hadrurus thayeri NEW SPECIES

(FIGURE 3)

TYPES.—*Holotype.*—♀, ASU 68-814, length 99 mm, 5.3 mi. N.E. Cabo San Lucas, Baja California del Sur, Mexico. Under rock in shallow burrow. June 12, 1968. Z. L. and D. Thayer. *Allotype.*—♂, ASU 65–0912, length 100 mm, Las Cruces, Baja California del Sur, Mexico. In Fisher residence on terrazo floor in living room. April 29, 1965. A. Perez y Espinosa via K. Crosby. *Paratypes.*—3 ♀s, ASU 56–243, length 76 mm, Las Animas, Sierra Laguna, Baja California, Mexico. Oct. 12, 1941. Ross and Bohert. California Academy of Science; ASU 68-0611, length 62 mm, ASU 68-0931, 55 mm, west of Crosby residence, Las Cruces, Baja California del Sur, Mexico. Under rocks without burrow. June 10, 1968. L. L. and H. L. Stahnke. ♂, 65-0051, length 104 mm, under wood by guest house, Crosby residence, Las Cruces, Baja California del Sur, Mexico. April 2, 1965. M. S. Perez via K. Crosby.

Diagnosis.—Differs from *H. arizonensis* (Ewing) 1928 as follows: Caudal segment V dark brown rather than concolorous yellow with other segments. In older preserved specimens dark brown pigment may be sparse. Dark brown area of carapace dorsum not uniformly diffuse but invaded laterally just posterior to median ocular tubercle by projections of yellow. *H. thayeri* has only four large setae on posterior border of each half of genital operculum. Ratio of caudal segment III length to width, ♀ 1.30–1.35, ♂ 1.45–1.50. These ratios for *H. arizonensis*, ♀ 1.40–1.50, ♂ 1.60–1.70. Ratio of caudal segment IV length to width for *H. thayeri*, ♀ 1.60–1.65, ♂ 1.75–1.80, for *H. arizonensis*, ♀ 1.70–1.90, ♂ 1.90–2.00. Ratio of basal piece width to length for *H. thayeri*, 1.60–1.75; that of *H. arizonensis*, 1.25–1.50.


Fig. 3, *H. thayeri* ♀, (ASU 68-814).

Description.—Dorsum of trunk with variegated pattern of date brown over yellow base except for following solid yellow areas: Anterior portion of interocular triangle, narrow band of yellow posterior to median ocular tubercle and most of tergite VII. Ethanol preserved specimens lose much of brown pigment. Pedipalps, legs and all except caudal segment V are yellow. These structures are pale yellow in living specimens. Caudal segment V may be densely or diffusely brown; virtually disappears in large ethanol preserved specimens.

Prosoma.—*Carapace.*—Median anterior margin protruding, three lateral eyes with first two forming approximately 130° angle with third which is smallest. Large setae along anterior margin with one posterior to each lateral eye cluster and two on posterior slope of median ocular tubercle. Surface moderately covered with small granules except for agranular central portion ot frontal lobes. Posterior third of carapace somewhat coarsely granular. Median ocular tubercle well developed and broader on female than male. Ratio of carapace length to posterior width 0.94 to 1.00; length to anterior width 1.50 to 1.65. The following carapacial furrows are present: Anterior median, median ocular, lateraly ocular, central median, transverse median, posterior median, posterior transverse, posterior marginal and posterior lateral. *Sternum.*—Lateral sides converge inwardly at mid point; divided by deep median furrow forming two vaulted areas laterally and a depressed, diamond-shaped area anteriorly. *Pedipalps. Tarsus.*—Exterior surface with two continuous longitudinal ridges. Sparcely hirsute. Cutting edge straight with eight diagonal rows of denticulate granules plus a short basal row and eight large median and nine large inner lateral denticulate granules plus a large terminal tooth. *Tibia.*—Sparsely hirsute. Two discontinuous longitudinal ridges on external surface. Cutting edge like tarsus. Row of granules on inner surface parallel to basal row of granules on cutting edge. *Manus.*—Sparsely hirsute. Smooth to finely granular except for coarse granules of interior and exterior keels. External marginal keel well developed and bearing large granules. Superior digital keel vestigial and agranular except for a few large basal granules. Superior inner secondary keel weakly developed but granular approximately one-half length. Interior marginal keel well developed and granular over two-thirds length. Other keels lacking. Numerous trichobothria on inferior edge of manus. Ratio of tibia length to tarsus length 1.40 to 1.46. *Patella.*—Dorso-inner and ventro-inner keels well developed and coarsely granular. Dorso-exterior keel developed more strongly distad and lightly to densely granular; not conspicuously so in juveniles. Exterio-median keel moderately developed, agranular on juveniles and adults bearing a few granules distad. Ventro-exterior keel on proximal two-thirds and coarsely granular. Dorsal, inner and ventral surface densely granular. Inner surfaces with large setae. Ventral surface sparsely granular on juveniles. Only distal superior half of exterior surface moderately granular. Numerous trichobothria (over 24) on ventral surface along exterior margin and on exterior surface (over 30). *Femur.*—Dorso-inner, dorso-exterior and ventro-inner keels strong and granular. Extero-median keel vestigial, agranular but bears a row of large setae. Ventro-exterior keel lacking and agranular. Dorsal and inner surfaces granular; inner surface also bears large setae. Ventral surface granular on proximal half. Exterior surface rounded and agranular. *Chelicera.*—Five well developed, broad, flat teeth on superior margin of movable finger; second and fifth largest; first, about one-half as large; and third and fourth about one-half to one-third size of first. 6–8 setae on superior surface. One large, elongate, stout, dark tooth on inferior margin which is densely hirsute along basal two-thirds. Superior margin of fixed finger with three teeth; second and third large and broad; first about one-third as large and fused with base of second, often joined sufficiently to simulate double cusped tooth. *Walking legs.*—Tarsomeres and tibia densely hirsute; other leg segments lightly so. Tarsomere II with single row of short spines on inferior surface. Tarsomere I of leg I with three longitudinal rows of spines—one on exterior and two on interior edges; leg II with two rows; legs III and IV with one row. Comb of long bristles on exterior edge of tarsomeres I and II of legs I–III; represented by a few long setae on IV. Well developed pretarsal median and lateral claws. Exterior and interior pedal spurs with denticulate spines; three to four on interior edge and five to six on exterior. Median lobes of tarsomere II subtriangular with exterior edges densely hirsute. *Femurs.*—Row of large granules on inferior edge of femurs. Exterior surface of leg I sparsely granular; II–IV densely covered with small granules.

OPISTHOSOMA.—*Mesosoma.*—Tergites very sparsely hirsute; transverse median are of I–VI agranular and shiny with anterior margin finely granular and posterior and lateral areas more coarsely so. Tergite VII densely covered with small to large granules and bearing two vestigial lateral keels. Other tergites without keels. *Sternites.*—Sparesly hirsute on lateral and posterior edges; small cluster of setae just posterior to basal pieces of pectines. Sternites I–VI agranular; VII lightly granular and bearing two pair of lateral keels with confluent granules; median pair vestigial. Stigma slit-like; lung book areas elevated above sternal surface. *Genital operculum.*—Divided and without genital papillae on either sex. Four sublinearly arranged large setae near posterior margin of each opercular sclerite. *Pectines.*—Densely hirsute; numerous subcircular middle lamellae, each bearing one bristle. Angle of proximal middle lamellae with dentate edge approximately 100° for ♂ and 130° for ♀. Three marginal lamellae with third longer than second. Fulcra subtriangular with each bearing 1–3 bristles; adults commonly with three. Basal piece transversely oblong with narrow, ventral median notch. Teeth: ♀ 23–29, ♂ 33–35. *Metasoma.*—Intercarinal spaces mostly agranular except sparse granulation on dorso-lateral areas and caudal segment V; juveniles less granular. Caudal segments I–IV sparsely hirsute; V moderately to densely so. Dorsal furrow weakly developed. Dorsal and superior lateral keels moderately developed and granular. Median laterals moderately developed and granular on all segments; covering only distal two-thirds of III and IV and proximal third of V. Inferior and median lateral keels well developed on all segments; agranular on I and II, lightly granular on III and strongly on IV and V. Anal arch well developed and bearing widely spaced large setae; anterior crest with medium sized chisel-shaped granules; posterior crest bearing row of small cone-shaped granules. *Telson* densely hirsute ventrally. Ampulla densely covered with very large granules on antero-ventral surface.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

Colorado Orthoptera.—A new state record and a major range extension: *Schistocerca americana* (Drury) (Acrididae) probably reaches, in the west, its "northern limit of continuous habitat in southeastern Kansas" (Hebard, 1931, Proc. Acad. Nat. Sci. Phila. 83: 119–227). It is, however, resident further west in the southern parts of its range; and it regularly wanders north of its resident range in the east, frequently appearing hundreds of miles further north. One specimen, undoubtedly a vagrant, has been taken in Colorado. This is an adult male, collected July 4, 1958, near Two Buttes, Baca County, in extreme southeastern Colorado by Kathleen D. and Douglas G. Alexander. *Capnobotes fuliginosus* Thomas (Tettigoniidae) is known primarily from desert mountains in the southwest, from California to the Davis Mountains of southwest Texas. It was first reported from Colorado in the northwest, in Yampa Canyon, Dinosaur National Monument (Alexander and Rodeck, 1952, Entomol. News 63: 238–240). It is now known from southeastern Colorado as well, two adults, male and female, having been collected August 29, 1960, near Undercliffe, Colorado, by T. Paul Maslin. These were in stream bottom vegetation near the mouth of Huerfano Canyon, about 23 miles southeast of Pueblo. The nearest previous record is from the Mesa de Maya in the Oklahoma panhandle (Blair and Hubbell, 1938, Amer. Midl. Nat. 20: 425–454). All three specimens are now in the University of Colorado Museum.—GORDON ALEXANDER, *University of Colorado, Boulder, Colorado 80302.*

A population of a European pseudoscorpion established in New York.—An earlier note (Muchmore, 1963, Ent. News, 74: 208–210) pointed out that the common European neobisiid pseudoscorpion, *Roncus lubricus* L. Koch, had been found living in the greenhouse at the University of Rochester in Rochester, New York. It can now be reported that this pseudoscorpion is well established in an outdoor location in Rochester, not far from the University.

Specimens of *Roncus lubricus* were first found in September 1967 in a Berlese sample from cindery soil along the base of a stone wall, which parallels the Lehigh Valley Railroad embankment near Mt. Hope Cemetery. Subsequently, the species has been found over a large area stretching for at least a third of a mile along both sides of the railroad right-of-way, bounded on one side by the Genesee River and on the other by a paved boulevard. (This site is 0.6 mile from the greenhouse from which the species was reported previously). Here it seems to live preferably in the loose, fine cinders in and near the embankment; but it has also been found, during summer months, in leafy litter on more compact soil in the vicinity. Except for the railroad tracks themselves, most of this area is covered by honeysuckle, sumac, and a variety of small, deciduous trees, so that the soil is usually moist and cool, even in the middle of summer. *R. lubricus* has been found in collections made during every month of the year, except January and February when the ground is usually frozen and covered by snow.

Along with *Roncus lubricus* have been found a number of other exotic arthropods, evidently brought from Europe many years ago when a large botanical nursery operated in this part of Rochester (see Cooper, 1962, Ent. News, 73: 187–190). Common among these forms are the pseudoscorpion *Chthonius tetrachelatus*, the terrestrial isopods *Trichoniscus pygmaeus*, *Trichoniscus demivirgo* (probably = *T. pusilla*) and *Hyloniscus riparius*, the centipedes *Chaetechelyne vesuviana* and *Scutigera* sp., and the beetle *Anommatus duodecimstriatus*, most of which appear to be of central European origin. It may be, then, that this population of *R. lubricus* is also of central European origin, which would account for some small differences noted between these and the English specimens recently described in detail by Gabbutt and Vachon (1967, J. Zool. London, 153: 475–498).

It is also worth noting here that all stages, including protonymphs, have been found throughout the year (except January and February). This is at variance with the observations of Gabbutt and Vachon who obtained protonymphs only in August, September, and October, and found deutonymphs absent or very rare during the winter and early spring. It is not yet clear whether this discrepancy represents a difference in the habits of the two populations or only a difference in sampling techniques.—William B. Muchmore, *Department of Biology, University of Rochester, Rochester, New York* 14627.

A beetle boom is building in Japan: "Japanese boys are especially buying one particular long . . . black, ugly variety [species of beetle] more than an inch long . . . at the beetle counters of major department stores at three for 100 yen (27 cents). They keep them in little bamboo cages, feed them rotten vegetables and go to the boy next door and say "My beetle can lick your beetle." The king of the beetle business is Toshio Imamura . . . who loves children and loves beetles and decided that he would bring the two together. . . . A spokesman for the giant Mitsukoski department store in Toyko says "We plan to gather 5,000 to 10,000 beetles . . . and put them in a special park on the roof so children can see how they are in their natural habitat." International Herald Tribune, Aug. 27, 1968.

(Continued on page 73)

A New Genus of Xystodesmid Milliped from Northern California[1]

JOHN S. BUCKETT[2] AND MICHAEL R. GARDNER[3]

The mountains of the California Coast Ranges and the foothills of the great Sierra Nevada Mountains abound with a prolific xystodesmid fauna. With few exceptions, the genera are allopatric, each one inhabiting a region of the mountains suitable to its climato-edaphic requirements. The presently described entity fills a significant gap in the almost continuous distribution of Xystodesmidae in northern California and occurs in the inner coast ranges of Colusa and Glenn Counties, where, to our knowledge, no xystodesmids have been taken previously. The most recent key to this family may be found in Loomis (1968). Closely related to *Wamokia* Chamberlin and *Xystocheir* Cook, *Anombrocheir* gen. nov., may be easily distinguished by the massive telopodite of the male gonopod which lacks secondary processes.

The holotype of *Anombrocheir spinosa* sp. nov., will be placed in the Arthropod Type Collection, University of California, Davis, and paratypes will be deposited in the Buckett-Gardner Collection, Davis, and the United States National Museum, Washington, D. C.

At present, no adequate key is available for the separation of California xystodesmid genera; therefore, below we present a key based primarily on the male. Female characters are used where known to be of value. Classification in the xystodesmids is based primarily on male sexual characteristics, thus our reason for predominantly using these characteristics in the key. In the sixth couplet, three genera are removed together because of the possibility of future synonymy.

KEY TO CALIFORNIA GENERA OF XYSTODESMIDAE

1. Male with pair of anterior processes on third coxae..................5
 Male lacking processes on third coxae..............................2
2. Gonopods of male small, not joined together at coxae[4]; female lacking processes on second coxae..............................3
 Gonopods of male prominent, joined with connecting tissue at coxae[4]; female with a pair of cylindrical processes on second coxae..4
3. Male gonopods with telopodite composed of long, slender tibiotarsus and short, slender femoral process............**Hybaphe** Cook

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[1] Diplopoda: Polydesmida: Xystodesmidae. Accepted for publication October 15, 1968.

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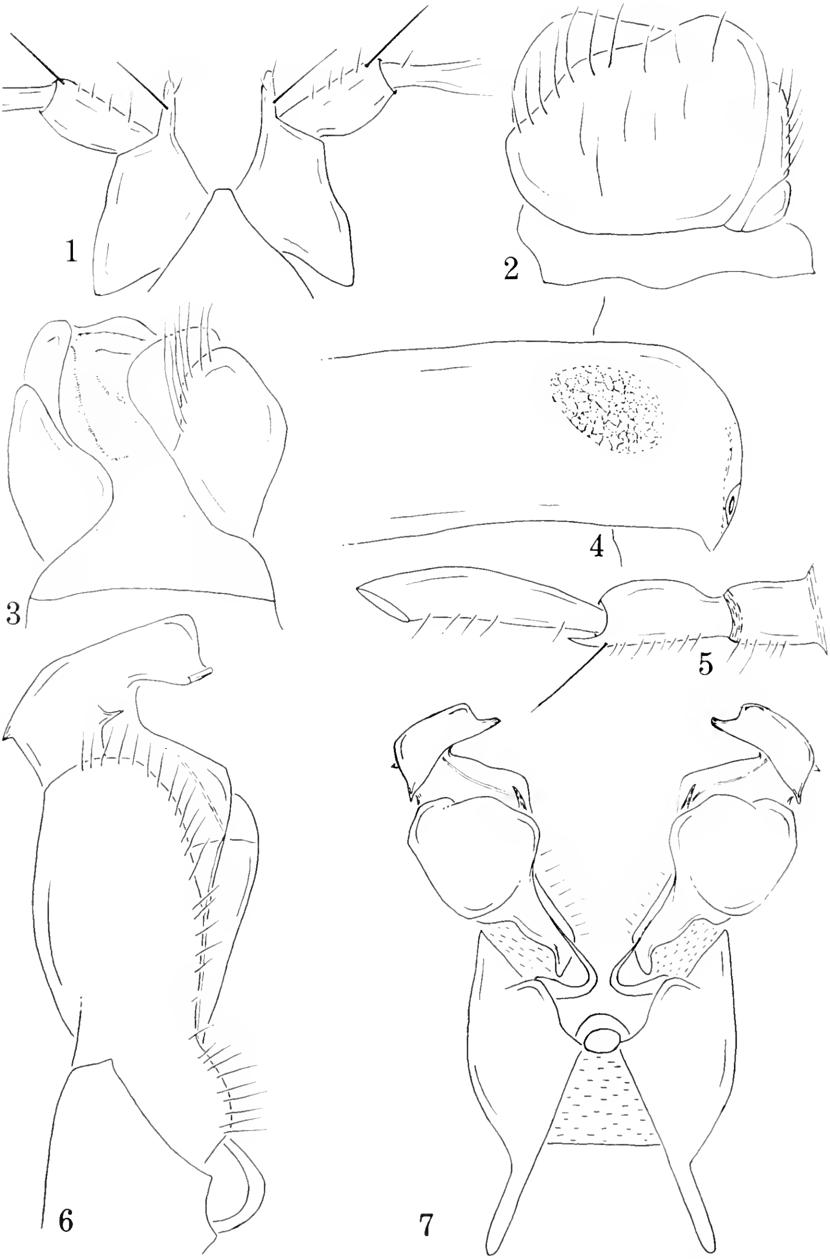
[4] Gonopods must be removed to verify this character in certain species.



FIGS. 1–7. All Figures of *Anombrocheir spinosa* are drawn from specimens collected 3.5 miles north of Leesville, Colusa County, California. FIG. 1.—Paratype

Male gonopods with tibiotarsus, femoral process, and definite lobate prefemoral process (see Buckett and Gardner, 1968, for illustrations) .... **Harpaphe** Cook

4. Collum equal to or narrower than head .... **Motyxia** Chamberlin

Collum much wider than head .... **Sigmocheir** Chamberlin

5. Sternum between fourth pair of legs of male distinctly swollen or produced 6

Sternum between fourth pair of legs of male flat or only slightly swollen 7

6. Telopodite of gonopod with broad, blade-like lateral process and narrow, smaller mesal process .... **Paimokia** Chamberlin

Telopodite of gonopod divided into several apical processes .... **Xystocheir** Cook, **Delocheir** Chamberlin, **Cheirauxus** Chamberlin

7. Gonopod telopodite massive, a single piece extending cephalad beyond sixth pair of legs .... **Anombrocheir** Buckett and Gardner, NEW GENUS

Gonopod telopodite divided into two or more slender processes 8

8. Dorsa of segments with numerous, round tubercles; telopodite of male gonopods with forked lateral piece and heavy, entire mesal piece .... **Amplocheir** Chamberlin

Dorsa lacking tubercles; male gonopods with long, simple lateral piece, the mesal branch simple or complex ..... **Wamokia** Chamberlin

Anombrocheir Buckett and Gardner, NEW GENUS

TYPE SPECIES: *Anombrocheir spinosa* Buckett and Gardner, new species.

DIAGNOSIS: Body averaging 25 mm in length and 5.0 mm in width; color a light yellowish-gray dorsally, with orange on tips of paranota and epiproct.

Head smooth and shining, with prominent coronal suture; antennae reaching back to fifth segment along paranotal margins.

Tergites smooth, paranota well developed, extending ventrolaterad from mid-body height, with anterior lateral margin rounded and posterior corners acute, though not produced much caudad (see Fig. 4); collum narrow, about one-third as long as broad, with anterior margin curving evenly back, posterior corners equal to posterior margin of collum. Sterna low mesally, distinctly produced laterally, a transverse groove present between legpairs of each segment. Legs long, with femur extending beyond lateral margin of segment; leg segments unmodified except for moderate prefemoral spine; second and third legs of male each with a pair of cylindrical ventral processes; second legs of female with a prominent pair of elongate coxal projections.

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female; sternum and proximal leg segments of second leg. FIG. 2.—Paratype female; cyphopod, anterior aspect. FIG. 3.—Paratype female; cyphopod, mesal aspect. FIG. 4.—Holotype male; right half of ninth segment, dorsal aspect. FIG. 5.—Paratype male; proximal three segments of right leg of twelfth segment. FIG. 6.—Paratype male; left gonopod, posterior aspect. FIG. 7.—Paratype male; gonopods, anterior aspect.

Gonopod socket large, sub-oval in shape, with posterior rim raised heighth of one coxal width; gonopods large, with coxae broad and joined together with a distinct sclerotized sternal connective which is surrounded by connective tissue and situated just distad of coxal muscles; telopodite joined to coxa distally by movable joint at oblique angle; prefemur-femoral region of telopodite subequal to coxa in size, without lobes or processes, surface slightly roughened and supporting many setae on posterior surface; tibiotarsal region narrowing abruptly, circled by several spines, apical portion produced mesad, terminating in a narrow, curved flange.

Anombrocheir spinosa Buckett and Gardner, NEW SPECIES

Holotype male: Coronal suture prominent, ending abrupting above antennal sockets, and with two prominent setae on each side; vertex smooth and shining, but etched with many minute transverse impressed striae; frontal and gular regions also marked by minute impressed striae; frons with a pair of setae dorsally between antennal sockets, a pair just below antennal sockets and separated by a distance equal to two-thirds the intersocket distance, and a row of 5 setae on each side near ventral margin of frons, with a distance equal to about two-thirds the interantennal area separating the inner most setae of each row; clypeus with a transverse row of 25 setae; labrum with a transverse row of 22 setae; gula with a broad, shallow groove parallel to lateral margin of facial shield; a distinct supra-antennal groove present; antennae moderate in length, reaching caudad to fifth segment along lateral margins of paranota, and separated by a distance equal to second antennal segment; first antennal segment cylindrical, not longer than width of socket, with two dorsal and two ventral sub-apical setae exceeding width of segment; second segment three times length of first, proximally half width of first, but apically equal to it in width, with numerous short setae along dorsal and ventral margins, and 4 long apical setae; segments three to five setose, equal in shape, cylindrical and narrower proximally; segment three subequal in length to two, segments four and five slightly shorter; segment six the longest segment, cylindrical, about two-thirds as wide at base as apex, and covered with fine setae; seventh segment sub-hemispherical, with four sense cones inset at apex.

Tergites smooth dorsally, except for many minute longitudinal impressed striae; lateral extensions of paranota with sub-cuticular reticulations, paranota projecting slightly ventrolaterad from mid-body height and each exceeding width of body cylinder by about thirty per cent of the cylinder; paranota slanted, with posterior margin about thirty degrees higher than anterior margin; collum with anterior margin broadly rounded, covering back of head; posterior corners of collum rounded, situated equal to posterior margin of segment; collum short, about one-third as long as broad; following seven segments with anterolateral corners increasingly rounded, posterior corners produced; segments eight to nineteen with anterolateral margins of paranota broadly rounded, with the posterior corners acutely rounded and produced slightly caudad of segment; repugnatorial pores opening on dorsal side of lateral margins of paranota and barely exceeded caudally by posterior margin of segment; segments seventeen to twenty progressively reduced, with segment nineteen greatly reduced, tergite narrower than distance between posterior corners of segment eighteen; epiproct subtriangular, with concave lateral margins and truncate apex with mucro exceeding anal valves; epiproctal setae situated as follows: two pairs of paramedial dorsal setae close to mesal line, one about mid-length of segment, the other near apex, 3 setae along each lateral margin of tergite and 2 pairs of apical setae; anal valves roughened, anal lips produced and lined by 2 pairs of setae; hypoproct sublenticular, longer than half its width.

Sterna of first and second legs not exposed between closely adjacent coxae; third through seventh segments with intercoxal area of sternum becoming gradually wider; following segments with sterna finely wrinkled, low mesally, raised out from body cylinder laterally by one-third coxal width, a distinct transverse groove present between legpairs of each segment; pleural area smooth; anterior stigma of each segment elongate-oval, the posterior one subcircular and smaller.

Legs long and robust, femur exceeding lateral margin of paranota, coxae separated by slightly more than 2 coxal lengths; second coxa with small, rounded caudal process; third coxa with elongate, anteroventral process; normal legs with coxa short, slightly flattened, densely setose; prefemur about 1.3 times length of coxa and slightly broader, with a distinct ventral apical spine; prefemur very narrow basally, widening to 3 times basal width at apex, about 1.2 times length of prefemur; postfemur shorter and narrower than coxa, and tibia of same proportions, but shorter and narrower yet; tarsus sub-cylindrical, more densely setose than previous segments, subequal in length to prefemur, with a large, slightly curved claw equal to almost half the length of tibia; femur and tarsus becoming exaggerated in length near posterior end of body, tarsus subequal to previous two segments in length and femur almost twice length of tarsus.

Gonopod socket suboval in shape, with a low anterior rim and raised posterior rim, socket extending to two-thirds length of prozonite, posteriorly to four-fifths of metazonite, and in width slightly narrower than distance between lateral margins of eighth coxal bases.

Gonopods very large, telopodites produced cephalad to anterior margin of fifth segment; coxae erect, longer along lateral margin than along mesal margin, with a short apophysis projecting baso-laterad from mesal margin; anteriorly, coxae joined at apex of mesal margins by a small, circular sternal remnant and a translucent band of connective tissue caudad of the sternum; coxae connected posteriorly by abundant transverse muscle tissue; telopodite joined to coxa by movable hinge which flexes longitudinally, permitting a vertical- or anterior-facing position of the telopodite; prefemur-femur as wide as coxa at hinged joint, then broadening distally until much exceeding coxa in width and equalling it in length; prefemur long-setose caudally, with an even row of equal setae extending up mesal margin and lining distal margin on posterior side, surface of the prefemur-femur being minutely roughened, not shining; beyond prefemur-femur, telopodite abruptly narrowing to half its former width, the distal portion curving mesad with apex truncate; at point where narrowing occurs, 3 prominent spines, anterior, lateral and posterior encircle telopodite; a longitudinal flange occurring mesally on posterior side of femur, cephalad of distal margin of which a large spine is based, the spine exceeding distal margin of femur on anterior face; apex of telopodite with a thin flange produced and curling distad on posterior side; solenite emerging distally on anterior face of coxa medially between lateral and mesal margins, inserting in seminal canal on prefemur mesally, the canal proceeding along mesal margin of femoral flange for about half its length, then to anterior side of flange, continuing to apical extremity and opening on mesal margin of apical flange near its anterior margin.

FEMALE: As in male except for sex characteristics. Second coxae with a pair of seta-bearing ventral processes. Cyphopod aperture oval, with a large median constriction on posterior margin; cyphopods extremely wide, almost ovoid in shape, with a broad groove on posterior margin and valves barely exceeding receptacle.

SPECIMENS EXAMINED: CALIFORNIA: Holotype male, 3.5 miles north of Leesville, Colusa County, 22 December 1965 (J. S. Buckett, M. R.

& R. C. Gardner). Paratypes: Colusa County: 13 males, 5 females, same data as holotype; 9 males, 14 females, same locality as holotype, 23 March 1968 (J. S. B. & M. R. G.); Glenn County: 26 males, 8 females, 3.3 miles north of Grapevine Pass, 23 March 1968 (J. S. B. & M. R. G.).

Discussion: Specimens from 3.3 miles north of Grapevine Pass differ from the holotype in the anterior sub-apical spine of the gonopod being much the largest, exceeding others in the ring by 2 times their size; also, the apical region of the telopodite exhibits a more pronounced distal hump, the apical flange not being perpendicular to the telopodite, as the posterior margin is proximad of the anterior. Specimens from 3.5 miles north of Leesville resemble the condition found in the Grapevine Pass specimens. Non-geographic variation is found in the number of sub-apical spines on the gonopod, with as many as five subequal spines present on the lateral face.

Anombrocheir has been found in the rainshadow region of the inner coast ranges of northern California. The known range of *A. spinosa* spans about 25 miles in its greatest dimension, greater than the known range of any of the species of *Wamokia*, a close relative which inhabits similarly dry terrain in the Sierran Foothills (see Buckett & Gardner, in press). Presently it seems that *Anombrocheir* is probably not splintered into a number of localized species as is *Wamokia*, although further collecting must be carried out to confirm this hypothesis. No explanation can be given for this apparently great genetic stability at this time.

Anombrocheir appears to be allopatric with all other xystodesmids. Specimens of *Xystocheir* have been collected 40 miles south of the southern collection of *Anombrocheir*, and specimens of *Harpaphe* over sixty miles to the north, both other genera in very different habitats.

The habitats occupied by *spinosa* all lie in areas with average annual rainfall of about 20″–22″. The specimens were found in areas where accumulated leaf litter was thickest (about one inch), although it was only slightly moist. The major components of the litter were leaves from *Quercus douglasii* H. & A., although *Pinus sabiniana* Dougl. also influenced the habitat. Specimens were also found in the litter under a bush of *Adenostoma fasciculatum* H. & A., in an area where the population of *spinosa* was large.

Anombrocheir is closely related to the group of genera including *Xystocheir*, *Cheiraxus* Chamberlin, *Delocheir* Chamberlin, *Wamokia*, *Amplocheir* Chamberlin, and *Paimokia* Chamberlin. The genera in this group possess the common features of the gonopod coxae being bound tightly together with connective tissue and muscle, a distinct, sclerotized sternum, the telopodite joined to coxa by a movable hinge, the second and third legs of the male with cylindrical coxal processes, and second leg of female with a cylindrical coxal process.

Of these related genera, *Xystocheir* and *Wamokia* appear to be the closest relatives of *Anombrocheir*. Though *Xystocheir* is the nearest genus geographically, *Anombrocheir* differs from it by lacking tubercles on the dorsum, by possessing a shorter, more evenly oval gonopod aperture, lacking sternal swellings on the pregenital segments, and by the obsolescence of the apical processes of the telopodite of the gonopods. *Wamokia*, on the other hand, resembles *Anombrocheir* in all these characters, as well as inhabiting terrain as dry as that which supports the latter. *Anombrocheir* does differ from *Wamokia*, however, by possessing a broader body (length/width ratios in male of 5.3–6.9 for *Wamokia* vs. 5.0–5.2 for *Anombrocheir*) with a disproportionately greater separation of the pregenital legs, as well as a much more massive telopodite of the gonopod. From the above comparisons, we conclude that *Wamokia* is the genus most closely related to *Anombrocheir*.

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(THE ENTOMOLOGIST'S RECORD, continued from p. 66)

Nomenclature Notice.—Possible use of plenary powers by the International Commission on Zoological Nomenclature is announced for the following cases pertaining to insects and spiders, the case number in parenthesis: (see Bull. Zool. Nomencl. 25, pt. 2/3, 27 September 1968), Arachnida (1838) type-species for *Oligolophus* C. Koch, 1872; Hemiptera (1843) validation of *Aphis gossypii* Glover, 1877; Hymenoptera (1845) type-species for *Anoplius* Dufour, 1834; Hymenoptera (1845) neotype for *Sphex niger* Fabricius, 1775, and *Sphex nigerrimus* Scopoli, 1763; Hemiptera (1852) suppression of *Siphocoryne angelicae* del Guercio, 1911, and Lepidoptera (1853) validation of emendation to *Hyposmocoma* of *Hyposmochoma* Butler, 1881. Send comments in duplicate, citing case number, to the Secretary, International Commission of Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.—W. E. CHINA, *Assistant Secretary*.

Announcement.—The 1969 Summer Institute in Systematics is being organized by the Society of Systematic Zoology with the support of the National Science Foundation and the Smithsonian Institution, the site of the Institute. The goal of this activity is to expose younger, teaching-researching zoological systematists to the full range of current concepts and techniques available to them. A series of provocative lecturers will present various facets of the subject during the mornings of three weeks in a manner calculated to evoke maximum discussion. Afternoons will be left unstructured so that participants may use the National Collections for their individual research projects, which they are encouraged to discuss in informal afternoon sessions. The Institute is limited to twenty-five participants who will be given air coach fare and per diem while in Washington. Applications may be obtained from: DR. R. S. COWAN, *Office of Systematics, Museum of Natural History, Smithsonian Institution, Washington, D. C.* 20560.

Thousand-Year-Old Boll Weevil Identified.—The boll weevil, one of the world's worst cotton pests, has been active for a thousand years longer than history has indicated until now, as demonstrated by Rose Ella Warner, of the Systematic Entomology Laboratory, United States Department of Agriculture, in Washington, D. C. Recently she identified a perfectly preserved, thousand-year-old boll weevil, which she said appears to be of a form (Fig. 1) intermediate between two other weevil species: *Anthonomus grandis grandis*, and *A. g. thurberiae*. The ancient specimen look just like its two extant species and it cannot be distinguished from an intermediate form that infests cotton in Arizona and Mexico. The weevil was concealed within some upland cotton that Dr. C. Earle Smith, Jr., of the U.S.D.A., obtained from an archeological excavation in a cave near Oaxaca, Mexico. The discovery may lead to new sources of cotton germ plasm that possess desirable characteristics for improving commercial varieties of the crop. Dr. Smith credits discovery of the boll weevil to Dr. S. G. Stephens, of North Carolina State University's Genetics Department. Dr. Stephens was examining fragments of cotton that he borrowed from Dr. Smith when he found the weevil in a cotton seed. The presence in the cave of pottery belonging to a known era in Indian civilization and radioactive carbon-14 dating determined that the cotton had been in the cave since about A. D. 968, according to archeologist Dr. Kent V. Flannery, who sent the cotton to Dr. Smith. Entomologists are certain that the weevil lay entombed in the cotton seed for 1,000 years, a conclusion they base on the weevil's habits and the appearance of the cotton.

FIG. 1. Thousand-year-old Boll Weevil. U.S.D.A. photo.

The boll weevil had previously been known as a cotton pest for less than 100 years. It was described as a distinct species in 1843, but its plant host was unknown until 1880, when boll weevils were found infesting Mexican cotton crops.—U.S.D.A. release.

(Continued on p. 78)

A New Species of Capnia (Plecoptera: Capniidae) from Arizona[1,2]

RICHARD W. BAUMANN and ARDEN R. GAUFIN[3]

Intensive collecting during the last two years as part of a study on the Nemouridae of Western North America resulted in the discovery of an interesting species of *Capnia*. Since a revision of the western Capniidae was recently completed by Nebeker and Gaufin (1968), it was felt that a name should be given to this species at this time. This paper describes a new species of *Capnia* from Arizona which is quite different from most *Capnia* in its morphological and ecological characteristics.

Capnia (Capnia) arizonensis, NEW SPECIES

MALE.—Wings brachypterous. Length of forewing 3.5 mm; length of body 4.5–5.5 mm. Body and appendages brown; wings hyaline. First nine abdominal tergites without special modifications. Supra-anal process (epiproct) reflexed, extending forward nearly to margin of eighth tergite, spatulate dorsally, slightly narrower behind, the apex with a sharp median spine, in line with ventral surface of process in lateral view. Process narrow laterally with a fairly constant width throughout (Figs. 1, 2).

FEMALE.—Wings macropterous. Length of forewing 6.0 mm; length of body 6.0–7.0 mm. Body color brown; wings hyaline. Dorsal broad membranous stripe on abdomen extends from tergite one to eight. Subgenital plate not well defined, with a small broadly rounded projection medially. Eighth abdominal sternite recessed slightly on either side of subgenital plate. Oblong, darkly pigmented sclerotized areas on the lateral posterior margins of the eighth sternite. Larger L-shaped sclerotized patches centered laterally on the ninth sternite (Fig. 3).

MATURE NYMPH.—Body length 6.0–7.5 mm (excluding antennae and cerci). Segments of cerci 24–26, of antennae 40–42. Maxilla with lacinia with 3 teeth at apex. Fourteen to 15 stout hairs on inner apical margin. Galea equal in length to lacinia, tapering to a point and clothed with stout bristles. Maxillary palpi with 5 segments. Labium with glossae and paraglossae equal. Palpi short, equal in length to glossae and paraglossae, with 3 segments, second longer than the first and third. Mandibles similar, with two cusps outside, outer cusp blunt, a small cusp in center and a fringe of fine bristles on inner half. Y-ridge of mesosternum as in Fig. 4.

TYPES.—Holotype male, allotype female, and 65 male and 17 female paratypes, Big Bug Creek, Hwy. 69, 10 miles south of Mayer, Yavapai Co., Arizona, 8–IV–68, R. W. Baumann (UU). Additional paratypes as follows: ARIZONA: Small mountain stream 15 miles south of Globe, Gila Co., 5–IV–66, Joe Schuh, 6 males, 3 females, 5 nymphs (SGJ): East Verde River between Payson and Pine, Gila Co., 6–IV–66, Joe Schuh, 1 female.

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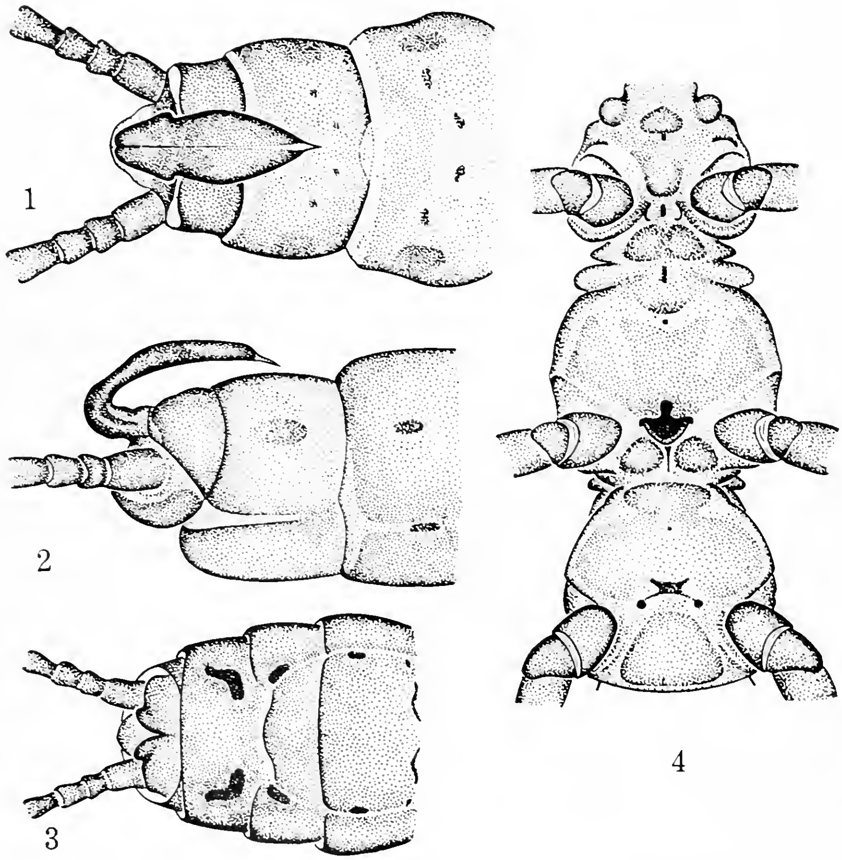
[1] This work was supported by NSF grant No. GB 3118 and Water Pollution Control grant No. WP 54.

[2] Accepted for publication December 3, 1968.

[3] Department of Zoology, University of Montana, Missoula, Montana 59801.

2 nymphs (SGJ); San Carlos River near springs, 40 miles east of Globe, Gila Co., 2–IV–68, W. L. Minckley, 2 males (UU); East Verde River, Hwy. 87, 5 miles north of Payson, Gila Co., 8–IV–68, R. W. Baumann, 58 males, 12 females (UU); Yaeger Canyon Creek, Hwy. 89, 3 miles southwest of Mingus Mountain Summit, Yavapai Co., 9–IV–68, R. W. Baumann, 3 males, 1 female (UU).



FIGS. 1–4. FIG. 1.—*Capnia arizonensis*, dorsal view of part of male abdomen. FIG. 2.—*C. arizonensis*, lateral view of part of male abdomen. FIG. 3.—*C. arizonensis*, ventral view of part of female abdomen. FIG. 4.—*C. arizonensis*, thoracic sterna of nymph, ventral view.

Specimens are deposited in the collections of the University of Utah (UU) and S. G. Jewett, Jr. (SGJ).

Nymphs were taken at the type locality and at both additional localities collected by the senior author.

ECOLOGICAL NOTES.—The localities where all specimens to date have been collected are between four and five thousand feet in elevation. Two localities, Big Bug Creek and Yaeger Canyon Creek are intermittent streams which dry up during the summer months. From the number of specimens collected, it is assumed that collections were made near the peak of emergence. This places the emergence time in April, which is late for most *Capnia*. It is also interesting because the floral surroundings of the type locality belonged to the Sonoran type, and the air temperature was near 80° Fahrenheit.

DISCUSSION.—This species is near *C. projecta* Frison and several other species in this complex. It differs principally in the broadness of the male supra-anal process and by the brachypterous condition of the wings of the male.

The following key will separate *C. arizonensis* from the closely related *Capnia* species found in the southwestern United States.

MALES

1. Supra-anal process flattened dorso-ventrally 2
   Supra-anal process not flattened dorso-ventrally 3
2. Supra-anal process wide throughout its length, tapering abruptly at apex, appearing as a broad spatula in dorsal view, tip developed into a sharp delicate spine; wings brachypterous .... **arizonensis**
   Supra-anal process tapering from wide base to pointed apex, appearing as an elongate triangle in dorsal view, tip pointed but not developed into a sharp spine; wings macropterous .. **utahensis**
3. Spine at tip of supra-anal process thin and delicate, one seventh length of supra-anal process, not bent downward at tip ...... **projecta**
   Spine at tip of supra-anal process not delicate, one third length of supra-anal process, bent downward at tip .... **limata**

FEMALES

1. Eighth sternite mostly membranous, with small sclerotized patches only on lateral margins 2
   Eighth sternite sclerotized, not mostly membranous, heavy sclerotization medially 3
2. Posterior edge of subgenital plate with small pointed projection medially .... **projecta**
   Posterior edge of subgenital plate with broadly rounded projection medially .... **arizonensis**
3. Seventh and 8th sternites united by median sclerotized connection .... **limata**
   Seventh and 8th sternites not connected, separated by membranous area .... **utahensis**

ACKNOWLEDGMENT

The authors are grateful to W. L. Minckley, Arizona State University and Stanley G. Jewett, Jr., Portland, Oregon, for sending material for study. We are indebted to William E. Ricker, Stanley G. Jewettt, Jr. and Alan V. Nebeker for helpful suggestions on the preparation of this paper. The drawings were made by Michael L. Miner.

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GAUFIN, A. R., and S. G. JEWETT, JR. 1962. New Capnias from Utah (Plecoptera). Wasmann Jour. Biol. 20(1): 69–71.

NEBEKER, A. V., and A. R. GAUFIN. 1968. The Winter Stoneflies of the Rocky Mountains (Plecoptera, Capniidae). Trans. American Ent. Soc. 94: 1–24.

(THE ENTOMOLOGIST'S RECORD, continued from p. 74)

A Record of Rachiceridae from New York (Diptera): On July 25, 1968, I found a male specimen of *Rachicerus obscuripennis* Loew on the inside of my garage window at Ludlowville, New York.

Apparently no species of *Rachicerus* is known from New York. Although *R. nitidus* Johnson has been recorded from as far north as Maine and New Hampshire and *R. fulvicollis* Walker from Massachusetts, most records of this genus are from well south of New York. *R. obscuripennis* has been collected in Maryland, Virginia, Indiana, Illinois, Michigan, Missouri and Kansas. The 1968 record from New York appears to be an interesting range extension.

In life, *R. obscuripennis* closely resembled in general appearance and activity a specimen of *Sylvicola* sp. (Anisopodidae) and I suspect collectors in the past may have overlooked the rarely collected *Rachicerus* for this reason.—L. L. PECHUMAN, Department of Entomology and Limnology, Cornell University, Ithaca, N. Y. 14850.

New records for Orthoptera.—*Paropomala wyomingensis:* Jacques Helfer of Mendocino, California, has added a new distributional record for this species for New Mexico when he collected 3 females and 1 male on the Mescalero Dunes, New Mexico, September 1, 1961. Another new record for Nevada should be noted as David Rentz, Kensington, California, collected the same species at Soldier Meadows, Nevada during the summer of 1968.—GLENN E. WINOM, *Oroville, California* 95965.

(Continued on p. 81)

A New Species of Hydroptilidae (Trichoptera)[1, 2]

R. L. BLICKLE

During a light trap survey specimens of a new species of Hydroptila were taken. The species belongs to the *H. ampoda* Ross group, an aggregation of quite similar species. The tenth tergite with its beak shape, especially in lateral view, the short downward curved clasper, and the long process of the seventh sternite are features that indicate that this species belongs here.

The group to which this species belongs is comprised of approximately a dozen species, mainly known from the northeastern part of the U. S. A. *Hydroptila hamata* Morton to which the new species is closely related is a very widespread species, occurring from Mexico to the state of Maine (Ross, 1944). Since so many of the Hydroptilidae have a distribution north and south along the Appalachian Mountains and east and west across northern U. S. A. and Canada, it is extremely probable that this species will be found to have a wide distribution. The description is offered at the present time to enable a more accurate determination of the species likely to be encountered in studies concerning aquatic life.

The holotype specimen will be deposited in the Illinois Natural History Survey collection, paratypes will be placed in the National Museum and in the collection of the University of New Hampshire.

Hydroptila lennoxi, NEW SPECIES

MALE.—Length from front of head to tip of wings 2.8–3.0 mm. Seventh sternite with a very long apico-mesal process which extends posteriorly beyond the apex of the claspers.

Genitalia (figs. 1–4).—Claspers short, curved ventrally; apex slightly hooked. A finger-shaped process extends dorsally from clasper base; a long spine projects posteriorly from tip of this process. Tenth tergite rectangular-shaped in dorsal view (fig. 3); appearing concave in lateral view; apical margin slightly emarginate. The ninth segment is concave in ventral view and in lateral aspect apico-lateral margin is irregularly crenulated; this margin is set with long hairs. Aedeagus, 0.46 mm long. The base and titillator are sclerotized; apex appears pushed back on itself at its base and appears to be folded accordion-like; the titillator is curved downward sharply in its apical third. Fig. 4 was drawn from a slide preparation, the others from whole specimens to show slight variations in the titillator position.

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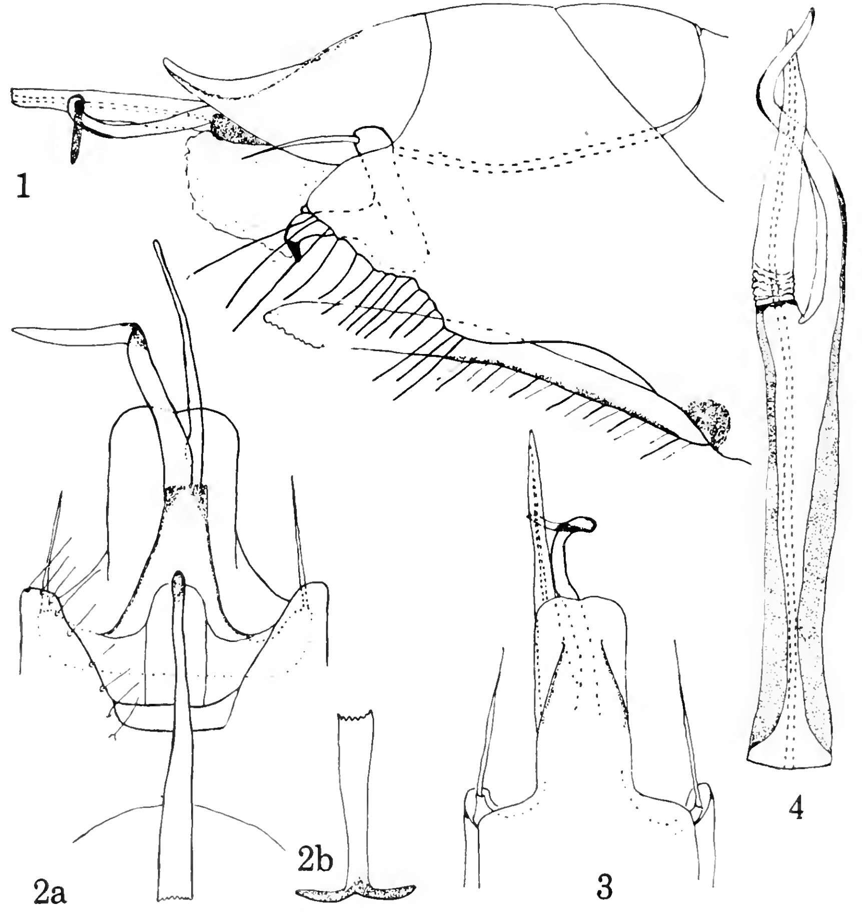
[1] Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as Scientific Contribution No. 441. Collecting equipment furnished by Central University Research Fund (University of New Hampshire) Grant No. 172.

[2] Accepted for publication October 11, 1968.

[3] Department of Entomology, University of New Hampshire, Durham, N. H. 03824.

The distinctive aedeagus, the hooked claspers, and the rectangular tenth tergite will serve to distinguish this species from closely related forms.



FIGS. 1–4. *Hydroptila lennoxi* new species, genitalia. FIG. 1, lateral view; FIG. 2a, ventral view; FIG. 2b, extension of 7th sternite from 2a; FIG. 3, dorsal view; FIG. 4, aedeagus, lateral view.

This insect will key to *H. hamata* Morton in Ross, 1944 (p. 142); the following couplet will serve to separate the two species.

Aedeagus rod sharply right angled close to the end; 10th tergite, in
  dorsal aspect, widest at middle......................**H. hamata** Mort.
Aedeagus rod curved gradually to the right; 10th tergite, in dorsal
  aspect, with sides parallel.........................**H. lennoxi** n. sp.

Holotype Male.—Jefferson, New Hampshire, 24 June 1964.

Paratype Males.—Jefferson, New Hampshire, 24 June 1964, 30 August 1964, 15 August 1966, 16 specimens.

LITERATURE CITED

Ross, H. H. 1944. The Caddis Flies or Trichoptera of Illinois. Bul. Illinois Nat. Hist. Surv. Vol. 23: 326 pp.

(THE ENTOMOLOGIST'S RECORD, continued from p. 78)

Comments on a Preliminary Revision of the Genus Tropihypnus: *A preliminary revision of the genus Tropihypnus* (Coleoptera, Elateridae), by J. N. L. Stibick (Ent. News, July 1968, pp. 169–187): *T. chatterjeei* Fleut.—7 males, 6 females from Miss C. M. F. von Hayek, British Museum (N.H.), H. G. Champion Collection, are all from Kumaon, W. Almora, India; one collected March 1918, another in December 1917. The male genitalia has a slender penis, and its parameres are expanded only at the base; it is otherwise similar to that of Uniques A and C, but not to the Unique D previously suggested as conspecific. The pronotum is coarsely and closely punctate, but not rugose. The distinctive rusty red-brown body color is always present, sometimes more reddish on the elytra. The pubescence is white, but appears as a pale yellow under high magnifications.

Queries have been made on the distinctive genitalia of *T. rungbongi* Stibick. *Tropiphynus* may be divided into four arbitrary groups. The genitalia, keeled scutellum, and notched 5th abdominal segment of the male separate *T. rungbongi* from the others. Fleutiaux's two species with a complex and attenuate elytra form another group. The male genitalia separate *T. punjabae* Stibick and Unique B (parameres broad at apex) from the remaining species (i.e., *T. namsooa* Stibick, parameres knobbed at apex). Insight into the relationships of *Tropihypnus* may not be possible unless more material becomes available from the interior of Tibet and China, and after a complete study made of the Negastriinae, in which it is currently placed.

ERRATA: p. 174, lines 27, 28: the *holo-*, *allo-*, and $\frac{2}{3}$ of the *paratypes* are in the British Museum (N.H.); $\frac{1}{3}$ of the *paratypes* are in my collection or in the Purdue Entomology Research Collection. There are 84 males, 71 females from the type locality (not 77 males, 78 females). P. 177, line 9: delete *Crypnoidus setosus* Fleutiaux (LAPSUS); add *Quasimus setosus* ab. *ferruginosus* Buysson. The latter name should also be listed on p. 175, after line 5. Include here (p. 175) *Crypnoidus setosus* (Buysson) Fleutiaux (1928, p. 254). P. 185, line 5: delete *scutellum*, add *elytra*. P. 184, lines 23, 24 and p. 186, line 19: Fleutiaux (1908 not 1907). P. 177, line 9: Fleutiaux (1932 not 1934). P. 175, line 4: Buysson (1914 not 1934). P. 169, line 11: (1930, p. 636 not 31). P. 175, line 3: (1966, p. 145 not 45).

The full descriptions of the "Uniques" have been deposited at the United States National Museum, Washington, D. C. To these are added descriptions of *T. chatterjeei* and the species groups mentioned above.—J. N. L. STIBICK, 3617 N. Rockingham St., Arlington, Va. 22213.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

ANGEWANDTE ENTOMOLOGIE

By Rolf Fritzsche, Heinz Geiler, and Ulrich Sedlag. Gustav Fischer Verlag, Jena, 1968, 778 pp. Cloth approx. $21.75.

The stated purpose of this book is to provide a text in applied entomology in German, that area according to the editors, being inadequately represented in that language. It is intended to develop the subject in terms of principles.

Approximately half of the book is concerned with material which can be considered basic to understanding the "applied" aspects of entomology. This includes morphology, anatomy, histology, reproduction, growth and development, physiology, ecology, and systematics. The remainder of the book is devoted to more obviously applied subjects: beneficial insects, harmful insects and the nature of their harmful effects, methods of preventing insect damage including preventive measures, and physical, chemical, and biological control. There is a relatively short section on particular insect problems and methods for their solution.

The editors have managed to include a surprising amount of detail for a book of this kind. They have, for example, included discussions of such things as chromosome puffing and the roles of DNA and messenger RNA in metamorphosis, energy production in insect flight muscle, the various taxic responses of insects, and centers of control in developing embryos. These discussions are, of course, necessarily short, but readers interested in more detail or further discussion will find suitable source material in the bibliography.

The editors pointed out the necessity of restricting the number of literature citations, and for the breadth of material covered, the approximately 550 citations really seem scanty. They were, however, judicious in their selections. Approximately one third of the references are to compilations in the form of either texts or review articles. About forty per cent of all the references are from 1960 or later, and less than 30% from earlier than 1950. In the first four chapters there are no text citations of literature, but since the bibliographies for these, and all other chapters, include complete titles this is not a serious shortcoming.

Examples of species upon which discussions of various subjects are based (e.g. parasitism, predation, migration, etc.) are drawn mainly from Central Europe, other sources being used only where necessary. In spite of this, however, the presentation of the material is such as to not limit its significance to a regional basis, and the reader will find his appreciation of applied entomology sharpened no matter where his location. —D. L. Shankland.

SIX-LEGGED SCIENCE

By Brian Hocking. Schenkman, 1968. vii + 199 pp. Cloth, $4.50.

Six-Legged Science presents nearly the equivalent of a beginning college course in entomology with a light-hearted enthusiasm intended to woo the lay reader into harmony with "his tiny protagonists," the insects. Professor Hocking manages to pack an amazing quantity of entomological knowledge into this small book; e.g., in a single sentence he accomplishes a relatively complete, yet simple description of the structure and function of an insect circulatory system. His ability to simplify without significant loss of accuracy should be commended. The author has effectively selected many exciting events from the lives of insects, which are certain to capture the general reader's interest.

Considerable variation is apparent in the degree to which the author has employed levity. While the author's wit is entertaining, it sometimes detracts from a narrative which is inherently fascinating. Undoubtedly to hold his lay audience, Professor Hocking has adopted an anthropomorphic style which may charm the unscientific but will surely repel entomologists. In many places the presentation seems disjointed, with the relevance of some sections in doubt. For example, the first chapter, which alludes to scientific method, seems quite unrelated to either the remaining contents or the objectives interpreted through the preface. Illustrations throughout appear rather casually drawn and add little to clarify the text.

The entomologist will probably find little to hold his interest, while the general public will find much information and perhaps entertainment.—William J. Fischang.

Insect Ecology

GUIDE TO THE CHECK SHEET FOR IBP AREAS

G. F. Peterken et al., IBP Handbook no. 4, Blackwell Scientific Publications, x + 133 pp., 11 p. check sheet, 1967.

HANDBOOK TO THE CONSERVATION SECTION OF THE INTERNATIONAL BIOLOGICAL PROGRAMME

E. M. Nicholson, IBP Handbook no. 5, Blackwell Scientific Publications, ix + 84 pp., 1968.

Both of these publications are useful for those interested in preserved areas, their evaluation, and the increase of such areas.—R. H. A.

Orthoptera

REVISIONARY STUDIES IN THE NEARCTIC DECTINAE

David C. Rentz and James D. Birchim. Mem. Ser., 3, Pacific Coast Ent. Soc., California Acad. Sci., Golden Gate Park, San Francisco, 94118. xvi + 173 pp., 1968. Paper, $4.00 plus $.25 postage.

"The shield-backed katydids have long attracted the attention of entomologists whether by their presence in large numbers destroying crops and rangeland or by the striking appearance of most species when seen alive in the field. Not since 1907 has the group been systematically studied for the entire Nearctic Region, but rather scattered reports have appeared from time to time regarding single genera or limited geographic regions." Preface.

Lepidoptera

THE MOTH BOOK

By William J. Holland. Dover Publications, Inc., New York, 1968, xxiv + 479 pp., 262 black and white figs., 48 color pls. (facsimile of 1903 ed., with new foreword and emendations by A. E. Brower). Paperback, $5.00.

Holland's *Moth Book* has been the only fairly comprehensive, color-illustrated manual of North American Heterocera for 65 years. Although long out of print, it has been in so much demand as to command premium prices from dealers. Now Dover has blessed the budding lepidopterist by reprinting the book with a striking cover, quality paper, signature stitching for long life, and a refreshingly low price tag. The color plates are surprisingly clear to one used to older editions; and the nomenclature is partially modernized by A. E. Brower's emendation of some 85 of the names used in connection with the plates.

One must forgive Dover's misleading statement on the back cover that this work "offers the collector (both experienced and beginning) all the information he is likely to need to identify North American moths." There are over 10,000 species of moths in North America; this book treats 1,500 species. Again, while many groups have been revised since inclusion in *The Moth Book*, a larger number are still sadly in need of critical study, with many name changes and additions of species to be anticipated. Brower has apparently not attempted to be complete in bringing nomenclature up to date; he has ignored name changes which have appeared in recent publications, especially when they are in families other than his specialty, the Noctuidae. An endeavor to enlist the aid of other moth specialists would have made the emendations more extensive and, consequently, the book more valuable.

Finally, the treatments of most species are rather brief, consisting usually of little more than a statement of geographical range. For some of the more familiar species, however, we find quite a bit of information on immature stages, food plants, behavior, economic importance, etc. Holland was limited by both space restrictions and also his limited knowledge of moths. He admitted this in his preface. By today's standards his keys, descriptions, and nomenclature are quite inadequate; genitalic features were apparently unknown to him. He stated that he was depending upon his illustrations to provide means for identification.

Despite its shortcomings the book has great value still. This fact is due largely to the colored photographs of common members of many moth families. More recent works, notably W. T. M. Forbes' *Lepidoptera of New York and Neighboring States*, refer to the Holland plates, correcting or confirming the names used by Holland. Further, the charm of Holland's writing, with his generous sprinkling of quotations and anecdotes ("Sugaring for Moths," pg. 146, has long been a favorite of mine), give the book that romantic quality that enhances its value to those who appreciate the Golden Age of American lepidopterology. Most important, *The Moth Book* holds between the covers of a single volume enough information, albeit incomplete and inaccurate, to give the beginner a fairly sturdy foundation in moth taxonomy. For want of such a book, many who might become serious students of Heterocera would turn to other endeavors.

It is indeed unfortunate that *The Moth Book* is still the best elementary manual on North American moths. Until a new and better one is published, *The Moth Book* will continue to be an important reference for the lepidopterist, with a new lease on life given it by Brower and the Dover Press.—Charles V. Covell, Jr.

The Entomologist's Market Place

Advertisements of goods or services for sale are accepted at $1.00 per line, payable in advance to the editor. Notices of wants and exchanges not exceeding three lines are free to subscribers. Positions open, and position wanted notices are included here and may be referred to by box numbers. All insertions are continued from month to month, the new ones are added at the end of the column, and, when necessary, the older ones at the top are discontinued.

Pieris protodice (Lepid.), living ova or pupa urgently needed for research. Buy or exch., all season. A. M. Shapiro, Dept. Entomology, Comstock Hall, Cornell University, Ithaca, N. Y. 14850.

South American Coleoptera badly needed in exchange for Eastern North American species, mounted or unmounted. Eric Strahl, 23 Priory Lane, Pelham, N. Y., U. S. A.

For sale: Townsend's Manual of Myiology, 12 parts, complete, unbound; Ferris' Principles of Systematic Entomology, new condition; Creighton's Ants of North America, new condition; Ewing's Manual of External Parasites, excellent condition. Make offer. J. S. Wiseman, 152 E. Stenger, San Benito, Texas 78586.

Oedemeridae (Coleoptera) preserved in alcohol (preferred) or pinned desired for revision of family for World. R. H. Arnett, Jr., Department of Entomology, Purdue Univ., Lafayette, Ind. 47907.

Aquatic Bugs of World in exchange for Dutch insects except Lepidoptera. N. Nieser, Zoölogisch Laboratorium, afd. Systematiek, Janskerhof 3, Utrecht, Netherlands.

Insect Pins: $4.00 per thousand plus 10¢ per M postage. Prompt service. Clair Armin, 191 W. Palm Avenue, Reedley, California 93654.

Colombian Insects for sale, all kinds upon request. Many showy Lepidoptera and Coleoptera available. Carlos A. Pineda, c/o Comercial Antolf Apartado Aéreo 8811, Bogotá, Colombia.

Sphaerophoria (Diptera: Syrphidae) desired for revision of genus for North America. R. G. Gunther, 124 Lauder, Peoria, Illinois 61607.

Wanted: News, notes, and reviews of less than one page for immediate publication in ENTOMOLOGICAL NEWS. Send to: R. H. ARNETT, JR., Editor, c/o Department of Entomology, Purdue University, Lafayette, Indiana 47907.

For Sale: Coleopterists' Bulletin, volumes 1 to 19, complete, unbound. $95.00. Selwyn S. Roback, Academy of Natural Sciences, Philadelphia, 19th and Parkway, Philadelphia, Pa. 19103.

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Insects

ENTOMOLOGICAL NEWS

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FATTY ACID COMPOSITION OF LIMITED USE IN APHID TAXONOMY

William J. Yurkiewicz[1]

Abstract

An examination, by gas-liquid chromatography, of fatty acids within the various neutral lipid fractions of the milkweed aphid, *Aphis asclepiadis* Fitch, shows that myristic acid (C:14) is the major fatty acid in glycerides. C:16 and C:18 fatty acids are predominant in the other lipids. Total neutral lipid analyses reflect the composition of triglyceride which comprises 87.1 per cent of the lipid.

Following periods of starvation the composition of fatty acids within each lipid fraction remains the same, but if the total neutral lipid is analyzed before separation into its fractions C:14 appears to decrease and C:18 fatty acids increase. This change is due to utilization of triglyceride during starvation causing a lowered amount of triglyceride in the total neutral lipid sample.

It is suggested that carefully controlled experiments combined with biochemical improvements in fatty acid analysis will be necessary if fatty acid composition is to be used as a taxonomic tool at the species level.

Aphids have been characterized as having high concentrations of myristic acid (C:14) (Strong, 1963; Barlow, 1964; Fast, 1966) and it has been suggested that fatty acid composition might be of use to the insect taxonomist (Gilbert, 1967). The high percentage (i.e., > 50%) of myristic acid was found only in neutral lipids and not in phospholipids (Fast, 1966) and, unfortunately, the neutral lipid fraction was not further separated into its individual components for more detailed fatty acid analyses in any of the studies. I have examined fatty acids within the various neutral lipid fractions of the milkweed aphid, *Aphis asclepiadis* Fitch, to determine the feasibility of using chemical composition as a taxonomic tool.

Nymphs and adults were collected in the field from a single stand of the common milkweed, *Asclepias syriaca*. The insects were divided into nine equal lots for analysis. Three lots each were examined immediately, and after 24 hr. and 48 hr of starvation. Only water was provided during the periods of starvation and the insects were held in the laboratory at 22° C and 50% R.H.

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Lipids were extracted, fractionated, and quantitated as described previously (Yurkiewicz and Whelchel, In press). Fatty acids were prepared using the boron trifluoride technique of Metcalfe and Schmitz (1961). Standard gas chromatographic techniques (F and M Scientific Methods Bulletin No. 117) including the use of 6% diethylene glycol succinate columns at 190° C and a hydrogen flame detector were employed.

The results indicate that the neutral lipids of aphids analyzed immediately comprise 11 per cent of the wet weight and contain 87.1 per cent triglyceride, 8.2 per cent sterol ester and hydrocarbon, 2.2 per cent mono- and diglyceride, 1.5 per cent free fatty acid and 1.0 per cent sterol. After 24 and 48 hr. of starvation, the triglyceride fraction had decreased to 79.4 and 72.5 per cent, respectively, of the neutral lipid fraction. There was a corresponding increase in the per cent composition of all other neutral lipid fractions.

The fatty acid composition of *A. asclepiadis* analyzed immediately after collection is shown in Table 1. It is interesting that myristic acid (C:14) is the major fatty acid (> 50%) only in the triglyceride fraction. Total neutral lipid fatty acids are, of course, reflecting the composition of triglyceride, the major neutral lipid. After 24 and 48 hrs. the per cent composition of fatty acids within each fraction remained essentially the same, but by 48 hr. the amount of C:14 within the total neutral lipid fraction had decreased from 71 to 62 per cent. Concomitantly, the amounts of C:18, 18:1, 18:2, and 18:3 increased. This change is obviously due to the lowered amount of triglyceride in the total neutral lipid pool following starvation.

TABLE 1. Fatty acids in the lipids of the milkweed aphid, *Aphis asclepiadis* Fitch

Lipid Fraction	Per Cent Composition of Fatty Acids									
	12	14	14:1	16	16:1	18	18:1	18:2	18:3	>18:3
Triglyceride	3.5	77.6	t[1]	18.8	t	t	t	t	t	t
Mono- and diglyceride	t	32.2	t	22.4	6.9	9.5	15.2	8.1	5.3	t
Free fatty acid	3.2	18.0	t	34.0	8.2	14.2	15.9	5.3	1.2	t
Sterol ester	t	15.7	t	15.6	6.0	4.1	31.4	24.7	1.5	t
Total neutral lipid	2.2	71.0	t	16.5	1.1	2.5	3.2	3.5	t	t
Phospholipid	1.3	18.1	1.0	5.9	3.1	3.9	24.4	28.5	10.2	2.6

[1] t = trace, less than 1.0 per cent.

The great disparity in fatty acid composition among the neutral lipid fractions indicates that studies on the fatty acids within each fraction would be more useful than information on total neutral lipid fatty acids. Furthermore, that physiological state must be carefully controlled is clearly shown when fatty acids are examined following starvation. Myristic acid decreased significantly following a relatively short period of foot deprivation. A change of this magnitude suggests that fatty acid composition could vary from one insect sample to another thus making fatty acid taxonomic identifications difficult. It is probable that carefully controlled experiments combined with biochemical improvements in fatty acid analysis will be necessary if fatty acid composition is to be used as a taxonomic tool at the species level.

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NOTICE

Prompt publication of papers.—We are pleased to announce that due to the increased line size, and more extensive use of 8 point type, we have printed most of our backlog of papers for the NEWS. We are now able to give prompt publication to informative and useful papers. Almost any entomological subject is suitable for publication in the NEWS if it meets professional standards. New taxa must be illustrated, and keys provided or referred to. Information on behavior, physiology, and biochemistry is of great current interest. We suggest that "news" of discovery in these areas will help this journal, the only monthly publication on general entomology in the United States, in its role as an entomological news medium. We may suggest, also, that your subscription would insure that you see each month's copy, and help pay for additional pages.—R. H. A.

The Entomologist's Record

"To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

Two Species of Odonata previously unreported from New England.—On the 10th and 31st of July, 1966, a male and a female, respectively, of *Enallagma daecki* Calvert were captured in the tall grass near the outlet to Ponkapoag Pond, a 200 acre natural pond in the Blue Hills Reservation south of Boston, Massachusetts. Extensive collecting at this pond during the subsequent two years has failed to yield additional specimens of this southern damselfly whose previous reported distribution extended as far north as New Jersey.

More notable was the small series (7 ♂, 1 pair) of the rare *Somatochlora incurvata* Walker, collected August 30, 1968 at Big Heath, Acadia National Park, Mount Desert Island, Maine. Males of this species were seen frequently as they hovered over small sphagnum-choked pools in the center of this large bog. They were quite aggressive, chasing away other males and also males of *Aeshna sitchensis* Hagen which were also frequent at the same location. The females of *Somatochlora incurvata* oviposited singly in the sphagnum pools when they were not being pursued by males. In the United States this species had been reported only from northern Michigan. *Aeshna tuberculifera* Walker, a new record for Mount Desert Island, was also taken at Big Heath.

I wish to thank the superintendent of Acadia National Park for permitting me to collect Odonata within the park.—Harold B. White, III, *Graduate Department of Biochemistry, Brandeis University, Waltham, Massachusetts 02154.*

William Trowbridge Merrifield Forbes (1885–1968): Professor W. T. M. Forbes who died on the 23rd of April, 1968, in his 83rd year, was the son of William Trowbridge and Harriet Merrifield Forbes. He received his Bachelor of Arts degree from Amherst College in 1906, his Doctor Philosophy degree from Clark University in 1910. In the period between 1906 and 1908 he was an instructor in biology at Roberts College in Constantinople. He was also an instructor in zoology and entomology at Rutgers College during the academic year 1910–11; while at Rutgers he worked with Professor John B. Smith. It was Professor Smith who suggested the idea which finally became the "Lepidoptera of New York and Neighboring States."

In 1915 he joined the staff of the Department of Entomology at Cornell University; in 1921 he became an Instructor, in 1943 an Assistant Professor, in 1950 an Associate Professor, and in 1953 he retired as Professor Emeritus. He stayed on at Cornell until the late fall of 1954 at which time he moved to Cambridge, Massachusetts to continue his research studies at the Museum of Comparative Zoology at Harvard

(Continued on page 92)

Metapsaenythia, a New Panurgine Bee Genus (Hymenoptera, Andrenidae)[1]

P. H. Timberlake[2]

Abstract

The new genus *Metapsaenythia* is based on *Calliopsis abdominalis* Cresson, and includes *M. sonorana*, a new species from Sonora.

A new genus is being based on *Calliopsis abdominalis* Cresson, which is a common and well known species of the United States from Kansas and Texas eastward to the Atlantic coast. One other species is included, represented, unfortunately, by only one female from Sonora, Mexico.

The species *abdominalis* remained in *Calliopsis* for many years, but was removed to *Pseudopanurgus* in 1937, and later to the subgenus *Heterosarus* by Michener. At one time, also, it was thought by Cockerell, to belong through its synonym in the genus *Camptopoeum*, with which it certainly has some resemblance. Although *Pseudopanurgus*, in a broad sense, including the segregated group *Heterosarus*, was derived probably from *Psaenythia*-like ancestral stock, it seems likely that *Metapsaenythia* is a more recent development from *Protandrena*, with which it shares certain characters.

METAPSAENYTHIA, NEW GENUS

Description.—Wings with two submarginal cells, the second narrowed about one-half, or less, above and receiving first recurrent nervure about one-fifth of its length from base, rarely in some cases closer to base than second from apex. Pterostigma narrow, four or more times longer than wide. Marginal cell reaching halfway from stigma to apex of wing. Tibial scope of female thin and short, the hairs simple. Female with well-developed yellow or whitish face marks of the pattern seen in *Protandrena*. Males (as far as known) with face yellow below level of antennae. Abdomen of male slender, elongate, three or more times longer than wide. Apical depression of tergites strong, but only moderately wide, and basal impression moderately developed. Two apical lobes of seventh sternite narrow, acute at apex, with their tips curved outward. Eighth sternite (subgenital plate) of the general type seen in *Protandrena* and *Pseudopanurgus*, longer than wide, gently deflexed from its base, with parallel or diverging keels on dorsal surface and rounded at apex. Genital armature with gonocoxites separate from base and tapering into the fused gonostyli (parameral lobes); sagittae (penis valves) fused, or only briefly divided at apex, depressed, broader than parameral lobes and almost as long.

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[1] Accepted for publication November 12, 1968.

[2] Associate Entomologist, Emeritus, Department of Biological Control, University of California College of Biological and Agricultural Sciences, Riverside, California 92502.

Type of genus.—*Calliopsis abdominalis* Cresson.

KEY TO SPECIES OF METAPSAENYTHIA

Female with frons, vertex and mesonotum finely and densely punctured; black, with scutellum, metanotum, posterior face of propodeum and abdomen more or less completely ferruginous; large mark on face below antennae, not reaching margin of eyes but leaving anterior part of clypeus dark, and tubercles yellow (males similar, with face below level of antennae yellow) .... **abdominalis** (Cresson) (The subspecies *tricolor* differs in lacking most or all of the ferruginous color.)

Shining black, sparsely punctured; head much broader than long; transverse mark on lateral extensions of clypeus, transverse band above clypeus, tubercles and interrupted band on hind margin of pronotum creamy white; punctures of mesonotum faint, minute and close, with distinctly larger, but still small punctures sparsely interspersed............ **sonorana,** new species

Metapsaenythia abdominalis abdominalis (Cresson)

Calliopsis abdominalis Cresson, 1878, Trans. American Ent. Soc. 7: 68, ♀, ♂; Crawford, 1915, Proc. United States Nat. Mus., 48: 578.

Camptopoeum semirufum Cockerell, 1937, American Mus. Novitates, 817: 1, ♀.

Pseudopanurgus abdominalis Michener, 1937, Ann. Mag. Nat. Hist. (16) 19: 321.

Pseudopanurgus (*Heterosarus*) *abdominalis abdominalis* Michener, 1951, Hym. America, Syn. Cat., p. 1098.

This is a common species in Kansas and Texas and I have examined over three hundred specimens, many of them from flowers of *Monarda*, from which the females collect pollen. Some specimens were collected at flowers of *Helianthus annuus*, *Dalea aurea*, *Brazoria truncata*, *Aster tanacetifolius* and *Gaillardia*.

Metapsaenythia abdominalis tricolor (Cockerell)

Calliopsis abdominalis Fox, 1892, Entom. News, 3: 29; Bradley, 1943, Ent. News, 53: 190.

Calliopsis tricolor Cockerell, 1897, Trans. American Ent. Soc.: 151, ♀.

Pseudopanurgus (*Heterosarus*) *abdominalis tricolor* Michener, 1951, Hym. American, Syn. Cat. p. 1099; Mitchell, 1960, Bees Eastern United States, 1: 270.

This is merely a dark color form of *abdominalis* and is known from New Jersey and Pennsylvania south to North Carolina and Georgia.

Metapsaenythia sonorana, NEW SPECIES

This is a small, but robust bee, with a very broad head, a transverse white band on face below antennae, white marks on disk of pronotum and tubercles, and a very minutely punctured and shining mesonotum.

Female.—Black, shining; transverse mark on lateral extensions of clypeus, transverse supraclypeal mark rounded above, nearly circular subantennal marks, broadly interrupted band on hind margin of disk of pronotum and mark on tubercles creamy white. Thorax and abdomen otherwise dark, except sternite 6 testaceous brown. Legs dark, small mark at apex of front femora on anterior side, anterior side of front tibiae except at apex, and small spot at base of middle tibiae creamy white; small joints of front tarsi and spurs of middle and hind tibiae brown. Antennae black, flagellum more brown above and broadly reddish brown beneath. Mandibles dark red at apex, shading into rufotestaceous at middle and becoming fuscous at base. Proboscis black. Tegulae testaceous but fuscous on inner margin and with a white mark on nearly anterior half but not quite reaching outer margin. Wings brownish subfuliginous, nervures pale ferruginous, subcosta and margins of stigma infuscated.

Head much broader than long, inner orbits somewhat divergent above. Cheeks strongly receding, less than half as wide as eyes. Posterior ocelli slightly less than their distance apart from occipital margin and slightly more than same distance from nearest eye. Facial foveae slightly less than their own width from margin of eyes and about as long as space between posterior ocelli. Antennae inserted well below middle of face, reaching nearly to tegulae and with middle joints of flagellum somewhat thicker than long. Face depressed from level of ocelli to just below antennae, but clypeus strongly convex from side to side. Subantennal plates barely longer than wide, with inner suture much shorter than outer or the oblique anterior suture. Supraclypeal area much broader than high with its pale mark intruding between antennal sockets. Disk of clypeus nearly twice as broad as high, broadly rounded above, very obtusely angled on each side of the base of labrum, and with lateral extensions broadly inflexed and partly visible in frontal aspect. Labrum very large and both it and its process much broader than long; anterior border rather broadly finely rugose, but process polished, concave at middle and gently rounded across apex. Mandibles stout, acute, nearly reaching far margin of labrum. Proboscis moderately long, galeae nearly reaching base of stipites; first joint of labial palpi longer than next three joints together. Pterostigma slender, about five times longer than wide and about half as wide as first submarginal cell; second submarginal cell narrowed more than one-half above and receiving first recurrent nervure about one-seventh of its length from base and second one-sixth from apex. Abdomen ovate, about twice as long as wide, convex above; pygidial plate, except for well-rounded apex, concealed in type. Calcar of middle tibiae very slender, slightly curved and about three-fourths as long as basitarsus; calcaria of hind tibiae minutely serrate. Tarsal claws with small inner tooth. Head and thorax smooth, shining, very finely punctured; punctures of frons and vertex mostly well separated, those of clypeus somewhat coarser and closer and those of cheeks finer. Mesonotum very minutely, rather closely punctured, with somewhat larger punctures sparsely interspersed; mesopleura densely and finely punctured. Propodeum smooth, minutely punctured; basal area narrow and minutely rugulose. Abdomen slightly dull, very minutely shagreened or lineolate, and with moderately close minute punctures; apical depression of tergites narrow, not differing much from disk in sculpture except on tergite 1; basal impression of tergite 2 a narrow shining groove. Pubescence of face, cheeks and sides of thorax short, thin, erect and whitish, but mesonotum almost bare. Abdomen with very fine short, appressed hair, even on apical depression of tergites (except of first); apical fimbria ochraceus, rather dense but short; hair of venter erect, most evident on sternite 5. Scopal hair of hind tibiae very thin, shorter than greatest width of segment, but with somewhat longer hairs on outer margin very minutely plumose. Length, 5.5 mm; anterior wing, 4.8 mm; width of head, 2.3 mm.

Holotype.—Female, Oroz, Sonora, Mexico, on *Tidestromis lanuginosa*, Sept. 17, 1957 (Timberlake).

Type in collection of the University of California, Riverside.

(THE ENTOMOLOGISTS' RECORD, continued from p. 88)

University and to be near the members of his family who reside in and near Worcester.

During his long association with Cornell and the Department of Entomology he made many contributions to the departmental library and the collections. He spent a considerable sum of his personal money on building the Lepidoptera collection. His final gesture upon leaving Cornell was a substantial gift to the Department of Entomology to be used for graduate students and projects related to their work.

He was very much interested in the geographical distribution and Classification of the Lepidoptera, especially the butterflies of the American tropics. In pursuing these studies he made two long trips to South America in 1920 and 1927 and a shorter trip to the island of Puerto Rico in 1930.

He was the last of the great general workers in the Lepidoptera, and his command of the field was unrivalled. There was no area upon which he had not read and upon which he had not formed opinions. He published approximately 150 scientific papers; the majority were on the morphology and classification of the butterflies and moths. His outstanding contribution in this area was the work already referred to, "Lepidoptera of New York and Neighboring States." He also published some noteworthy and basic contributions on the wing venation and wing folding of the Coleoptera. His interests outside of entomology were many; two were the psychology of color vision, on which he published, and the archaeology of the Near East.

(Continued on page 102)

New Species of Pheidole from Pacific Coast Islands (Hymenoptera: Formicidae)[1]

ROBERT E. GREGG[2]

Specimens of ants in the genus *Pheidole* have been received from Mr. Roy Snelling, of the Los Angeles County Museum, and they prove to represent two new species. I am indebted to him for the opportunity to describe these insects. One of the species was collected on the Island of San Clemente, off the coast of southern California, and the other was found on the Tres Marias Islands adjacent to Nayarit, Mexico.

Pheidole clementensis NEW SPECIES

(FIGURE 1)

MAJOR.—Total length 3.62 mm; head length (excluding mandibles) 1.28 mm; head width 1.12 mm; head index 0.87; thorax length (excluding neck) 0.76 mm; petiole-postpetiole 0.46 mm; gaster length 1.12 mm. Holotype.

Head (excluding mandibles) distinctly longer than broad; cephalic sulcus deep, occipital notch profound, and occipital lobes distinct; clypeus emarginate with edges of the notch rounded; frontal lobes prominent, frontal carinae divergent; sides of head straight and subparallel, but angled toward the occipital lobes; eyes anterior to the middle of the head, composed of 40 to 45 facets. Antennae 12-segmented, club distinctly 3-segmented; scapes unflattened, wider distally than basally, and reach about one-half the distance to the occipital corners. Mandibles with two stout apical teeth and one small basal denticle. Mandibles, clypeus, and frontal area glabrous and shining; genae and frons with longitudinal and slightly divergent rugae, partly reticulate medial to the eyes; vertex partially crossed with finer rugae or striae, otherwise smooth and shining; tops of occipital lobes and their anterior faces covered with very coarse, strong, transverse rugae that are somewhat wavy, and which are reticulate where they cross the occipital sulcus; surfaces between cephalic rugae smooth and shining or only slightly subopaque in some areas; sides of occipital lobes very smooth and polished; gula smooth.

Thorax moderately convex, humeral angles distinct; meso-epinotal suture impressed, but the general contour of the thoracic dorsum straight and uninterrupted, except for the suture, not saddle-shaped. Pronotum and mesonotum smooth and shining; propleurae and mesopleurae smooth except for a few fine striae. Epinotal base and declivity subequal, and joined by a very obtuse angle; base and declivity smooth and shining, hardly any punctures visible; sides of epinotum punctate, ventral portions with a few striae. Epinotal spines narrow, pointing abruptly vertical, and with rather sharp tips; spine length ⅓ their interbasal distance.

Petiolar node low, its superior border broadly concave; surface of node smooth, petiolar peduncles punctate. Postpetiole broader than long, trapezoidal, with rounded lateral borders and no connules; node smooth.

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[1] Accepted for publication November 1, 1968.

[2] Department of Biology, University of Colorado, Boulder, Colo. 80302.

Gaster smooth and shining throughout; proportions usual for the genus.

Pilosity: hairs yellow and pointed, covering all surfaces of the body, legs, scapes, and mandibles; moderately long on the head, and longer on the thorax, pedicel, and gaster. Pubescence erect, and restricted to antennae and legs, where it appears to grade into the hairs.

Color: anterior half of head, gula, mandibles, antennae, legs, and gaster light reddish brown; posterior part of head, thorax, petiole, and postpetiole dark brown.

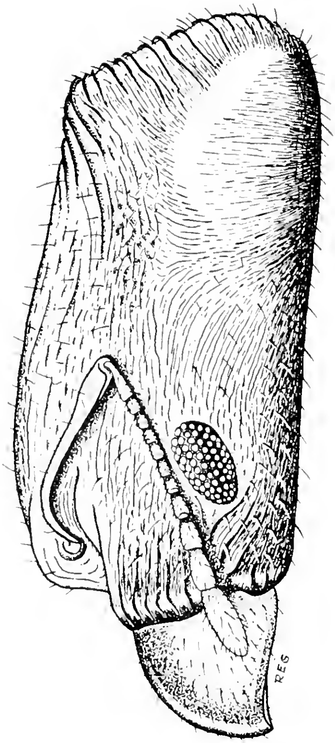

Fig. 1. *Pheidole clementensis*, new species, lateral view of head of major.

Minor.—Total length 2.17 mm; head length (excluding mandibles) 0.56 mm; head width (excluding eyes) 0.49 mm; head index 0.875; thorax length (excluding neck) 0.59 mm; petiole-postpetiole 0.30 mm; gaster length 0.72 mm. Morphotype.

Head longer than broad (excluding mandibles); occipital border weakly concave; frontal lobes well developed, frontal carinae short, straight, and indistinct; clypeus convex, not emarginate; scapes barely surpass occipital corners; mandibles with two sharp apical teeth and several denticles. Surface of head smooth and shining throughout. Eyes with 38 to 40 facets.

Thorax moderately convex, meso-epinotal suture distinct. Epinotal spines triangular, vertical, and sharp. Surface smooth and shining except mesopleurae which are in part punctate. Petiolar node low and blunt, with superior border convex. Postpetiole very slightly broader than long, subquadrate. Pedicel and gaster smooth and shining.

Pilosity: similar to that of the major.

Color: head, thorax, and petiole very dark brown; mandibles yellow; legs, antennae, postpetiole, and gaster light brown.

The major of *Ph. clementensis* differs from that of its closest ally, *Ph. californica* Mayr, in the following particulars: in size it is greater (3.62 mm vs. 3.50 mm); cephalic sculpture, especially on the occiput, is much heavier; occipital rugae are extremely coarse and rise higher from the surface of the head, and on each side of the sulcus they are so prominent that in profile the head appears to have conspicuous brow ridges, with the result that the vertex immediately in front of the ridges is slightly concave; posterior occipital corners, in profile, more angular; eyes smaller (approx. 40 facets vs. approx. 55 facets). The mesonotal disc descends to the meso-epinotal suture through an even curve, whereas in *californica* there is a distinct mesonotal declivity that forms an angle with the disc; sides of the epinotum not as completely punctate; epinotal base and declivity very smooth and shining (not completely punctate and opaque); epinotal spines narrow and slender (not broad and triangular). Petiole and postpetiole smooth and shining (not punctate and subopaque). Color dark brown mostly, in contrast to orange brown.

In my key to the species of *Pheidole* (Gregg, 1958), it will be necessary to modify couplet 34, first alternative, to read as follows:

Occipital rugae of the major coarse and wavy, usually forming reticulations in the occipital sulcus............................**californica**
Occipital rugae coarse and wavy, and prominent enough to produce brow ridges on the head in profile; vertex slightly concave..**clementensis**

The worker minor of *clementensis* differs in that the epinotal pleurae are mostly smooth and shining, the epinotal spines are slightly sharper, and the epinotal base and declivity are very shining. The color is blackish brown rather than yellowish brown.

HOLOTYPE: worker major; deposited in the Los Angeles County Museum, Los Angeles.

PARATYPES: hundreds of worker majors and minors, the bulk of them deposited in the Los Angeles County Museum; others in the author's collection, and the collections of W. S. Creighton, A. C. Cole, U. S. National Museum, American Museum, and the Museum of Comparative Zoology.

TYPE LOCALITY: Pyramid Head, San Clemente Island, San Diego County, California. Nest found under a stone by R. R. Snelling, December 7, 1963.

I include the following notes by Snelling on the biology of this new ant. "This species was one of the commonest ants on the island; it appears to be most abundant on the seaward side, and nests under stones. Workers begin foraging shortly before sundown; the ants are harvesters, bringing in seeds of *Cressa cretica* in preference to others which are available. A few grass seeds were collected, and on one occasion I observed them gathering seeds from a small legume, probably a species of *Lotus*. An interesting feature of the colonies examined was the very high percentage of majors."

Pheidole clementensis is of special interest, not only as a new species and as an addition to an already known rich fauna of North American *Pheidole*, but because of the location from which it comes. Ants from the offshore islands of southern California have in the past been described as subspecific forms and regarded as insular endemics. Wheeler seems to have been much taken by this explanation, as for example with *Monomorium minimum* subsp. *ergatogyna*, but which Creighton later (1950) showed to be a synonym of the mainland *minimum*. In the case of *clementensis* it seemed obvious from the start that we were dealing with a different population and that it might be a subspecies of the closely related mainland *Pheidole californica*. Further study revealed, however, that it is quite distinct from the latter and should be regarded as a separate species. This led to a consideration of the possible origin and the probable range of the new form. So far, it is known only from the island of San Clemente, but Creighton feels that it will eventually turn up on the mainland coast of California and perhaps on other islands in the vicinity. His reason for this (in litt.) is the fact that during much of the year the southern Californian coast is in the path of strong onshore westerly winds, and that consequently any flying insects would sooner or later be carried to the continent. It should be important, therefore, to determine whether the nuptial flights of this ant occur during the periods of these winds. While San Clemente is farther from the coast than Santa Catalina and certain other islands, it is still only about 60 miles distant, so the suppositions that Creighton makes are altogether possible. It seems strange, however, that if *clementensis* does occur on the mainland, it has not yet been found there in an area that has been repeatedly searched for ants. Although I can accept the view that this ant is probably not endemic to San Clemente, such an admission does not preclude the possibility that it may have had its origin on the island or some other island nearby. At a remote time, the mainland species from coastal stations could have been emplaced on the island during rare occasions when conditions may have been favorable for accidental transport. The rarity of these occasions would tend to favor the isolation of the population and bolster the speciation process. Some specimens would presumably be blown back to the mainland, but those that remained could have continued their divergence. After full evolutionary separation was achieved, the new species would, of course, be subject to periodic and fortuitous transport back to the mainland. Thus, the allopatric origin of this ant is at least a feasible explanation, and may be offered tentatively until more information is at hand. It will be interesting and critical to see whether this insect does in fact show up later as a member of the mainland fauna.

Pheidole dwyeri NEW SPECIES

(FIGURE 2)

MAJOR.—Total length 6.19 mm; head length (excluding mandibles) 2.32 mm; head width 2.24 mm; head index 0.97; thorax length (excluding neck) 1.29 mm; petiole-postpetiole 0.86 mm; gaster length 1.72 mm. Holotype.

Head (excluding mandibles) only slightly longer than broad; cephalic sulcus deep, occipital notch profound, and occipital lobes pronounced but well rounded in full-face view; in profile the lobes show a distinct dorsal flattening which extends forward to about the middle of the head; anterior margin of clypeus sinuate; frontal carinae strongly divergent, and about one-half as long as the scapes in repose; sides of head straight, but converging toward the mandibular insertions. Eyes lateral, placed anterior to the middle of the head; approximately 100 facets. Antennae 12-segmented; club slender, indistinctly 3–4 segmented; funicular joints 2 to 7 short and only gradually increasing in length, merging into the club; scape short, curved, but unflattened, extending about one-half the distance to the occipital corners. Mandibles with two stout apical teeth, incisor border entire, one faint denticle near the basal border. Frons, vertex, and genae with longitudinal and somewhat divergent rugae that are partly reticulate, especially medial to the eyes; rugae fade out on the occipital lobes. Interrugal spaces and occipital lobes heavily punctate, the surfaces opaque; hair foveolae noticeable on the lobes; a small but distinct pit is located at the anterior end of the cephalic sulcus in the approximate position of a median ocellus; sulcus cross-striate; tops of the occipital lobes finely striate and faintly shining; gula smooth. Mandibles mostly glabrous and shining, except for hair punctures and several strong rugae on the lateral borders. Frontal area triangular, smooth and shining.

Thorax moderately convex, humeral angles distinct; posterior part of mesonotum concave and forming a small saddle in front of the epinotum; meso-epinotal suture distinctly impressed. Epinotal base shorter than the declivity, and connected by an obtuse angle; epinotal spines long and sharp, spine length almost ½ their interbasal distance; epinotal spiracles round and prominent. Pronotum and mesonotum transversely rugose (neck smooth); interrugal spaces punctate, opaque. Epinotal base and declivity transversely striated and weakly shining. Entire thoracic pleurae, including epinotum, punctate and opaque, partly rugose. Petiolar node moderate in size, merging gradually with the anterior peduncle, its superior border truncate and faintly concave. Postpetiole very broad and lenticular in shape, twice as wide as the petiole; lateral connules fairly sharp. Both segments of the pedicel punctate and opaque, the postpetiole also with foveolae.

Gaster shagreened throughout its dorsal surface, and subopaque to slightly shining; sides and venter shining.

Pilosity: entire body, including scapes, funiculi, mandibles, and legs covered with abundant, yellow, pointed hairs which vary greatly in length. Pubescence absent except on the funiculi where it grades into the hairs.

Color: head, thorax, and pedicel for the most part reddish brown, the head notably lighter and redder in tone; clypeus, anterior border of head, mandibles, postpetiole, and gaster blackish brown; legs and antennae light reddish brown.

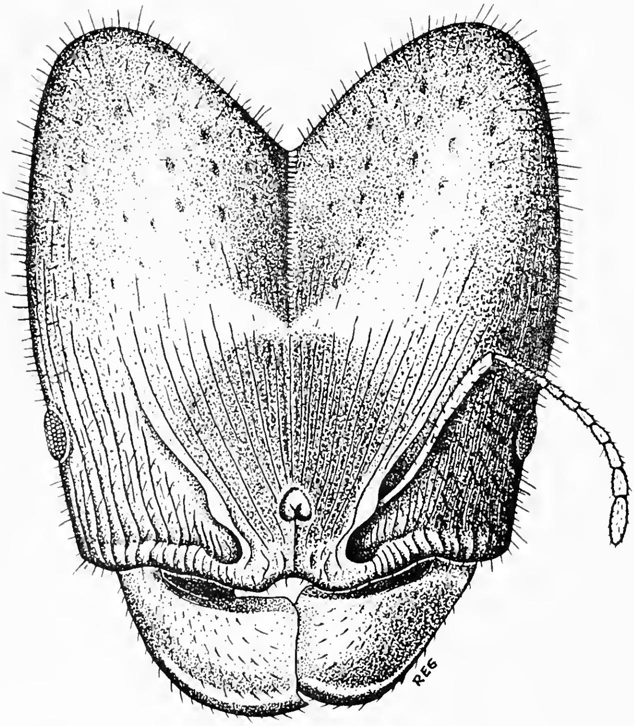

FIG. 2. *Pheidole dwyeri*, new species, anterior view of head of major.

MINOR.—Total length 2.68 mm; head length (excluding mandibles) 0.73 mm; head width (excluding eyes) 0.66 mm; head index 0.904; thorax length (excluding neck) 0.83 mm; petiole-postpetiole 0.36 mm; gaster length 0.76 mm. Morphotype.

Head longer than broad; occipital border flat; clypeal border convex; frontal carinae short and parallel; frontal area distinctly impressed, and continuous with a fine median sulcus which ends in a minute pit; compounds eyes lateral, about midway between anterior and posterior borders of the head, comprised of about 40 facets; mandibles with sharply denticular masticatory border; antennal scapes long, extending a little over one-fourth their length beyond the occipital corners; antennal club of 3 to 4 segments that seems more distinct than in the major worker.

Thorax moderately convex; meso-epinotal suture distinct and impressed, but not saddle-shaped; epinotal base longer than declivity; spines long, almost vertical, pointed. Petiolar node low, dorsal border flat, about as long as the peduncle. Postpetiolar node very low, slightly wider than long, not quite twice the width of the petiolar node. Entire body of insect shagreened to punctate and granular; subopaque, except occipital border, pronotum, and sides and venter of gaster which are somewhat shining.

Pilosity: hairs as in the major, except sparser and shorter in length.

Color: dark brown, except funiculi, mandibles, and tarsi which are paler.

In the two most recent tables to the species of North American *Pheidole* (Creighton, 1950; Gregg, 1958), this ant would run either to *Pheidole pilifera coloradensis*, or to *Pheidole titanis*, depending upon how one chooses to interpret the couplets, or stretch the meanings of the couplets. It does not fit comfortably in either of the above species, and as a matter of fact, it is completely impossible to identify the ant by means of these keys. This is not surprising considering the little-known and very inadequately studied region from which the specimens have come (vide infra). Direct comparison with the above two species shows them to be quite unrelated.

The peculiar cephalic flattening in the major of *Pheidole dwyeri*, together with its overall appearance seems to indicate that it may be closely allied to *Pheidole xerophila*, but if so, the latter then is a diminutive relative. *Dwyeri* may be said to differ from *xerophila* in the following particulars: in size much larger (approx. 6.2 mm vs. not more than 4.3 mm); head heavily sculptured with longitudinal rugae and densely punctured interspaces and verteces, the surface opaque in contrast to lighter sculpture confined to the anterior half of the head with vertices and occipital lobes smooth and shining; cephalic hairs arising from narrow punctures rather than punctures much wider than the hairs in *xerophila;* eyes with a much greater number of facets; epinotal spines proportionally longer and sharper and reclining posteriorly; gaster strongly shagreened; the entire insect noticeably more opaque. *Pheidole dwyeri* differs from *macclendoni* in the soldier caste by its larger size, (the latter 6.0 mm); by the cephalic flattening; complete cephalic sculpturing (posterior half of head in *macclendoni* smooth and shining); sharper and more reclining epinotal spines; broader, more lenticular postpetiole with sharper conules; and shagreened gaster. The major of *dwyeri* differs from that of *militicida* by its slightly larger size (the latter about 6.1 mm); cephalic flattening more definite, but occipital lobes more rounded in profile; complete head sculpturing (posterior half of head in *militicida* smooth and shining); pronotum transversely rugose and subopaque (smooth and shining in *militicida*); promesonotum lower and less strongly arched; epinotal spines slightly sharper; petiole lower and more blunt (superior border sharper and concave in *militicida*);

anterior border of postpetiole less convex, connules not as sharp; gaster shagreened and subopaque (not smooth and shining); color dark reddish brown in contrast to the golden to reddish golden color of *militicida;* antennal club indistinctly 3 to 4 segmented (clearly 3-segmented in *militicida*). The minor of *dwyeri* differs from that of *militicida* in that the epinotum is flat (not convex), spines are long and distinct (not short and triangular); petiole and postpetiole are shorter; body surface of all tagmata shagreened and subopaque (not smooth and shining); long diameter of eye only $\frac{2}{3}$ that of *militicida;* antennal club like that of the major.

My key to *Pheidole* could handle the placement of this new species if couplet 30, first alternative, were modified to read as follows:

Front and vertex of the major with coarse, piligerous foveolae, longitudinal rugae, and interrugal granulations; feebly shining; occipital sulcus shallow, lobes moderate; head small (1.5 mm long) .... **pilifera** subsp. **coloradensis**
Front and vertex granular, piligerous foveolae indistinct, longitudinal rugae confined to the anterior portion of the head; occipital sulcus deep, lobes pronounced; head large (2.4 mm) .... **dwyeri**

Although this treatment will separate *dwyeri* from other North American species of *Pheidole* so far known, the key is an artificial one and makes no claim to show relationship between *dwyeri* and the forms of *pilifera.*

Holotype: worker major; deposited in the Los Angeles County Museum, Los Angeles.

Paratypes: hundreds of worker majors and minors, most of them deposited in the Los Angeles County Museum; others in the author's collection, and the collections of W. S. Creighton, A. C. Cole, U. S. National Museum, American Museum, and the Museum of Comparative Zoology.

Type locality: Maria Cleofas, Islas Tres Marias, Nayarit, Mexico. Two colonies of this ant were collected by R. R. Snelling, one on March 30, 1964 (#36430-C), and another on March 31, 1964, both on Maria Cleofas. The holotype specimen was selected from the colony taken on the latter date. This insect is named for Mr. Richard F. Dwyer, who supported the work of Mr. Snelling and made it possible for him to visit the Tres Marias Islands.

Pheidole dwyeri on first examination appeared to be related to *Pheidole* (*Ceratopheidole*) *granulata* Pergande, because the antennal club seems to be 4-segmented, and thus to represent another new form in this small subgenus. But *Ceratopheidole* as a taxonomic entity has been questioned (in litt.) by Creighton and by Snelling. The latter has studied the two original specimens of *granulata* in the United States National Museum, and has discovered that the type locality of Pergande's specimens is San Jose del Cabo, Lower California, not Tepic, Mexico, as cited by Pergande. This appears to indicate why the species has not been found subsequently on the main part of Mexico. Snelling has also compared the *granulata* types to *grallipes*, and considers the two species closely related. In size, color, pilosity, and sculpturation the two are much alike, and the main difference, he states, is the longer eighth flagellar segment of *granulata*, together with minor differences in cephalic and thoracic sculpturing. Both ants are similar in the general form of the antennal club, with the last segment elongated and narrowed. The club is said to be poorly defined. Specimens of *grallipes* in my collection all show the antennal club to be unequivocally 3-segmented. The foregoing shows that the distinction heretofore made between the subgenera *Pheidole* and *Ceratopheidole* may be suspect and that the latter name may have to be abandoned. The indefinite nature of the club in *Ph. dwyeri*, making it intermediate between the 3-jointed club of typical *Pheidole* and the supposed 4-jointed club of *Ceratopheidole*, shows that it would be inadvisable to assign *dwyeri* to the second subgenus until the status of *Ceratopheidole* can be clarified. I therefore place the new species in the subgenus *Pheidole*, sen. st.

ACKNOWLEDGMENTS

I wish to thank Mr. Roy R. Snelling for generously permitting me to study and describe these new ants, and for making certain critical comparisons with species of *Pheidole* in the collections of the United States National Museum. Dr. W. S. Creighton has assisted with the evaluation of the status of these ants and several others in the genus *Pheidole*, and has carefully reviewed the manuscript for this article.

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(The Entomologists' Record, continued from p. 92)

He was a delightful man, and he was well liked and admired by the students. He was much sought after for advice and for comment on work in progress. He could often suggest some paper that should be consulted or some overlooked aspect that should be considered. At times his information seemed limitless; he had a prodigious memory. He always had time for a discussion, and some of the most enlightening times during graduate study were those spent in late evening discussions which might range over many subjects. One time he might present arguments on one side of a question, and not long afterward, if the occasion arose, he might take the opposite view just for the sake of a discussion. He was a man of strong convictions, but he was kind, and he was considerate, and above all he was a gentleman. The science of entomology suffered a great loss in his death.—John G. Franclemont, Department of Entomology, Cornell University, Ithaca, New York 14850.

The Catalogue of Neotropical Diptera, officially entitled "A Catalogue of the Americas South of the United States," is currently being published in Brazil. The area covered includes all of the Americas, including adjacent islands, and will therefore exactly supplement the North American catalogue of 1965. The director of the Departamento de Zoologia da Secretaria da Agricultura do Estado de São Paulo, Dr. P. E. Vanzolini, is to be credited with initiating this important project. Approximately 50 of the projected 110 fascicles have now been published. Some 40 authors are responsible for fascicles, each of which treat a single family. The Departamento is distributing the catalogue as it appears on a liberal exchange basis. Authors are also liberally supplied with separates. Information and copies of the work may be obtained from: Diretor do Departamento de Zoologia, Secretaria da Agricultura do Estado de São Paulo, Caixa Postal 7172, São Pauo, Brazil.—Introduction

Amateur Entomological Clubs.—Dr. Alvah Peterson, one of the country's greatest entomology teachers, published a short paper several years ago on having fun with insects (*Turtox News*, 38: 192–193, 1960). In his article he states that Japan has over 500 amateur entomology clubs. Such figures are frequently cited for various countries so that we get the impression that insects are of general interest throughout the World, except in the United States. United States Entomologists in general, and your editor in particular, deplore "Oh my!" and "Bug Hunter" type amateurs. But there are some aspects of amateur clubs that bear investigation.

From time to time I hear of amateur clubs devoted primarily or secondarily to insect study. How many such clubs are there? If any reader knows of such a club, please send me the name and address. A directory of these organizations would be mutually beneficial.

If, as we suspect, those of us who claim to be professionals are concerned about amateurs in our field, then perhaps we should do something to discourage the features that we object to, and encourage the things that will aid the field. Many professional societies are encouraging high school students to become acquainted with the field through aid to science fairs, 4H, and Scout projects. None to my personal knowledge has investigated clubs that may be composed primarily of adults. It would seem that this merits study. Your help will be appreciated.

(Continued on page 105)

Sarcophagous Habits of Trichoptera Larvae on Dead Fish[1, 2]

Merlyn A. Brusven[3] and Allen C. Scoggan[3]

Available information concerning the feeding habits of Trichoptera larvae is largely fragmentary and general. Lloyd (1921) reported the larvae of Trichoptera were principally herbivorous with some members becoming carnivorous or cannibalistic when confined. From gut analyses examinations, Jones (1950) reported *Anabolia* and *Halesus* larvae (Limnephilidae) were largely herbivorous. Slack (1936) indicated the food habits of several species of Trichoptera ranged from herbivorous to omnivorous; they sometimes ingested insects and on one occasion caught and ate a small live fish. Ross (1944) and Chapman and Demory (1963) also re-

Fig. 1. Aggregations of Trichoptera larvae around the pectoral fins, anus and tail region.

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[1] Submitted with the approval of the Director, Idaho Agricultural Experiment Station as Research Paper No. 783.

[2] Accepted for publication February 27, 1969.

[3] Department of Entomology, University of Idaho, Moscow, Idaho 83843.

ported omnivorous feeding by trichopteran larvae, but acknowledged differences among genera and species.

Squawfish, *Ptychocheilus oregonensis* (Richardson), eradication by means of a selective fish toxicant on a portion of the St. Joe River in northern Idaho in July, 1968, resulted in mass kill of this undesirable fish. Many of the dead and dying squawfish came to rest in the deeper holes, among rocks and debris, and in slack waters. A high incidence of feeding by trichopteran larvae was noted during a 24 hour period following initial squawfish mortality.

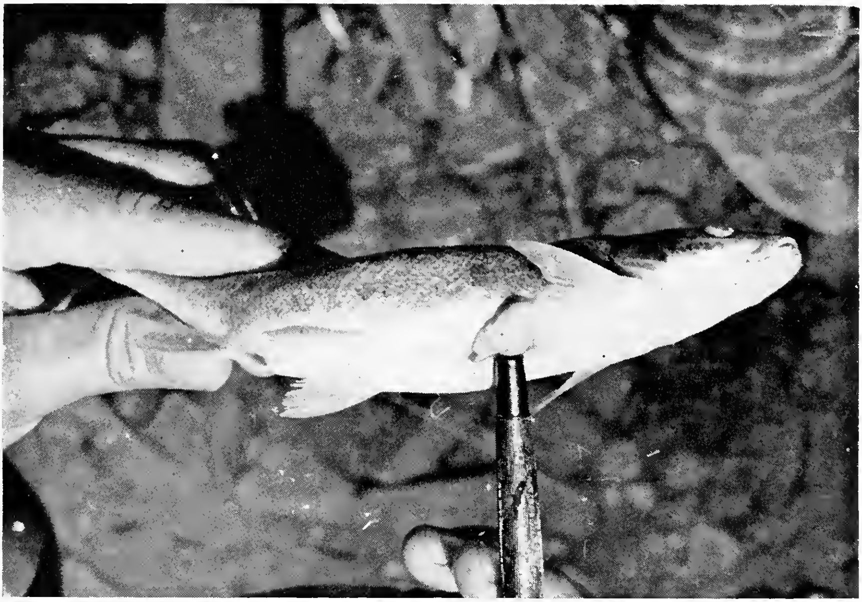

FIG. 2. Visceral protrusion caused from feeding by Trichoptera larvae.

Dicosmoecus and *Psychoglypha* larvae (Limnephilidae) were the principal feeders on dead squawfish; however, *Lepidostoma* larvae (Lepidostomatidae) were also observed feeding but occurred in smaller numbers. Six to ten inch squawfish had an average of 50 larvae, particularly on fish coming to rest in slow, shallow waters along the margins of the river (Fig. 1). Fish lodged in the main channel where the current was fast had few or no larvae. Initial feeding occurred principally around the pectoral fins, anus and tail region; largest concentrations occurred at the base of the tail. Openings into the body cavity causing visceral protrusions were noted within 24 hours after squawfish had died (Fig. 2). The larvae maintained a loose attachment to the fish during feeding; if the fish were moved or removed from the water many would drop off. Since large numbers of larvae were observed feeding on fish only a few hours after the fish had succumbed, it would suggest that they were endowed with certain sensory receptors for finding these fish.

The authors submit that trichopteran larvae contributed directly and indirectly to the removal of dead squawfish from the St. Joe River. Working in conjunction with other organisms of decay they hastened the return of the aesthetic condition of the river.

Acknowledgments.—The authors wish to express appreciation to Drs. Norman H. Anderson, Department of Entomology, Oregon State University and Tosh Yamamoto, University of Toronto, Canada, for identifying the Trichoptera larvae referred to in this paper.

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(THE ENTOMOLOGISTS' RECORD, continued from p. 102)

Contact with amateur societies can result in at least two benefits, and probably more. It could result in the wider dissemination of professional literature, including journals. Much of the information currently available for the beginners is so vague that it is of little value. The use of professional information will tend to improve the amateur studies. The demand for such publications should in turn help encourage the publication of more intermediate aids to bridge the gap between the "trade" books and "professional" literature.

It is our belief that awareness of the true nature of the field will improve the situation rather than flood us with "bug swappers."—R. H. A.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

Diptera

THE CRANE FLIES OF CALIFORNIA

By CHARLES P. ALEXANDER. Bull. California Insect Survey, vol. 8, 269 pp., 1967. Paper, $6.00.

The biologists of the state of California are very fortunate on two scores; they have a well edited series, the Bulletin of the California Insect Survey, to provide a useful tool for the identification of California insects, and they now have a manual of the Cane Flies. This large work contains an interesting history of collections and revisions of material from California. The keys to the several families, the genera, and species are well illustrated (there are 524 figures and 106 maps). Every known locality for crane flies have been indicated on a fine relief map. This work will be, of course, the standard for this group for many years to come.—R. H. A.

Trichoptera

THE COMPARATIVE MORPHOLOGY AND EVOLUTION OF THE INTERNAL FEMALE REPRODUCTIVE SYSTEM OF TRICHOPTERA

JOHN D. UNZICKER, Illinois Biol. Mon. 40, Univ. Illinois Press, Urbana, xiii + 72, 15 pl., 50 fig. Paper $3.95.

"An examination of the different modifications of the internal female genitalia characters in the Trichoptera and other closely related orders resulted in the establishing the probable ancestral and derived conditions of these characters." INTRODUCTION.

Thysanoptera

THE THRIPS, OR THYSANOPTERA, OF ILLINOIS

LEWIS J. STANNARD, Ill. Nat. Hist. Survey Bull., 29(4): 215–552, 1968.

"This report is presented to make our tiny thrips better known—to show what thrips really are, to explain which ones are harmful and which ones are beneficial, and to introduce the many thrips that are of no direct economic consequence to man but are a part of the native fauna of Illinois. As [is] shown, thrips are exquisite creatures, complicated in form, delicate in habit, and most distinct from the usual run of insects. About 200 species of thrips have been collected in Illinois. Herein is an account of those species and of some others that may occur, but so far have not been found, in our state." p. 215.

(Continued on p. 108)

The Black Fly, Simulium venustum, Attracted to the Turtle, Chelydra serpentina [1]

Stephen M. Smith [2]

The females of the several blood-sucking families of the Diptera are best known as pests of mammals and/or birds. Nevertheless, many species in several families (Culicidae, Psychodidae, Ceratopogonidae, and Tabanidae) normally obtain the blood meal from various poikilotherms such as reptiles, amphibians, or insects (for a review see Downes, 1958). The Simuliidae, however, have been reliably reported sucking blood from only mammals and birds (Fallis, 1964). There are no records from either Amphibia or Reptilia (Bequaert, 1938; Downes, 1958) and the few records of supposedly insectivorous species (Hagen, 1883; Pryer, 1887; Theobald, in Emery, 1913; Hill, 1923) have not been confirmed by subsequent observation and some, at least, represent misidentifications of various ceratopogonids (Downes, 1958). This note presents the first record of black flies attracted to a reptile.

On May 23, 1964, a large, female of the common snapping turtle (*Chelydra serpentina* (L.)) (Testudines: Chelydridae) was found on a dirt side-road in Algonquin Park, Ontario (46° N., 79° W.). Attention was drawn to the animal by the presence of a large swarm of simuliids flying actively about the animal. The swarm of fles was concentrated about the head of the turtle and many females were seen to land and remain at the margins of the eyes. Flies landed repeatedly on the carapace but did not remain there for more than an instant. Only those flies landing on the head remained for any period of time.

It was not possible to collect specimens from the head of the turtle but ten specimens were captured with the aid of a sweep net. All specimens proved to be females of *Simulium venustum* (Say). None of the captured specimens was engorged and it was not possible to determine whether any flies were successful in obtaining a blood meal. It is not inconceivable, however, that some flies might have been able to penetrate the skin around the eyes and engorge. This may account for the marked tendency of the flies to remain clustered about the membranes of the eyes.

Many simuliids, particularly the ornithophilic species, are unusually host specific (e.g., Fallis and Smith, 1964) whereas the so-called "mammaliophilic" species such as *S. venustum* normally frequent a variety of hosts.

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[1] Accepted for publication March 3, 1969.

[2] Dept. of Entomology, University of Manitoba, Winnipeg 19, Canada.

Females of such common species may occasionally utilize reptilian hosts as sources of blood.

Voucher specimens are deposited in the Canadian National Collection of Insects in Ottawa.

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(THE ENTOMOLOGISTS' LIBRARY, continued from p. 106)

LIFE ON A LITTLE-KNOWN PLANET

By HOWARD E. EVANS. E. P. Dutton & Co., Inc., N. Y., 1968, 318 pp. Cloth, $7.95.

This is the type of book which is the bane of a reviewer's existence, a good one. It is far easier to say that . . . has written a fine book, but . . . than it is to unreservedly praise a book without sounding fatuous.

Dr. Evans' work can be read at two levels—the choice is up to the reader. The first is as a purely informational volume on insect life. As such, it is far superior to the average "oh my" book on insects. In language, which, at times, is almost lyrical, the reader is led or rather accompanied through the wonder which is the world of insects. He will perhaps absorb some of Dr. Evans' enthusiasm and reverence for the miracle and the importance of insect life, as well as sadness at how little we really understand regarding them.

There are whimsically titled chapters on soil insects and their relatives, cockroaches, dragonflies, crickets, fireflies (reprinted by "Natural History" in a recent issue), butterflies, flies, bedbugs and relatives, locusts and parasitic wasps. Each is highly informative—even to the professional entomologist. The notes on Classification and references for further reading will be helpful to the interested layman.

It is in the remaining chapters, supplemented by the ones above, that the other level of this volume emerges . . . a lament for the passing natural scene; how little we know about it and, most sadly, how little we seem to care. The fact that Dr. Evans felt moved to title one chapter "Is Nature Necessary" is illustrative of this point. The chapter "Of Springs, Silent & Otherwise" should be required reading for all biologists and conservationists, economically oriented or not. It contains a most rational exposition of problem of insecticides—a subject whose discussion in the past has been characterized by more emotion and irrationality than reason.

The following passage taken from Chapter 7 is illustrative, at least to myself, of the meaning of this volume.

"Now that man is more sophisticated and there are so many more of him, his world is more regulated and standardized, no matter how well adorned with gadgets. He has learned to do without the virgin prairie and the cry of the eagle, and he will presumably someday learn to do without much of the world that nurtured him. It was his choice to eliminate the wolf, and he would like to eliminate the mosquito and the bark beetle; but in doing so he is losing the untamed forest, the wild lake haunted by a loon. So it must evidently be."—Selwyn S. Roback.

ECOLOGY AND BIOGEOGRAPHY OF HIGH ALTITUDE INSECTS

By M. S. Mani. Dr. W. Junk, N.V., The Hague (Series Entomologica, Vol. 4). 1968, xiv + 527 pp. 80 figs., 41 tables. Cloth, $27.80.

Professor Mani's earlier work (Introduction to High Altitude Entomology, Methuen, 1962) has now been followed by this more comprehensive work, some two and a half times as long as the former. While the former work was based largely on the author's studies in the Northwest Himalaya the present volume includes summaries of high altitude insect distribution in every major mountain area of the world. And the author's experience now includes field studies in the Pamirs, Tien-Shan, and Caucasus.

About 20% of the volume is devoted to the general ecology of insects that occur at altitudes above tree growth (the environment, special adaptations, communities), perhaps 10% to a summary of groups of insects (and other arthropods) typical of high altitudes, and the rest of the volume to distributional accounts, region by region, of high altitude insects. This last portion is primarily geographical, and it is therefore something of a catalogue, but it incorporates much ecological discussion. The Bibliography includes over 1,100 references.

This will be an essential reference for all interested in the problems of insect distribution at high altitudes.—Gordon Alexander, *University of Colorado, Boulder* 80304.

THE OXFORD BOOK OF INSECTS

John Burton. Oxford University Press, 1969, viii + 208 pp. $10.00.

This is another volume in the Oxford natural history series. Though the text and figures are oriented towards the British fauna, the general information contained in the book would be useful to any amateur entomologist. The 96 colored plates are each faced by a page of text which offers descriptive material and ecological data on the insects illustrated. About 800 species of insects are shown. The work closes with brief sections on classification, structure, metamorphosis, protection from enemies and references for further study.—Selwyn S. Roback

REGISTER OF INSECT SPECIMENS (EXCLUDING ENTOMOPHAGOUS PARASITES) AND ASSOCIATED PHOTOGRAPHS AT THE FOREST RESEARCH LABORATORY FREDERICTON, N. B.

By F. A. TITUS. 1968. Forest Research Laboratory, Fredericton, New Brunswick, Information report M-X-17, 102 pp. Paper.

"This register should (1) facilitate arrangements for exchanges or loans of material, (2) stimulate the interchange of illustrative material associated with economically important species, and (3) focus the attention of specialists on species that are known to occur in the Maritimes but are not represented in this collection or in their own. Periodic supplements will be prepared if they become necessary."—INTRODUCTION.

INVERTEBRATE ZOOLOGY, Vol. 2

ALFRED KAESTNER. Translated and adapted by HERBERT W. LEVI and LORNA R. LEVI. John Wiley & Sons, 1968, ix + 472 pp. $22.95.

We have here the second of a projected 4 volume series. It covers the Onycophora, Tardigrada, Pentastomida and Arthropoda exclusive of the insects. These are only briefly discussed. The Arthropoda is divided into 3 subphylathe Trilobitomorpha, the Chelicerata (scorpions, spiders and related orders) and the Mandibulata (centipedes, millipedes, Pauropoda, Symphala and insects). For each order there are sections on anatomy, development (including embryology), relationships, habits and classification. The discussion of the Aranaea is outstanding among the many fine sections. Here and elsewhere, the information is clearly presented, well organized and up-to-date. As this volume proves, one can be informative without being dry or pedantic. Each chapter is concluded by a moderately comprehensive bibliography. The illustrations, drawn from many sources, are of high quality and the overall excellence of the printing and typography add greatly to the readability of the book.

In an attractive format, this volume brings together a great deal of useful information on the groups covered. It is worthwhile reading for any zoologist wishing to refresh or broaden his knowledge of the invertebrates covered and could serve as a supplementary student text. The price is unfortunate but is perhaps a reflection of the times.—SELWYN S. ROBACK

ADVANCES IN PEST CONTROL RESEARCH

By R. L. METCALF (ed.). Interscience Publishers, viii + 255. Cloth, $15.00.

The editor has selected three excellent specialists to present comprehensive reviews and critical evaluations of new concepts and developments on the behavior and fate of *s*-triazines in soil (C. I. Harris, D. D. Kaufman, T. J. Sheets, R. G. Nash, and P. C. Perry), insect sex pheromones (H. H. Shorey, L. K. Gaston, and R. N. Jefferson), and the bipyridylium herbicides (A. Calderbank).

Harris *et al.* have provided a comprehensive summary of 173 reports on their subject and have integrated unpublished data into the discussion. In addition to the physical behavior, persistence, and metabolism of the *s*-triazines in the soil, the methods of analysis and chemistry are summarized.

While the chapter on insect pheromones is not intended as a review of all literature dealing with pheromones, the authors have cited over 200 reports to make comparisons and generalizations on ways sex pheromones are used by insects, the nature of the chemicals themselves, the structure of the glands that produce them, and the ways in which sex pheromones might be used for insect control.

For these generalizations, the review is restricted to the sex pheromones that are typically released by one sex only and induce a response in the other sex only. The information is nicely presented and is one of the most interesting chapters in the book.

The synthesis, chemistry, herbicidal properties, mode of action, toxicology and fate of the bipyridylium herbicides is well reviewed with 225 literature citations. In addition to the more conventional agricultural uses, the author discusses several major new developments. This chapter is completed with colored illustrations.

This book and others in the series provide excellent reference material for those researchers and students interested in pest control research.—Edward J. Armbrust, *Illinois Natural History Survey, Urbana* 61801.

THE POCKET ENCYCLOPEDIA OF PLANT GALLS IN COLOUR

A. Darlington. Philosophical Library, N. Y., 1969, 191 pp. $7.50.

This small volume, though British oriented, is an excellent beginners book on gall identification. Preceding the plates are short sections on the biology of gall occupants and how to collect, preserve and rear them. The 293 illustrations, mostly color photographs of galls and gall formers, are combined into 80 plates. They are arranged by host and generally are of good quality. Closing the book is a listing and description of representative British galls under their host plants.—Selwyn S. Roback

Hymenoptera

FEMALE GENITALIA OF HYMENOPTERA AND COMPARATIVE MORPHOLOGY OF MALE AND FEMALE GENITAL SEGMENTS OF BOMBINAE (HYMENOPTERA, APIDAE)

William E. Hazeltine, Research Bull. no. 833, Purdue Univ., Lafayette, Indiana 47907, 36 pp., 37 figs., 1967.

"A comparative study was made of the female genital sclerites in species representing the superfamilies of Hymenoptera and the families of bees (Apoidea). Structural changes in the female genitalia were followed throughout the order, and an accurate interpretation of most of the structures found in the bumble bees was possible."—Summary.

TAXONOMIC REVISION OF THE NEARCTIC GENUS ACANTHOMYOPS (HYMENOPTERA: FORMICIDAE)

M. W. Wing, Agric. Exp. Stat. Mem. 405, New York State College of Agric., Ithaca, N. Y. 14850, 173 pp., 203 figs., 41 tables, 1968.

"*Acanthomyops*, an exclusively North American genus, is closely related to the common, dominant holarctic genus *Lasius* [treated as a subgenus of *Lasius* by Wheeler, 1910] . . . *Acanthomyops* . . . [has] a convenient diagnostic character for field collectors using a mouth-type aspirator . . . the presence of a characteristic odor . . . that of oil of citronella or lemon verbena." p. 3.

"The present status of *Acanthomyops* is as follows: 15 named species, including 3 new, plus the recognition of 2 clear-cut and 3 putative hybrids. . . ." p. 4.

POGONOMYRMX HARVESTER ANTS—A STUDY OF THE GENUS IN NORTH AMERICA

By ARTHUR C. COLE, JR. University of Tennessee Press, Knoxville, 1968, x + 222 pp. Cloth, $7.50.

This is the first comprehensive treatise on the North American *Pogonomyrmx*. In all, 22 species placed in two subgenera are treated. Four of these are new. The entire genus consists of 60 taxa, 37 of these being South and Central American and one Haitian. There is a short section discussing, with figures, the characters used in the classification. For each caste keys are given to the subgenera, complexes and species.

For each species, synonymy, description of each caste and discussion of its relationships, variation and distribution are given.

There are 13 distribution maps, 11 photographs of nest sites and 197 figures in 12 plates.—SELWYN S. ROBACK.

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PHORETIC COPULATION IN HYMENOPTERA

Howard E. Evans [1]

Abstract

In several groups of wasps, including members of the families Bethylidae, Tiphiidae, and Mutillidae, it is known that the males carry the wingless females about suspended from their genitalia for considerable periods of time. The mechanics of such phoretic copulation have not previously been studied in detail. On the basis of museum specimens pinned *in copulo*, the method of locking of the genitalia is discussed in a bethylid (*Apenesia nitida*) and in two thynnine tiphiids (*Dimorphothynnus haemorrhoidalis* and *Elaphroptera scoliaeformis*). These three forms show striking differences in the modifications of the male and female genitalia, confirming the belief that phoretic copulation has evolved several times independently. All examples occur in families in which the females are adapted for burrowing in the soil or in wood. Evidently some elements in these families underwent a loss of wings as a further adaptation for hypogaeic life. Several of these stocks independently evolved phoretic copulation, at least partially removing the major disadvantage in flightlessness, namely, decreased capacity for dispersal.

It has long been known that in certain groups of wasps (in all of which the females are wingless and smaller than the males) the sexes remain *in copulo* for a considerable period of time, the males carrying the females about suspended from their genitalia (Figs. 1, 5). It has been assumed that more than copulation is involved, that this prolonged attachment serves in carrying females to feeding sites (at least in the Thynninae) and in aiding in the dispersal of the species (Burrell, 1935; Durán-Moya, 1941). The females in question are highly modified for burrowing through soil or rotting wood in search of their hosts: the legs are relatively short, stout, and spinose; the thorax has various reductions associated with loss of wings; the ocelli are absent and the eyes reduced in size or even vestigial. In some cases the males are known to fly at a considerable height and to carry the females for more than an hour, so it is not unlikely that they do at times scatter the females in such a way that they will find new local populations of their hosts or, given suitable wind currents, cross physical barriers that the females alone would rarely surmount.

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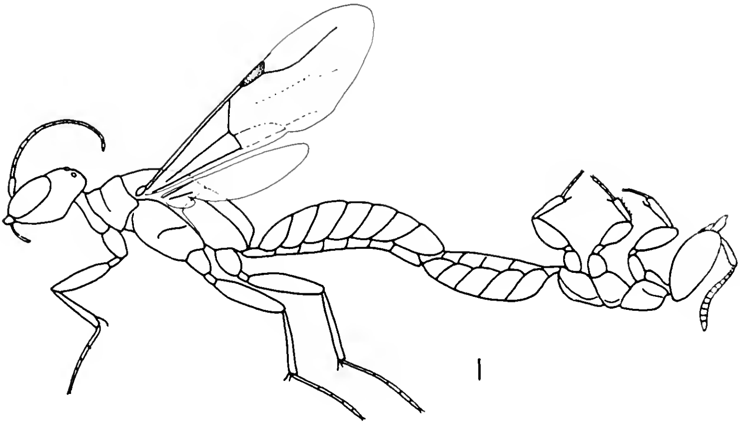
[1] Museum of Comparative Zoology, Harvard University, Cambridge, Mass. 02138.



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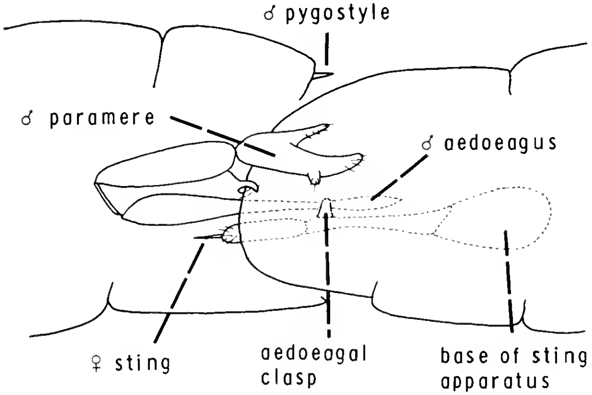

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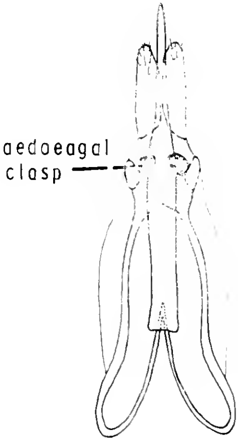

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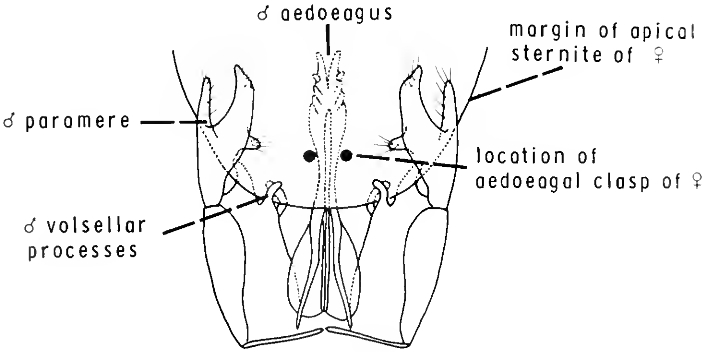

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(See caption, bottom p. 115)

Phoretic copulation is best known in the Tiphiidae, especially in the Thynninae (Janvier, 1933; Given, 1954) but also in the Myrmosinae (Krombein, 1956). It has also been reported in the genus *Timulla* of the Mutillidae (Linsley, 1960) and suggested for the genera *Pristocera* and *Dissomphalus* of the Bethylidae (Evans, 1964). All of these are wasps that attack insects occurring in the soil or in wood and exhibiting a decidedly spotty distribution dependent upon a particular substrate. Thynninae attack scarabaeid larvae, *Pristocera* the larvae of Elateridae (wireworms), Myrmosinae the larvae of ground-nesting bees and wasps, and *Timulla* evidently both wasp and scarabaeid larvae. These groups of wasps are not closely related, and one wonders whether they have evolved similar mechanisms of fastening the genitalia. In fact, how is it possible to achieve so firm an interlocking that the male is able to carry the female for long periods with no other grasp? How is disengagement brought about? Is phoretic copulation a unique phenomenon, or can precedents be found among wasps that are fully winged in both sexes? What can the study of copulating pairs teach us about the function of various parts of the genitalia?

Before attempting to answer these questions, it will be necessary to examine representative pairs in detail, for in fact no one has studied the phoretic mechanism on more than a superficial level. The material available to me consists of museum specimens, dried and mounted on pins, and the muscles and other soft parts are not preserved. These pairs remained together after being killed, with no evident change in the manner of attachment. By relaxing and softening them it is possible to learn a great deal about the interlocking mechanisms, but study of the behavioral aspects of copulation as well as of specimens preserved in a good muscle fixative will be needed to provide complete answers. The available material belongs to the Bethylidae and to two tribes of Thynninae.

Phoretic copulation in the bethylid wasp *Apenesia nitida* (Kieffer). FIG. 1.—A pair as preserved, the male (left) having been mounted on a minuten nadeln. FIG. 2.—Attachment of the male and female enlarged and after drawing the two apart slightly. The male (left) is dorsum-up, the pygostyles being appendages of the apical tergite. The female (right) is venter-up; structures enclosed by the apical sternite of the female are shown as dashed lines. The apical, lateral margins of the last tergite and sternite of the male are omitted for the sake of clarity. FIG. 3.—Sting apparatus of female after dissection from the body (dorsal aspect, sting and sting sheaths uppermost). FIG. 4.—Male genitalia as seen in dorsal view still attached to the apical sternite of the female, the parts located beneath the sternite being shown by dashed lines.

Bethylidae

The cases of prolonged copulation in flight I reported in 1964 were based on indirect evidence in a few species of *Pristocera* and *Dissomphalus*. More recently I have obtained better evidence from a different genus of the same subfamily, Pristocerinae. Throughout this subfamily the females are wholly apterous, depressed, short-legged, and often blind or nearly so, in general admirably adapted for entering wood or soil in search of their hosts (often, perhaps always, the larvae of Coleoptera). The new material consists of two pairs of *Apenesia nitida* (Kieffer) taken on a recent expedition of the American Museum of Natural History to South America. Both pairs are labeled Bolivia: Dept. Beni, Rio Itenez, Pampa de Meio, IX–11–13–1964; J. K. Bouseman, J. Lussenhop Collectors. I do not know how the specimens were collected, but the fact that one of them was covered with lepidopterous scales suggests that they may have been taken in a light trap.

The male of this species is 4–5 mm long and is dark brown in color; I redescribed the male from the type in my revision of *Apenesia* (Evans, 1963), and later provided additional locality data and a figure of genitalia (Evans, 1966a). The female is only 2.5 mm long and is light yellowish brown; it is apparently blind, although a smooth interspace between the large punctures near the base of the mandibles may represent a vestigial ommatidium. This is not only the first instance of an American *Apenesia* taken *in copulo*, but the first female *Apenesia* from South American known to science (although 42 species are known from males). Doubtless the females are hypogaeic, perhaps emerging briefly at night to mate and to seek new hosts.

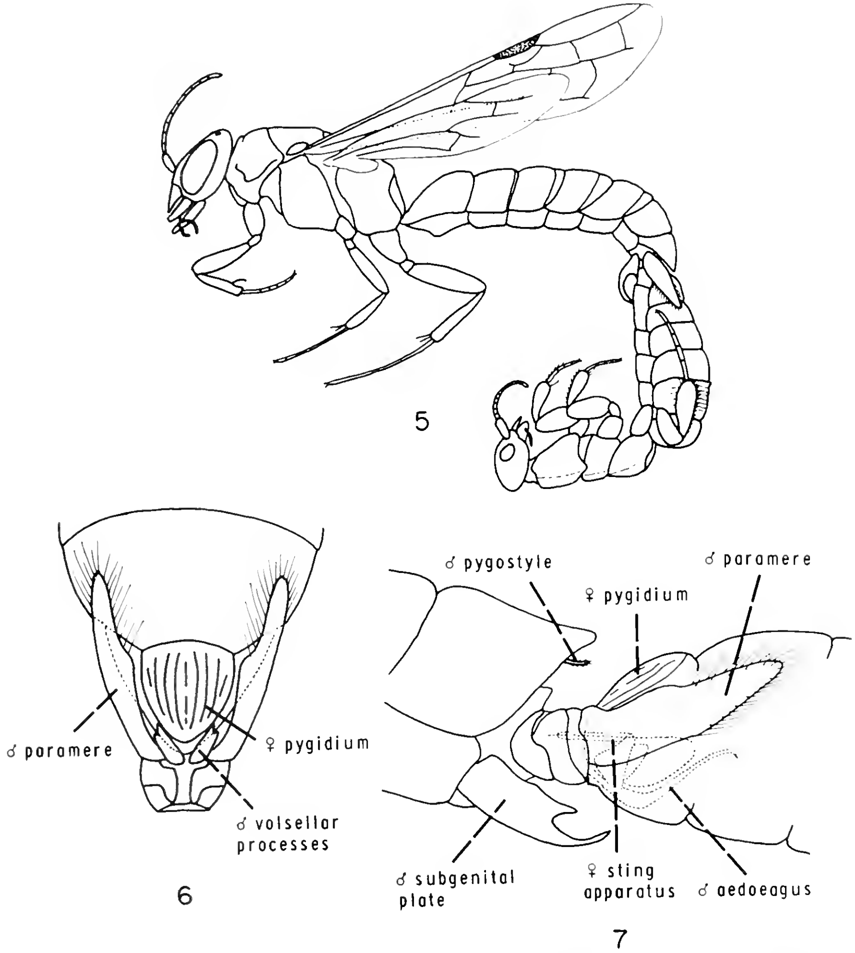
Each pair of *Apenesia nitida* is mounted with a minuten nadeln through the thorax of the male, the female being suspended from the posterior end of the male in an inverted position (Fig. 1). The attachment of the two is broad, and the parameres and other parts of the male genitalia are not visible externally. One assumes that this position is assumed by the male mounting the female dorsally, both individuals facing in the same direction (the most common copulatory posture in wasps), and that upon the male's taking flight the female simply flips backward into a venter-up position.

I placed one pair in a relaxer for 24 hours and then transferred it to 10% KOH for two hours. I then placed it in 50% alcohol and gently lifted the apical tergite of the male to reveal the small pygostyles and the large, trifid parameres, the latter embracing the apical sternite of the female like a three-fingered hand on each side (Figs. 2, 4). I then tried to pull the male and female apart, but without success, as the union was very firm indeed. Further dissection revealed that the apices of the volsellae grasped the edge of the apical sternite of the female like a pair of small pincers, while the aedoeagus extended deep inside the female just above and closely parallel to the sting. Here it was held tightly in place by a pair of sclerotized, pigmented structures suggesting the retinaculum of Collembola, which I shall call the aedoeagal clasps. Only after considerable dissection and manipulation was I able to separate the aedoeagus from the clasps. These clasps evidently arise from the sting sheaths just basad of the apical section and are directed mesad (Fig. 3); they arise from weakly sclerotized bases and the nature of their articulation and musculature (if any) cannot be determined in this material.

I was surprised to find that the aedoeagus assumed quite a different form than previously described. I had previously figured it as considerably shorter and more compact and complex (Evans, 1966a, fig. 3). It is evidently capable of being driven forward by movements of the transverse rods at the base of the genital capsule and their associated muscles; when this occurs various parts apparently slide against one another and some of them project well beyond the apices of the parameres. Furthermore, the extended aedoeagus is constricted at the point of attachment to the aedoeagal clasps and expanded beyond; presumably the somewhat serrated margins of this apical expansion play a role in pushing through the clasps or in holding it fast. So far as I know, such aedoeagal clasps have not previously been described, nor has it been appreciated that the aedoeagus is capable of such great extension and change of form. One would like to know, of course, whether it resumes its usual form following copulation; if not, it is possible that some of the supposed species differences in the aedoeagus may merely represent postcopulatory changes in shape. It is interesting to note that in most genera of Bethylidae the aedoeagus is of very simple form (see Figures in Evans, 1964); highly complex aedoeagi occur principally in *Pristocera*, *Dissomphalus*, and *Apenesia*: precisely the genera in which phoretic copulation has been reported.

Thynninae

Phoretic copulation apparently occurs in all members of the large tiphiid subfamily Thynninae (I exclude the genus *Diamma*, which is sometimes placed in a separate subfamily). The females are invariably considerably smaller than the males and not only have the usual reductions in the eyes and in thoracic structures but sometimes have reductions in the mouthparts; the males, in turn, often have modifications of their mouthparts and head capsule which enable them to feed the females (Given, 1954). Given's discussion and sketches indicate that, in the Australian species he studied, the female is attached to the male in a position the reverse of that in *Apenesia*: that is, the female extends behind the male in a dorsum-up position or the bodies of the male and female form a loop so that the female is beneath the male in a venter-up position. Study of museum specimens pinned *in copulo* suggests that this is indeed the usual condition in Australian species but not in all South American species (as discussed further in a later paragraph).



Phoretic copulation in the thynnine wasp *Dimorphothynnus haemorrhoidalis* (Guerin). FIG. 5.—A pair preserved dry, male (left) mounted on a pin. FIG. 6.—Dorsal aspect of end of female abdomen (above) to which male genitalia (below) are still attached. FIG. 7.—Attachment of male (left) and female (right) in lateral view after drawing the two apart slightly. Both are dorsum-up; structures located within the apical segment of the female are shown by dashed lines. Margins of female tergites and sternites are omitted for the sake of clarity.

For purposes of this study I selected a pair of *Dimorphothynnus haemorrhoidalis* (Guérin), a member of the tribe Rhagigasterini. The pair was collected in Geraldton, Western Australia, by P. J. Darlington, Jr., in October 1931. In this pair the female is suspended downward and forward in the venter-to-venter position common to most Thynninae (Fig. 5). The apical sternite (subgenital plate) of the male has a concave upper surface and a large, hook-shaped terminal spine, fitting closely against the apical sternite of the female. The very large parameres embrace the last two tergites, the grasp enhanced by brushes of stiff setae. In dorsal view, it can be seen that the inner margin of the parameres fits the margin of the pygidial plate closely (Fig. 7). The pair was relaxed and treated in KOH, and with teasing I was able to draw the male and female apart as shown in Figure 7, the extension resulting from a tearing of the membrane at the base of the male genitalia, for the latter remained firmly attached to the female. In this species the apical processes of the volsellae are not hook-like but in the form of elongate folds which are rough on their inner faces; apparently these folds embrace the margin of the apical segment of the female (Fig. 6). The aedoeagus is a simple shaft which is curved up sharply and somewhat attenuate on the apical half; it is no-extensible and only slightly flexible. Its basal part appears to be held against the sternite by the sting apparatus, the lateral plates holding it on each side and a small, transverse phragma (not figured) holding it from above. The sting itself forms a loop, against which the outer part of the aedoeagus fits closely. As in all the forms studied, the sting is somewhat withdrawn and does not extend much beyond the apical segment of the female.

In contrast to *Apenesia*, the genitalia of *Dimorphothynnus* have obviously been rotated 280 degrees, so that the ventral surface is uppermost; this is clearly shown by the position of the volsellae. I would assume that the male mounts the female from above in the usual manner, inserting the genitalia and causing them to lock into place; however, instead of merely flipping back into a venter-up position, the female twists 180 degrees so that her dorsum is projected from the dorsum of the male (Fig. 5). When this occurs the male genitalia rotate on their basal membrane. Such a rotation has been described for some of the Chilean Thynninae by Durán-Moya (1941), who however compares them with the Strophandria in the sawflies, a group in which rotation of the genitalia occurs prior to eclosion. In *Dimorphothynnus* and in many other genera of Thynninae, copulating pairs are found to have the male genitalia inverted and to be attached to the male's body primarily by a twisted membrane, while non-copulating males have the genitalia uninverted. In *Dimorphothynnus* the locking device appears to consist of the rigid, angulated aedoeagus, held not by aedoeagal clasps similar to those of *Apenesia* but by parts of the sting apparatus itself; the tensile strength of the aedoeagus, combined with the application of the volsellar folds and the three-sided grasp provided by the large parameres and the subgenital plate, forms a very firm attachment indeed. Because of the inversion of the male genitalia and the body of the female, the aedoeagus is below the sting rather than above it as in *Apenesia*, although the two structures retain the same morphological relationship.

Perusal of museum material reveals that many (if not all) Australian Thynninae copulate with the females in a dorsum-up position, as do many South American forms (the subfamily is confined to those two continents). However, certain South American species copulate with the female in a venter-up position. Janvier (1933, p. 238) has provided an excellent photograph of *Elaphroptera nigripennis* Smith (tribe Thynnini) resting on a bush. A pair of this species in the collection of the Museum of Comparative Zoology, pinned through the body of the male, remains in exactly the pose figured by Janvier. Several pairs of *E. scoliaeformis* (Haliday) are also preserved in the some pose, the female being suspended venter-up but her body somewhat coiled, in the shape of a U. I relaxed one pair of this species, from Dalcahue, Chiloe, Chile, collected by Luis Peña in January, 1962, and present here a sketch (Fig. 8) and a few comments on the manner of attachment.

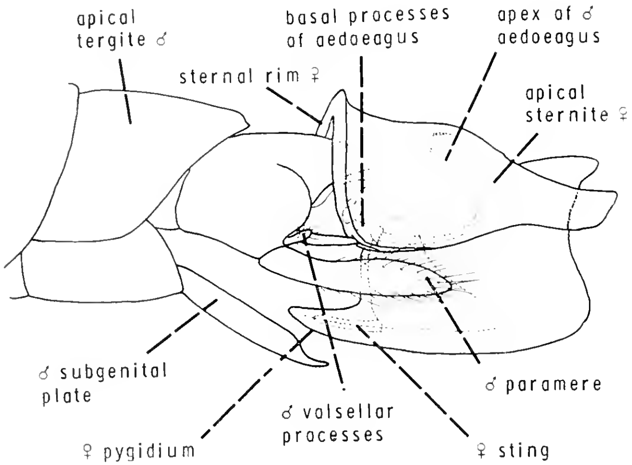


FIG. 8. Attachment of male (left) and female (right) *Elaphroptera scoliaeformis* (Haliday) (Thynninae), slightly drawn apart. Drawn from museum specimens, somewhat simplified.

The male of this species possesses heavily sclerotized parameres fringed with setae, as in the preceding example. They embrace the sides of the pygidium much as in *Dimorphothynnus*, although in this case the pygidium is ventral. The subgenital plate of the male is not unlike that of *Dimorphothynnus*, although with a much smaller apical spine; rather than pressing against the sternum it fits over the pygidial plate. The apical sternite of the female is hood-shaped, and its posterior opening has a broad, sclerotized rim through which the aedoeagus is thrust. The volsellae, however, remain outside this rim, the longer pair of appendages appearing to fit into slots toward the lower part.

The aedoeagus itself is so complex as to defy description. The greater part of it is in the form of a long, somewhat coiled flagellum (which Janvier has figured and aptly compared to the tongue of a lepidopteran). At its base, the aedoeagus is expanded and has various processes, one pair of which is large, flap-like, and directed back toward the base of the genitalia. These evidently push against the sclerotized rim of the sternite from the inside, while a second pair of hook-like processes appears to make a connection with the base of the sting apparatus. The sting itself is small and located close against the pygidial plate, far from the aedoeagus.

Evidently the locking effect is produced by pressure of the volsellae against the sternal rim from the outside opposed to that from the inside provided by the reversed flaps of the aedoeagus; the second pair of hook-like aedoeagal processes may provide added attachment to the sting apparatus. The whip-like part of the aedoeagus plays no obvious role in the locking mechanism; it may penetrate deeply into the spermatheca, but the latter was not preserved in this dried material. Obviously this mechanism would repay much further study. Judging from Janvier's and Durán-Moya's figures, several species of *Elaphroptera* have genitalia of this basic type, but differing in details. In the pair of *E. nigripennis* before me, the apical volsellar lobes are very large, hook-shaped, and curve up so as to embrace the outside of the expanded margin of the apical sternite of the female.

Discussion

In the examples considered here, and probably in most Hymenoptera, the basic function of the major elements in the male genitalia remains the same: the parameres embrace the outside of the apical segment of the female, the volsellar processes (digitus and cuspis) are associated with holding the margin of the apical segment, and the aedoeagus is thrust deeply into the female, its tip presumably in or near the spermathecal opening. The sting of the female is retracted, though at other times capable of great extension, probably by "taking up the slack" produced by the basal loop.

Wasps exhibiting phoretic copulation have evolved modifications of both sexes so as to provide a remarkably firm interlocking. In the forms studied, the female showed the following specializations: (1) paired, sclerotized aedoeagal clasps arising from the base of the sting sheaths (*Apenesia*), (2) median and lateral flanges of the sting apparatus, serving to hold the aedoeagus against the arching sternite (*Dimorphothynnus*), (3) a broad, sclerotized rim closing off a large part of the genital opening (*Elaphroptera*, and developed to varying degrees in most Thynninae). In the males, the volsellar processes assume various forms, serving either as clasps (*Apenesia*), as embracing folds (*Dimorphothynnus*), or as struts (*Elaphroptera*). The aedoeagus may be (1) extensible and with a constriction along its shaft (*Apenesia*), (2) rigidly angulate (*Dimorphothynnus*), or (3) whip-like but with complex basal processes, one pair of which is directed basad (*Elaphroptera*).

Whether or not other Bethylidae will be found to possess modifications similar to those of *Apenesia* remains to be seen. In the Thynninae, a scanning of museum material as well as the figures of Durán-Moya (1941), Salter (1958), and others, suggests that in this group the interlocking mechanisms assume many different forms. In fact, the many curious modifications of the male and female terminalia in this group are without parallel in any other group of wasps known to me. It is also remarkable that in most (but not all) genera, the male genitalia twist 180 degrees, apparently after locking with the female has been achieved. This rotation permits the female to feed readily if transported to a source of food by the male (since she is venter-down) or to be fed by the male in any of several ways, since she is able to bend up toward the venter of the male. The structural and behavioral adaptations for feeding described by Given (1954) could not have evolved had not the male genitalia developed the capacity to rotate. Presumably *Elaphroptera* represents a stock of Thynninae in which failed to develop the capacity to rotate the genitalia.

Two important questions cannot be answered: (1) how is separation effected? and (2) do the male genitalia return to their original orientation following copulation? There is no evidence that the male genitalia break away from his body as they do in the honeybee, so it must be assumed that unlocking is possible. Museum specimens not taken *in copulo* always appear to have normal, uninverted male genitalia, so it is probable that these structures do resume their normal orientation (or do the males die after copulating?) Burrell (1935) reported that certain female Thynninae simply "drop to the ground," sometimes while the male is flying more than ten feet high, but no one has described how separation occurs. In the case of *Apenesia*, separation would seem to be fairly simple if, in fact, the aedoeagal clasps are musculated, but how the complex aedoeagus of *Elaphroptera* is withdrawn through the sternal rims of the female is much more difficult to visualize.

It is interesting to speculate as to the possible origin of phoretic copulation. Evidently it has evolved several times independently, and one assumes it has done so because of the selective advantage of dispersing inseminated females into areas where new and unparasitized populations of hosts may be discovered. In each case it has evolved in subfamilies in which winglessness is universal in the female sex. Winged females of Tiphiidae and Bethylidae also possess the depressed body form, short, spiny legs, and other adaptations for seeking out hosts in the soil or in wood. Since burrowing adaptations are widespread in these groups and in related families such as the Scoliidae, one assumes they evolved first, and that loss of wings and associated thoracic reductions of the females of certain stocks followed (Reid, 1941). Not only may wings hamper a female burrowing through the soil, but if lost the body materials which go to make up the flight musculature may be redeployed, for example toward the musculature of digging. In a few diverse stocks, there has been evolution toward a smaller relative size of the female and toward the development of diverse modifications of the genitalia permitting the males to carry the females about. In these stocks the major disadvantage of flightlessness, namely, decreased power of dispersal, has been partially cancelled. In some elements in at least one of these stocks, there has developed a rotation of the genitalia such that the females are able to feed or to be fed by the male during the copulatory flight. One assumes that more prolonged phoretic copulation is thus possible.

The reduction in the relative size of the female has an interesting corollary. There is evidence that in many Hymenoptera, fertilized, female-producing eggs are laid on larger prey or in nest-cells containing (on the average) more prey than cells in which unfertilized, male-producing eggs are laid. The result is that in virtually all higher Hymenoptera the females are larger than the males. In the groups exhibiting phoretic copulation, have the females undergone a behavioral reversal such that they lay unfertilized, male-producing eggs on larger prey, fertilized eggs on smaller prey? Or do female larvae fail to consume all their food?

Finally, we should ask if there are instances of fully winged Hymenoptera exhibiting phoretic copulation. Hymenoptera, indeed insects in general, show much variation in the amount of time required for mating, and I am not aware that it is known why some species are able to effect insemination in a few seconds, others only after many minutes. Several species of wasps which are fully winged in both sexes are known to remain *in copulo* for many minutes and, if disturbed, to fly about, the larger female usually pulling the male behind her attached by the genitalia. Such behavior has been described in the eumenid wasp *Monobia quadridens* by Rau (1935) and in the sphecid wasp *Sphecius speciosus* by Lin

(1966). Lin has provided photographs of mating pairs and has conjectured that prolonged copulation may have evolved "as an adaptation to conspecific interference by rival males" in this gregarious species. He suggests that the capacity to fly during mating may represent an escape mechanism from predators during this period of high vulnerability. The method of attachment of males and females in *Sphecius* has not been studied, but the shape of the male volsellar processes is suggestive of a hooking mechanism (Evans, 1966b, p. 11).

Of course, eumenids and sphecids are by no means ancestral to the tiphiids and bethylids discussed earlier, and we presently know of no cases of what might be called "facultative phoretic copulation" among these more primitive wasps. However, the situation in *Sphecius* and *Monobia* suggests that the potential exists and permits us to postulate other factors—rivalry of males and escape from predators—which may have been operative during the perfection of these elaborate locking mechanisms.

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New Exotic Crane-flies (Tipulidae: Diptera). Part XVII[1]

Charles P. Alexander[2]

The preceding part under this general title was published in Entomological News, Vol. 79 (9): 240–248. At this time I am continuing the survey of Hexatomine crane-flies that were collected in South India, Assam and Sikkim by Dr. Fernand Schmid, who has made the single greatest contribution of materials in this family for the Oriental fauna.

Riedelomyia lipoleuca, NEW SPECIES

General coloration of mesonotum brownish yellow, patterned with darker brown, thoracic pleura with two broad dark brown longitudinal stripes that are separated by a narrow yellow line; antennae with the fusion-segment comprised of five articles; legs yellow, without white pattern, femora with a vaguely indicated darkened subterminal ring; wings yellow, patterned with light brown, the apparent vein R_2 transverse.

Male.—Length about 7 mm; wing 6.5 mm.

Rostrum brownish yellow, palpi black, the intermediate segments short and crowded, terminal segment smaller, oval. Antennae with fusion-segment yellowed, remainder light brown, the fusion comprised of five segments, the succeeding ones short, outer segments longer but shorter than their excessively long verticils. Head brown.

Pronotum light brownish yellow. Mesonotal praescutum brownish yellow with two poorly indicated slightly darker intermediate stripes, sublateral darkened areas broader but paler, lateral margins darker brown, pseudosutural foveae yellowed; posterior sclerites of notum brownish yellow, vaguely patterned with slightly darker, including the scutal lobes. Pleura with the restricted ground obscure yellow, including the dorsopleural region and a narrow stripe between two broader subequal darker brown longitudinal stripes. Halteres yellow, knobs weakly darkened. Legs with fore coxae brown, remaining coxae and all trochanters yellow; remainder of legs light yellow, femora with a vaguely indicated darkened subterminal ring that is about one-half as extensive as the yellowed apex. Wings yellowed, the prearcular and costal fields clearer; a relatively conspicuous light brown pattern, including areas at origin of *Rs*, stigma, cord, outer end of cell *1st* M_2 and outer end of cell R_2; smaller brown marginal areas at ends of all longitudinal veins, smallest on R_5, progressively larger posteriorly; an oval marking in cell *R* at mid-distance between arculus and origin of *Rs*; still other vague clouds on veins and in cells before cord, including especially cells *M* and both Anals; veins yellow, darker in the patterned areas. Costal fringe of male long and conspicuous; macrotrichia on longitudinal veins beyond general level of cord, sparse and weak on *Rs* and *2nd A*. Venation: The apparent vein R_2 transverse, subequal to R_{1+2}, placed just distad of *r-m*; *m-cu* at near one-third M_{3+4}.

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[2] Contribution from the Entomological Laboratory, University of Massachusetts, Amherst, Mass. 01002.

Abdomen dark reddish brown, sides blackened. Male hypopygium with the outer dististyle a simple yellow blade that narrows outwardly, apex slightly recurved, tip obtuse; inner style longer, stout, tip broadly obtuse.

Habitat.—South India. *Holotype:* ♂, Periyakanal, Kerala, 5,000–5,500 feet, December 17, 1958 (Fernand Schmid).

Riedelomyia lipoleuca is distinguished from other members of the genus by the lack of white pattern on the legs. The other regional species, all from South India, include *R. chionopus* Alexander, with the legs dark except for the white tarsi, together with *R. gratiosa* Alexander and *R. niveiapicalis* (Brunetti), where the tips of the femora and tibiae as well as the outer tarsal segments are whitened. A comparison of the three Oriental species then known was provided by the writer when the genus *Riedelomyia* was proposed (Philippine Jour. Sci., 35: 481–484; 1928). It should be emphasized that the genus as here restricted is very close to *Eupilaria* Alexander, differing in the loss of tibial spurs and in the reduced venation of the radial field of the wing, the sector having only two branches. The Australasian species hitherto referred to *Riedelomyia* include *teucholabina* (Alexander) and *papuensis* Alexander which now are known to belong to a different genus. The male sex of these now is known and the hypopygial structure preclude their being placed in the same genus as the Oriental species above listed.

Atarba (Atarbodes) bilobula, NEW SPECIES

General coloration yellow; wings yellowed, *Sc* relatively long, Sc_1 ending opposite two-thirds *Rs*; abdomen without a darkened subterminal ring; male hypopygium with phallosome distinctive, including elongate rodlike apophyses, aedeagus short, terminating in two rounded lobes.

Male.—Length about 4.5 mm; wing 5.1 mm; antenna about 0.8 mm.

Rostrum yellow; palpi yellow, terminal segment black. Antenna and head yellow.

Thorax light yellow; mesonotal vestiture sparse, long and erect. Halteres yellow. Legs yellow, the genua scarcely to very narrowly darkened, tips of tibiae narrowly infuscated; tarsi yellow, outer segments slightly darker. Wings yellow, costal border slightly darker; veins yellow. Venation: *Sc* relatively long, Sc_1 ending about opposite two-thirds *Rs;* cell *1st* M_2 small.

Abdomen yellow, without a darkened subterminal ring. Male hypopygium with dististyles fused only on basal fourth, outer style relatively slender, straight, outer fourth with coarse denticles, inner style longer, curved gently to the narrowly obtuse tip. Phallosome with two long apophyses that appear as slender curved rods narrowing to the pointed tips, narrowest beyond midlength. Aedeagus short, subequal in length to the apophyses, terminating in two rounded lobes.

Habitat.—Sikkim. *Holotype:* ♂, Teng, 4,600 feet, August 1, 1959 (Fernand Schmid).

The structure of the hypopygium readily distinguished the present fly from all regional allies. The species with the apophyses most similar is *Atarba (Atarbodes) dicera* new species which has the thoracic coloration and structure of the aedeagus quite distinct.

Atarba (Atarbodes) bismila, NEW SPECIES

General coloration of entire body pale yellow, in male the two subterminal abdominal segments brown; legs yellow, tips of femora very narrowly brownish black; wings light yellow, the veins deeper yellow; male hypopygium with spines of outer dististyle short but strong; phallosome including the long slender aedeagus and a subtending pale sheath that terminates in two narrow pale blades.

Male.—Length about 5.3–5.5 mm; wing 5.5–5.8 mm; antenna about 0.9–1 mm.

Rostrum and palpi yellow, terminal segment of latter intensely black (broken in female). Antennae yellow, slightly longer and stouter in female. Head yellow.

Thorax uniformly pale yellow. Halteres yellow. Legs yellow, tips of femora very narrowly brownish black, of tibiae even more narrowly darkened. Wings light yellow, costal region and veins deeper yellow. Venation: *Sc* relatively long, Sc_1 ending about opposite one-third *Rs*, Sc_2 removed, just beyond origin of *Rs;* outer radial branches gently divergent, cell R_4 at margin more extensive than cell R_2.

Abdomen yellow, in male segments seven and eight brown to form a subterminal ring, hypopygium yellow. Male hypopygium with mesal face of basistyle with very long setae. Dististyles fused only at bases, outer style relatively short and stout, black, spines short and strong; inner style a long slender curved rod. Phallosome including the aedeagus and a subtending pale sheath, at apex produced into two pale blades, their tips acute, ending shortly before apex of aedeagus.

Habitat.—Assam, Sikkim. *Holotype:* ♂, Chumtang, Sikkim, 5,120 feet, July 18, 1959 (Fernand Schmid). *Allotopotype:* ♂, pinned with type. *Paratypes:* 1 ♂, Teng, Sikkim, 4,600 feet, August 1, 1959; 1 ♂, Lingtham, Sikkim, 6,500 feet; ♂, ♀, Bomdi La, Kameng, Northeast Frontier Agency, Assam, 8,800 feet, June 16–17, 1961 (all Schmid).

Atarba (Atarbodes) bismila is readily told from all similar regional allies by the hypopygial structure, especially the phallosome.

Atarba (Atarbodes) decincta, NEW SPECIES

General coloration of entire body, antennae and halteres pale yellow; legs yellow, tips of femora and tibiae narrowly blackened; wings yellow, veins darker yellow; abdomen with no indication of a darkened subterminal ring; male hypopygium with outer dististyle relatively short and compact, black, with a double row of long black appressed spines, with about five on either side, phallosome without spinous points.

Male.—Length about 5 mm; wing 5.5 mm; antenna about 1.3 mm.

Rostrum light yellow, first segment of palpus yellow, second brown, outer two black. Antennae and head yellow.

Thorax entirely light yellow. Halteres and legs yellow, tips of femora and tibiae narrowly blackened, outer tarsal segments dark brown. Wings yellow with darker yellow veins. Venation: Sc_1 ending shortly before midlength of Rs, Sc_2 opposite one-fifth this vein; *m-cu* just beyond fork of M.

Abdomen pale whitish yellow, only the outer dististyles black. Male hypopygium with outer dististyle relatively short and compact, with unusually long appressed black spines arranged in a double row, with about five on either side, additional to a terminal extension, the proximal one or two teeth very small, inner style longer, appearing as a flattened yellow paddle. Phallosome with apophyses appearing as flattened pale blades with no spinous points.

Habitat.—Assam. *Holotype:* ♂, Chingsao, Manipur, 3,800 feet, June 13, 1960 (Fernand Schmid).

The closest relative of the present fly is *Atarba* (*Atarbodes*) *flava* Brunetti which likewise has the narrowly blackened tips to the femora and tibiae. In *flava* the abdomen has a narrow incompletely darkened subterminal ring, as shown by specimens in my collection received from Brunetti and Edwards that had been compared with type materials. The male hypopygium of *flava* has the blackened spines of the outer dististyle different in size and arrangement, the more proximal ones small, the outer ones progressively longer, with two or three still longer spines near outer end, none of these as long as certain of those in *decincta.*

Atarba (Atarbodes) dicera, NEW SPECIES

General coloration yellow, margins of mesonotal praescutum and scutum chestnut brown; antennae, halteres and legs yellow; wings dark yellow, including the veins; abdomen of male with eighth segment brown to form a narrow ring; male hypopygium with outer dististyle having relatively few spines all on outer third; phallosome including a pair of rodlike apophyses that narrow into long slender spines.

Male.—Length about 4.5–4.6 mm; wing 4.8–5 mm; antenna about 0.9 mm.

Rostrum brownish yellow, palpi brownish yellow, terminal segment black. Antennae yellowed. Head above brownish black, yellowed on occiput.

Cervical region and pronotum yellow. Mesonotum polished yellow, anterior and lateral borders of praescutum and scutum broadly chestnut brown, mediotergite paler brown. Pleura and pleurotergite clear yellow. Halteres yellow. Legs yellow, outer tarsal segments with darkened setae; in the paratype apex of femur very narrowly darkened. Wings deep yellow, including the veins. Veins of outer half of wing with macrotrichia, including outer ends of both Anals and outer end of basal section of Cu_1.

Venation: *Sc* relatively long, ending at from one-fifth to beyond one-third *Rs*, outer branches of the latter gently divergent, cell R_4 at margin slightly more extensive than R_2; *m-cu* before midlength of M_{3+4}.

Abdomen yellow, eighth segment brown to form a narrow ring, hypopygium yellowed except for the blackened outer dististyles. Male hypopygium with dististyles small in comparison with the elongate basistyles, narrowly fused basally; outer style blackened, with relatively few teeth, all restricted to the outer third; inner style longer, pale, with a narrow flange near outer end. Phallosome conspicuous, the apophyses including two broadly flattened blades with obtuse tips and a pair of more sclerotized straight rods, each with the outer fourth prolonged at nearly a right angle into a long straight spine.

Habitat.—Sikkim. *Holotype:* ♂, Mangalbarey, 2,800 feet, April 30, 1959 (Fernand Schmid). *Paratype:* ♂, Mangang, 3,600 feet, May 9, 1959 (Schmid).

The present fly is told from other regional species by the coloration of the mesonotum and especially by hypopygial structure, including the outer dististyle and the phallosome. *Atarba (Atarbodes) trimelania* Alexander, of South India, has the mesonotum patterned with dark but with the hypopygium entirely distinct.

Atarba (Atarbodes) sikkimensis, NEW SPECIES

General coloration of body, antennae, halteres and legs yellow; wings light yellow, *Sc* long; abdomen with a narrow brownish black subterminal ring; male hypopygium with dististyles fused basally, outer margin of the outer style with blackened spines; apophyses appearing as flattened plates with both margins microscopically spinulose.

Male.—Length about 5.5–6.2 mm; wing 6–7 mm; antenna about 1.0–1.1 mm.

Female.—Length about 5.5 mm; wing 6 mm.

Rostrum yellow, palpi black, in some individuals with proximal segments paler. Antennae of male yellow to brownish yellow, brown in female. Head yellow.

Thorax yellow, virtually unpatterned. Halteres and legs yellow, outer tarsal segments slightly darker. Wings light yellow, including the veins, trichia darker. Venation: *Sc* long, Sc_1 ending a short distance before fork of *Rs*. Sc_2 removed; branches of *Rs* strongly divergent near outer ends, cell R_4 at margin about one-half more extensive than cell R_2; M_{3+4} shorter than M_4; *m-cu* shortly beyond fork of *M*.

Abdomen obscure yellow, segments seven and eight in male brownish black to form a narrow ring. Male hypopygium with dististyles extensively fused to beyond midlength, outer style shorter, with appressed spinules on outer margin of distal two-thirds. Phallosome with outer apophyses distinctive, appearing as flattened plates, their outer margins protuberant, with abundant coarse yellow spines, inner edge near apex with fewer more slender spines, the tip farther produced into one or two still stronger spines.

Habitat.—Sikkim. *Holotype:* ♂, Lachen, 8,900 feet, June 13, 1959 (Fernand Schmid). *Allotype:* ♀, Lachung, 8,610 feet, July 10, 1959. *Paratopotypes:* 3♂♂. *Paratypes:* ♂♀, with the allotype, July 6–9, 1959; ♂♀, Chumtang, 5,120 feet, July 18, 1959; ♂♀, Namnasa, 9,500 feet, July 13, 1959 (all Schmid).

Atarba (Atarbodes) sikkimensis is quite distinct from *A. (A.) flava* Brunetti and other regional species. In the present species several of the individuals show persistent greenish body tints that indicate the probability of stronger green coloration in living specimens.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

International Commission on Zoological Nomenclature: Announcement.

Required six-months' notice is given on the possible use of plenary powers by the International Commission on Zoological Nomenclature in connection with the following names listed by case number:

(see, *Bull. zool. Nomencl.* 25, pt. 6, 28th February 1969):

1859. Validation of emendation to *patchae* of *patchiae* (*Schizoneura*) Börner & Blunck, 1916; suppression of *Schizoneura patchi* Meunier, 1917 (Insecta, Hemiptera).

1864. Suppression of *Dicyphus tamaricis* Puton, 1886 (Insecta, Hemiptera).

1858. Type specimen for *Anthocoris pini* Bärensprung, 1858 (Insecta, Hemiptera).

Comments should be sent in duplicate, citing case number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W.7, England. Those received early enough will be published in the Bulletin of Zoological Nomenclature. W. E. China, *Assistant Secretary.*

Overwintering by Pupal Nympalids in New York?—Members of the genus *Nymphalis* (Lepidoptera: Nymphalidae) normally overwinter as adults at the latitude of central New York. Klots (*Field Guide to the Butterflies*, p. 106) records both *N. antiopa* L. and *N. milberti* Latr. overwintering as pupae. On April 7, 1969, I took a freshly emerged *N. antiopa* at Slaterville Springs, Tompkins Co., N. Y., which voided the meconium in my hand. The following day I took a seemingly fresh *N. milberti* at Robinson Hollow, Town of Richford, Tioga Co., N. Y. These are the

(Continued on page 138)

Parachernes (Arachnida, Chelonethida, Chernetidae) from the Coast of North Carolina[1, 2]

WILLIAM B. MUCHMORE and CHARLOTTE H. ALTERI[3]

In a series of collections of pseudoscorpions made by Dr. Peter Weygoldt in the vicinity of Beaufort, North Carolina, were found representatives of two new species of *Parachernes.* Inasmuch as Dr. Weygoldt's detailed observations of the courting and mating behavior of these new forms will appear in print shortly (1969), it is necessary to have formal descriptions of them on record.

We are greatly indebted to Dr. Weygoldt for supplying the specimens. The types are deposited in the American Museum of Natural History.

The genus *Parachernes* is widely distributed in America and the Pacific area. A number of species have been described from the United States, but none from the eastern part of the country is well known. It is hoped that the detailed knowledge of the two new species will serve as the basis for a critical review of the genus.

Parachernes litoralis, NEW SPECIES

MATERIAL. Holotype male (WM 914.01010) and twenty-two paratypes (fourteen males and eight females) collected under driftwood on beach at Beaufort, Carteret County, North Carolina in March 1966, and two paratype males collected under bark at Pine Knoll Shores, Morehead City, Carteret County, North Carolina in February 1966, all by Peter Weygoldt.

DESCRIPTION.—*Male:* (Measurements are given first for the holotype, followed in parentheses by ranges for all males.) Carapace and tergites yellow-brown in color, palps dark red-brown. Carapace longer than broad, the greatest breadth along the posterior edge; mid and posterior furrows very distinct; surface of carapace moderately heavily sclerotized and densely granulate cephalad of the posterior furrow, as shown in Fig. 1; caudad of the posterior furrow the granules are lightly sclerotized except for those occurring on the keel. The keel is a median, short, wide, slightly elevated, posterior projection of the sclerotized area of the carapace, about 0.3 times as long as basal width, as shown in Fig. 1. Granules between furrows are round-based, smoothly rounded, and moderately distant from one another; those on keel appear as separate, distinct, projections of thickened carapacal cuticle. Two large, distinct eyes present, each about one ocular diameter from the anterior edge. About fifty setae on carapace, of which four are at the anterior and six to nine at the posterior margin. Setae multidenticulate terminally.

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[2] Accepted for publication February 20, 1969.

[3] Department of Biology, University of Rochester, Rochester, New York 14627.

Tergites heavily sclerotized and densely granulate; tops of most granules flattened (Fig. 2). Tergal setae terminally multidenticulate; tergal chaetotaxy 7:9:6:10:8:9:10:10:9:8:8:2(6–9:7–9:6–10:8–11:8–11:9–11:8–13:9–12:8–11:7–11:5–10:2). Sternites not so heavily sclerotized as tergites. Sternal setae predominately acuminate, a few toward the posterior end weakly denticulate; chaetotaxy 47:[9]:(2)6(3):(1)5(1):11:11:13:12:12:8:6:2(32–49:[5–10]:(1–3)6–9(1–3):(1)4–6(1):10–12:10–14:12–14:11–13:9–12:6–12:5–6:2); lateral-most setae of each sternite somewhat distant from next in the row.

Anterior genital operculum with 6(6–8) long setae around genital aperture surrounded by 41(26–41) shorter setae. Posterior edge of aperture with 9(5–10) small setae. Posterior operculum with 6(6–9) marginal setae.

Chelicera about one third the length of the carapace. Palm with five (rarely six) setae; *sb* and *b* dentate, *es* long and acuminate; *sb* and *b* as long as or longer than *es*. Fixed finger with three small subterminal teeth and three larger teeth along middle of margin. Movable finger with a subterminal lobe plus an occasional small tooth. Galea long and with 5(4–6) rami. Serrula exterior with 20(16–21) blades. Flagellum with three setae, the most distal one serrate.

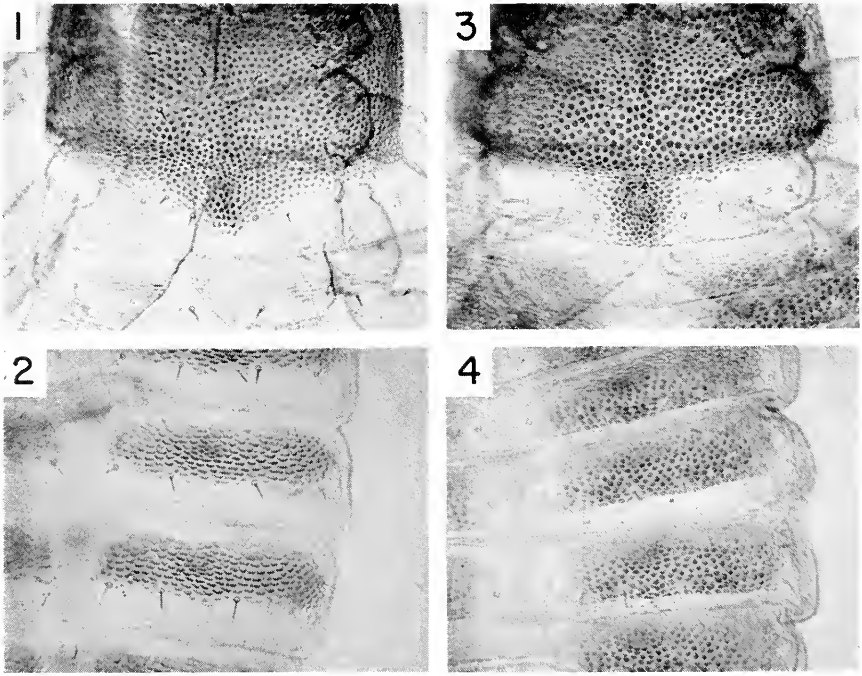

FIG. 1. *Parachernes litoralis*, n.sp.; paratype, posterior portion of carapace, showing granulations, keel, and marginal setae. Fig. 2. Same; right tergites 5 and 6, showing granulations and setae. Fig. 3. *Parachernes corticis*, n.sp.; paratype, posterior portion of carapace, showing granulations, keel, and marginal setae. Fig. 4. Same; right tergites 5 and 6, showing granulations and setae.

Palps short and stout, as shown in Fig. 5. Chela granulate on small area of flexor margin near base of movable finger and faintly granulate on dorsal surface. Tibia, femur, and trochanter densely granulate. Tactile setae of chela as shown in Fig. 6. Fixed finger of chela with 37(32–38) and movable finger with 41(35–43) low, cusped, marginal teeth, the cusps becoming reduced toward proximal end of row. Each finger with one to four interior and three to nine exterior accessory teeth. Nodus ramosus of movable finger very slightly proximad of seta *t*. Venom duct of fixed finger much reduced; nodus ramosus slightly proximad of seta *et*. Trochanter 1.6(1.25–1.8), femur 2.55(2.4–2.7), tibia 2.3(2.15–2.4), chela 2.65(2.3–2.7) times as long as broad; hand 1.35(1.3–1.5) times as long as deep; movable finger 0.95(0.85–1.0) times as long as hand.

Legs typical. Leg I with basifemur 1.5(1.35–1.6) and tibia 3.0(2.9–3.05) times as long as wide. Leg IV with entire femur 3.1(2.9–3.3) and tibia 4.0(3.45–4.05) times as long as wide; tactile seta on tarsus distal, about two thirds the length of the segment from the proximal end.

Female: (Measurements are ranges for the eight paratypes.) Carapace and tergites slightly lighter color than in male, palp the same color as male; lengths of carapace, chela, and femurs of first and fourth legs greater than those of male, lengths of other segments similar. Carapacal setae 46–54. Tergal chaetotaxy 9–10 : 9–11 : 9–10 : 10–14 : 11–13 : 10–13 : 10–14 : 11–13 : 11–13 : 9–12 : 8–11 : 2. Sternal chaetotaxy 22–28 : (1–3)6–7(1–4) : (1)5–7(1) : 11–12 : 12 : 13–15 : 12–14 : 12 : 10–12 : 6 : 2. Anterior operculum with two spaced setae on each side of a compact, central group of 18–24.

Chelicerae slightly more than one third the length of the carapace; galea as in male.

Palps similar to those of male but stouter. Fixed finger of chela with 34–37 and movable finger with 37–43 teeth. Interior accessory teeth 0–3, exterior accessory 3–9. Trochanter 1.4–1.7, femur 2.35–2.7, tibia 2.1–2.35, chela 2.5–2.8 times as long as broad; hand 1.3–1.6 times as long as deep; movable finger 0.8–0.9 times as long as hand.

Legs similar to those of male, but slightly stouter.

Measurements (in mm.): *Male:* Body length, 2.1(1.8–2.25); carapace length, 0.725(0.65–0.775); greatest width, 0.615(0.52–0.71); diameter of eyes about 0.06; chelicera 0.235(0.19–0.24) long by 0.12(0.11–0.13) broad, movable finger, 0.17(0.13–0.17). Galea 0.03(0.025–0.03) long. Palpal trochanter, 0.305(0.27–0.32) long by 0.185(0.17–0.22) broad; femur, 0.55(0.495–0.595) by 0.22(0.20–0.235); tibia, 0.55(0.495–0.60) by 0.24(0.22–0.255); chela, 0.90(0.84–0.94) by 0.34(0.335–0.37); hand, 0.485(0.45–0.51) by 0.36(0.31–0.36); movable finger, 0.465(040–0.50) long. Leg I: basifemur, 0.185 (0.16–0.185) long by 0.125(0.11–0.125) broad; telofemur, 0.27(0.25–0.285) by 0.12 (0.105–0.12); tibia, 0.24(0.205–0.25) by 0.08(0.08–0.09); tarsus, 0.235(0.20–0.27) by 0.055(0.05–0.06). Leg IV: entire femur 0.495(0.465–0.53) long; basifemur, 0.185(0.18–0.205) by 0.135(0.13–0.15); telofemur, 0.38(0.34–0.40) by 0.17(0.155–0.17); tibia, 0.36(0.33–0.38) by 0.095(0.09–0.105); tarsus, 0.30(0.27–0.32) by 0.07(0.06–0.07); tactile seta, 0.22(0.16–0.23) from proximal end of segment.

Female: Body length, 2.07–2.83; carapace length, 0.74–0.80; greatest width, 0.54–0.85; diameter of eyes about 0.07; chelicera 0.22–0.25 long by 0.105–0.14 broad, movable finger, 0.155–0.19. Palpal trochanter 0.28–0.33 long by 0.18–0.205 broad; femur, 0.53–0.59 by 0.20–0.23; tibia, 0.53–0.58 by 0.22–0.27; chela, 0.91–0.99 by 0.335–0.39; hand, 0.49–0.53 by 0.30–0.35; movable finger, 0.415–0.48 long. Leg I: basifemur 0.17–0.20 by 0.12–0.13; telofemur, 0.26–0.29 by 0.12; tibia, 0.23–0.26 by 0.07–0.09; tarsus, 0.22–0.27 by 0.06. Leg IV: entire femur, 0.51–0.565 long; basifemur, 0.21–0.23 by 0.135–0.15; telofemur, 0.38–0.425 by 0.155–0.18; tibia, 0.34–0.40 by 0.09–0.105; tarsus, 0.285–0.32 by 0.07.

Parachernes corticis, NEW SPECIES

MATERIAL.—Holotype male (WM 925.02001), one paratype male and two paratype females collected in Carteret County, North Carolina along North Carolina Highway 58, April 1966; three paratypes, one male and two females, collected at Beaufort, March 1966; two paratypes, one male and one female, collected at Pine Knoll Shores, Morehead City, February 1966, under bark; all collections by Peter Weygoldt.

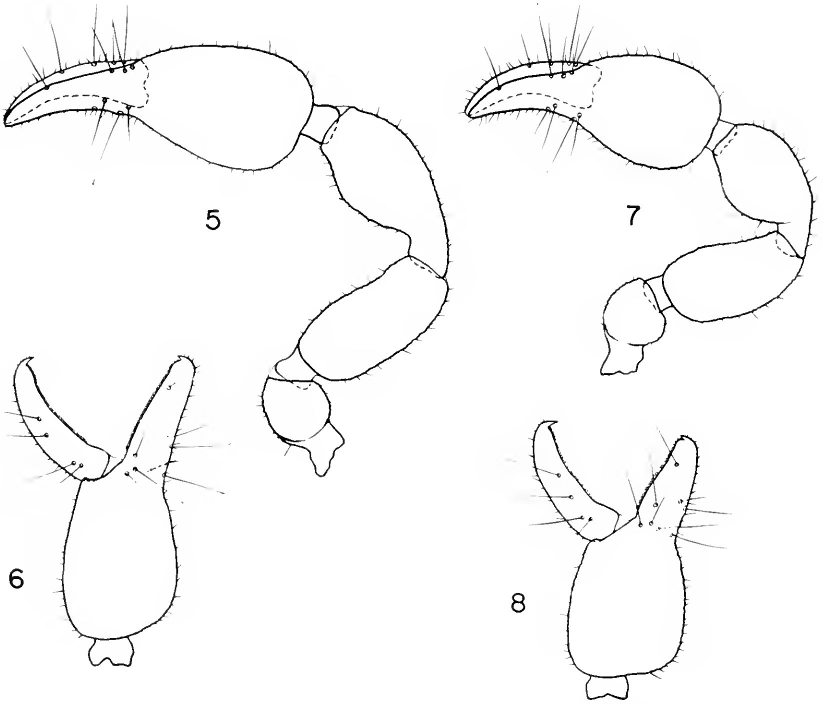

FIG. 5. *Parachernes litoralis,* n.sp.; holotype male, dorsal view of right palp. Fig. 6. Same; paratype male, lateral view of left chela. Fig. 7. *Parachernes corticis,* n.sp.; holotype male, dorsal view of right palp. Fig. 8. Same; lateral view of left chela.

Description.—Male: (Measurements are given first for the holotype, followed in parentheses by ranges for all males.) Carapace and tergites deep yellow-brown in color, palps very dark red-brown; carapace slightly longer than broad; generally triangular, though bluntly rounded anteriorly, the greatest breadth along the posterior edge; mid and posterior furrows usually distinct but narrow; surface heavily sclerotized and densely granulate, as shown in Fig. 3. Granules between furrows round-based, smoothly rounded, and moderately distant from one another. Medial posterior sclerotized keel of carapace as shown in Fig. 3, extends well caudad of the posterior furrow, is elevated and about 0.7 times as long as basal width, occasionally appearing rounded. Many granules on keel close-set, low, and not distinctly separated, while others occur as separate cuticular projections. Two indistinct eyespots present. Carapacal setae between 47 and 58 and clavate from base.

Tergites heavily sclerotized and granulate (Fig. 4); tops of most granules rounded. Tergal setae clavate from base; tergal chaetotaxy 8:10:8:12:12:12:12:12:12:10:8:2. Sternites not as heavily sclerotized as tergites. Sternal setae predominately acuminate, but some toward the posterior end weakly denticulate; chaetotaxy 45:[7]:(2)9(2):(1)8(1):12:17:13:13:12:9:6:2; lateral-most setae of each sternite somewhat distant from next in row.

Anterior genital operculum with 8(8) long setae around genital aperture surrounded by 37(23–37) shorter setae. Posterior edge of aperture with 7(7–9) small setae. Posterior operculum with 9(6–9) marginal setae.

Chelicera slightly more than one third the length of the carapace. Palm with five setae; *sb* and *b* dentate, *es* acuminate; *sb* and *b* equal to or less than the length of *es*. Fixed finger with three small subterminal teeth and three larger teeth along middle of margin. Movable finger with few to no small teeth distal. Galea long and with 6(3–6) rami. Serrula exterior with 18(18) blades. Flagellum with three setae, the most distal one serrate.

Palps short and stout, as shown in Fig. 7. Chela granulate in small area of flexor surface near base of movable finger and faintly granulate on dorsal surface. Tibia, femur, and trochanter densely granulate. Tactile setae of chela as shown in Fig. 8. Fixed finger of chela with 26(26–31) and movable finger with 33(31–33) low, cusped, marginal teeth, the cusps becoming reduced toward proximal end of row. Each finger with zero to three interior and four to seven exterior accessory teeth. Nodus ramosus of movable finger slightly proximad of seta *t*. Venom duct of fixed finger vestigial and with nodus ramosus slightly proximad of seta *et*. Trochanter 1.6(1.5–1.6), femur 2.15(2.15–2.2), tibia 1.9(1.85–1.95), chela 2.35(2.3–2.4) as long as broad; hand 1.2(1.2) times as long as deep; movable finger 0.9(0.9–1.0) times as long as hand.

Legs typical. Leg I with basifemur 1.15(1.15–1.35) and tibia 2.75(2.7–2.8) times as long as wide. Leg IV with entire femur 2.6(2.5–2.75) and tibia 3.2(3.2–3.6) times as long as wide; tactile seta on tarsus distal, approximately two thirds the length of the segment from the proximal end.

Female: (Measurements are ranges for the five females.) Color as in male; lengths of carapace, chela, and femurs of first and fourth legs longer than those of male, other segments similar. Carapacal setae 55–61. Usually some granules on keel indistinctly separated and appear connected by a ridge across their apices; other granules close-set, low and single. Tergal chaetotaxy 10–11:10–14:12–13:14–15:12–15:12–15:12–15:12–13:12–13:10–12:7–8:2. Sternal chaetotaxy 22–25:(1–2)6–8(1–2):(1)7–8(1):11–13:10–16:16–19:15–18:15–17:11–12:6–9:2. Anterior operculum with two to five setae scattered on each side of a compact central group of 13–19.

Chelicera as in male, slightly more than one third the length of the carapace. Galea as in male.

Palps similar to male but stouter. Granulation as in male. Fixed finger with 27 and movable finger with 30–33 teeth. Interior accessory teeth 0–3, exterior accessory 5–7. Trochanter 1.4–1.6, femur 2.1–2.4, tibia 1.85–2.0, chela 21–2.4 as long as broad; hand 1.15–1.25 times as long as deep; movable finger 0.8–0.95 times as long as hand.

Legs like those of male, but slightly stouter.

Measurements (in mm.): *Male:* Body length, 1.82(1.6–1.9); carapace length, 0.66(0.615–0.66); greatest width, 0.58(0.57–0.62). Eyes 0.05(0.04–0.08) from anterior edge of carapace, diameter 0.05(0.04–0.07). Chelicera 0.215(0.18–0.215) long by 0.12(0.10–0.12) broad, movable finger, 0.14(0.135–0.155). Palpal trochanter, 0.28(0.27–0.29) long by 0.175(0.175–0.185) broad; femur, 0.45(0.445–0.47) by 0.21(0.205–0.22); tibia, 0.435–(0.43–0.47) by 0.23(0.22–0.24); chela, 0.73(0.725–0.745) by 0.31(0.305–0.32); hand, 0.39(0.385-0.39) by 0.33(0.315–0.33); movable finger, 0.36(0.35–0.385) long. Leg I: basifemur, 0.135(0.135–0.155) long by 0.12(0.115–0.12) broad; telofemur, 0.23(0.22–0.255) by 0.125(0.11–0.125); tibia, 0.22(0.22–0.23) by 0.08(0.08); tarsus, 0.22(0.205–0.22) by 0.055(0.055). Leg IV: entire femur, 0.44(0.43–0.44) long; basifemur, 0.17(0.17–0.175) by 0.14(0.13–0.14); telofemur, 0.32(0.32–0.335) by 0.17 (0.155–0.18); tibia, 0.335(0.33–0.34) by 0.105(0.09–0.105); tarsus, 0.28(0.255–0.28) by 0.07(0.06–0.07); tactile seta, 0.18(0.175–0.19) from the proximal end of the segment.

Female: Body length, 1.89–2.40; carapace length, 0.67–0.755; greatest width, 0.64–0.755; eyes 0.09–0.055 from anterior edge of carapace, diameter 0.062–0.075; chelicera 0.19–0.235 long by 0.11–0.12 broad, movable finger, 0.14–0.17. Palpal trochanter 0.27–0.335 long by 0.175–0.205 broad; femur, 0.465–0.54 by 0.21–0.235; tibia, 0.445–0.51 by 0.22–0.27; chela, 0.77–0.855 by 0.33–0.40; hand, 0.42–0.495 by 0.335–0.40; movable finger, 0.40–0.415 long. Leg I: basifemur, 0.14–0.18 by 0.11–0.13; telofemur, 0.23–0.28 by 0.11–0.13; tibia, 0.23–0.26 by 0.075–0.08; tarsus, 0.21–0.235 by 0.05–0.06. Leg IV: entire femur, 0.445–0.53 long; basifemur, 0.185–0.21 by 0.125–0.16; telofemur, 0.315–0.38 by 0.155–0.185; tibia, 0.35–0.41 by 0.09–0.11; tarsus, 0.235–0.305 by 0.06–0.08.

REMARKS.—The two species of *Parachernes* described above are differentiated by the following:

P. litoralis: Eyes large, distinct; carapace clearly longer than wide; posterior keel short, wide, slightly elevated, with single, distinctly separate granules; setae of carapace and tergites multidenticulate from upper half; tops of granules on tergites two through seven mostly flattened; primarily a beach species, though occasionally found under bark in areas adjacent to beaches.

P. corticis: Eyes small, not distinct; carapace not longer than wide or only slightly longer, generally triangular; posterior keel, narrow, elevated, occasionally appearing rounded, with granules, particularly of the females, close-set, low, and not always distinctly separated; setae of carapace and tergites clavate from base; tops of granules mostly rounded on tergites two through seven; primarily a bark species.

P. litoralis and *P. corticis* are certainly different from the other species of *Parachernes* known from the eastern United States. They are easily distinguished from *P. latus* (Banks), *P. lalimanus* (Banks) and *P. diversus* (Banks), from Florida, by the shape of the chelal hand, which is smoothly rounded at the base in both the new species, but is broad and somewhat angular in *latus, latimanus* and *diversus* (see Hoff, 1947). And they may be separated from *P. virginica* (Banks) by the shape of the bases of the granules on the carapace, which are smoothly rounded in both new species but very irregular in *virginica*.

It is worthwhile to append here some comments made by Dr. Weygoldt (in litt.) concerning these two species as they were observed at the time of collection.

> "The *Parachernes* are two distinct species easily distinguishable in the field. One of them [*P. loitralis*] is a large form, occurring along the sea shore just above the high tide line and sometimes going higher into the dunes, though the more humid upper drift line seems to be its normal biotope. These animals are very agile, readily running away into small crevices as soon as a piece of driftwood is turned over. *Dinocheirus* [*tumidus*], too, lives in the drift line, but in the more humid or even wet parts below the high tide line. Sometimes both species occur on the same piece of wood, *Dinocheirus* on the wet end, *Parachernes* on the more dry end. *Parachernes* [*litoralis*], in Beaufort, hibernates as adult and is very difficult to find during winter. In April hundreds of animals appear rather suddenly and start mating. In July I find the first deutonymphs (I have not collected regularly) and it seems that all animals reach maturity within the summer."
>
> "The other *Parachernes* [*corticis*] . . . occurred under the bark at the base of dead or dying deciduous trees in the forests. On Pine Knoll Shores both species were collected rather close together, less than 10 meters between the two species; forest and drift line come rather close here. However, I never found specimens of both species in the same spot. . . . *Parachernes* [*corticis*] can be found during winter and . . . another sample was taken in May. In all samples there were all stages and the animals seemed to be active during winter. . . . This forest *Parachernes* is much smaller and very sluggish."

Other observations on these two species, concerning especially the courtship and mating behaviors, will be published elsewhere (Weygoldt, 1969).

Literature Cited

Hoff, C. C. 1947. The species of the pseudoscorpion genus *Chelanops* described by Banks. Bull. Mus. Comp. Zool. 98: 473–550.

Weygoldt, P. 1969. The biology of pseudoscorpions. Harvard University Press, Cambridge, Mass.

(The Entomologist's Record, continued from p. 130)

first fresh individuals I have seen among hundreds of spring individuals of both species here. *Nymphalis antiopa* is at least partially double-brooded as a fresh specimen was taken at Ithaca on October 23, 1967; late pupae of the second brood might occasionally overwinter.—Arthur M. Shapiro, *Department of Entomology & Limnology, Cornell University, Ithaca, New York 14850.*

Oriental caged insects—Sequel to "A beetle boom is building in Japan." Ent. News 80 (3): 66.—The "long . . . black, ugly variety . . ." is the dynastine *Xylotrupes dichotomus* (Linnaeus). This common species, the larvae of which develop in rich humus under rotting logs, rotting straw and similar environments, has long been well known to boys in Japan, but the growing fad of keeping the adults captive and putting them in cages is the result of modern news media and their being placed on sale in modern department stores. Thus they have become more accessible to city children, although they have always bred in city parks, gardens and compost piles. The common name "kabutomushi"—helmet insect, has always been familiar to all Japanese people.

The use of small bamboo cages for insects in Japan is nothing new. As far back as history, in both China and Japan, various insects have been kept in small bamboo cages. In particular, crickets and long-horned grasshoppers are sold in small bamboo cages, particularly at night bazaars in late spring and summer. They are supplied with a slice of cucumber for food and sing well in the little cages. Particularly in China certain kinds of crickets were used extensively for betting on cricket fighting (Gressitt, 1946, Ann. Ent. Soc. Amer. 39: 153–164). Another common use of insects in modern-day Japan is in plastic mounts of many kinds. These take the form of small blocks for paper weights or other ornaments, pendants, brooches, etc. Butterflies, with abdomens replaced by artificial paper ones, are laminated in transparent papers and plastics for use in lamp shades, trays, table mats and many other items. Many of the actual butterflies and beetles used for these purposes come from central Taiwan, where certain pretty species are extremely numerous and the principal occupation of certain villages consists of the collecting of these species by the thousands. The products using these insects are produced in both Taiwan and Japan, and there are similar smaller operations in Okinawa and other islands of the Ryukyu chain. Some of the dealers sell a wider range of species abroad, for collectors.—J. Linsley Gressitt, *Bishop Museum, P. O. Box 6037, Honolulu, Hawaii* 96818.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

NATURAL AREAS IN INDIANA AND THEIR PRESERVATION

By A. A. Lindsey, D. V. Schmelz, and S. A. Nichols. Department of Biological Sciences, Purdue University, Lafayette, Indiana, xi + 594 pp. [Available only to libraries.]

One hundred and sixty-three natural, areas in Indiana are described and many are photographed. In addition about 175 other areas are listed in an appendix and partially described; these are not being recommended for legal preservation.

This volume expands the old Shelford list for North America. It should be followed by companion volumes for each state.—R. H. A.

MELANDERIA

Edited by R. D. Akre, with C. A. Johnsen, Assoc. Ed. Washington State Entomological Society.

An irregular publication of the Washington State Entomological Society devoted to the following basic subdivisions of entomology: behavior, biology, biochemistry, ecology, morphology, pathology, physiology, and systematics. "The external morphology of Megachile rotundata (Fabricius) (Hymenoptera: Megachilidae" by Henry S. Gerber and Roger D. Akre, vol. 1, pp. 1–36, 75 figs.—*from* first issue. [Mailing address: Editors, Department of Entomology, Washington State University, Pullman, Washington 99163.]

INVERTEBRATES

By Harry D. Rounds. Reinhold, 1968. vii + 119 pp. Paper, $2.25.

This book has been written to fill what the author feels is a need for a brief overview of the invertebrated animals. Since about 95% of all animals are invertebrates, this branch of zoology must deal with almost the entire animal kingdom and therefore constitutes an immense body of knowledge. When confronted with the task of critically examining the mass of information, in any given field, a brief overview is of inestimable value in providing a foundation upon which to build. Further, once a conceptual framework involving a relatively small amount of information has been obtained, it becomes considerably easier to examine and order relatively large amounts of information. This seems particularly true in the field of invertebrate zoology, where without some brief introductory superstructure one may easily become bogged down even in the now abundant excellent introductory source material. In writing this short outline it has been difficult to know just where to draw the line between too much and too little; however, it is hoped that the resulting compromise will prove useful.—Preface

SPIDERS AND THEIR KIN

By HERBERT W. LEVI and LORNA R. LEVI. Golden Press, 1968. 160 pp. Paper, $1.00.

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STONES, CEMENT AND GUARDS IN HALICTINE NEST ARCHITECTURE AND DEFENSE

G. Knerer [1]

Abstract

Nest entrances of halictine bees provide an important interface between the outside world and the brood area, and they often show specific structural peculiarities. The openings serve constructional and nutritional functions, to which a defensive element is sometimes added in the social phase (supraorganism). The evolution of hidden and conspicuous nest entrances may regulate a density dependent mechanism for breeding populations of *Evylaeus malachurus*.

Function and types of nest entrance

Many aculeate hymenoptera nest in a variety of soils and construct one or several tunnels leading to a series of brood cells. Solitary species usually build less than twenty of these cells whereas a burrow of a social form contains many eggs and larvae during the summer. Such a potential source of high grade protein is exploited by diverse enemies which have often evolved ingenious methods to gain access to the buried treasures. The nest inhabitants are the first line of defense and must be eliminated before the nest is entered (Richards, 1965). The nest entrance therefore plays an important role not only in the removal of soil from the underground construction and in the passage of foragers but also as a distinctive landmark for the nest inhabitants and their parasites. Many halictine nests are built in aggregations, mainly because females establish new nests in the vicinity of existing ones. The range and diversity of nest entrances is striking in halictine bees and reflect the different behavior patterns and adaptations of the various species.

A hole in the ground is probably the simplest stage in the evolution of this structure. The expelled soil often forms temporary piles around the constricted entrances of *Halictus ligatus*, *Evylaeus malachurus*, *Dialictus imitatus*, *D. rohweri* and many more. *Halictus sexcinctus* and *Dialictus zephyrus* have simple openings in vertical cliffs.

Several species excavate loose soil more frequently so that a tumulus is a constant feature around the nest entrance. This has been observed

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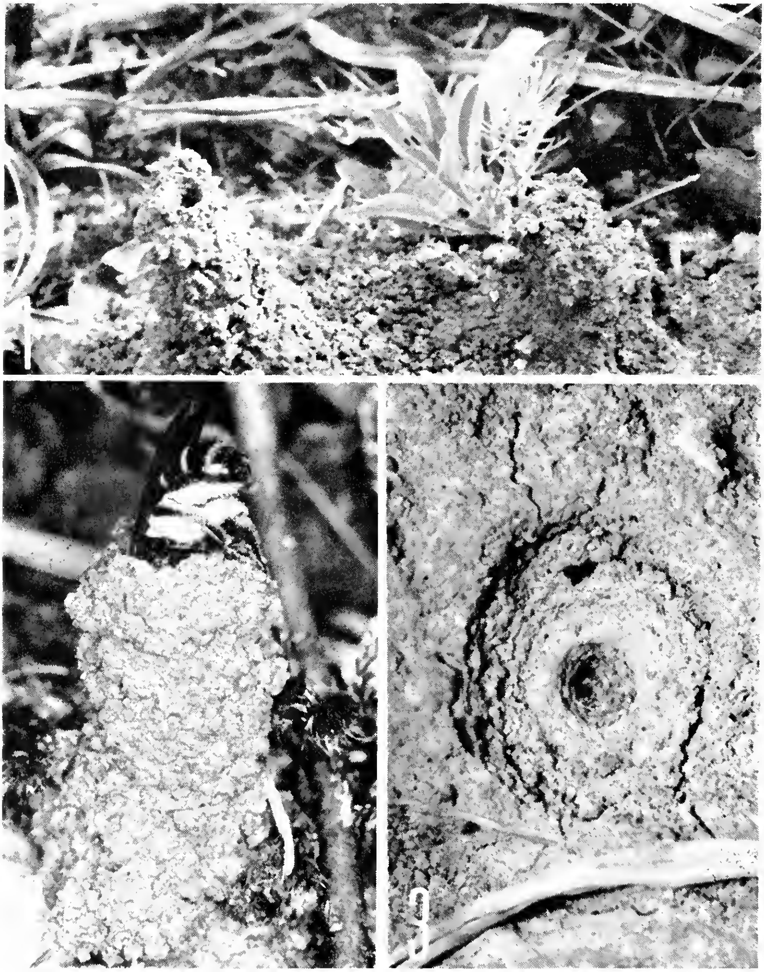
in *Lasioglossum leucozonium*, *E. nigripes* and *E. oenotherae*. The consolidation of the soil gives this structure a more lasting appearance in *H. quadricinctus* and *H. scabiosae* and also locates the nest entrance near the top of the cone. A progressively higher "chimney" indicates the age of the perennial *E. marginatus* nests (Plateaux-Quénu, 1959; Fig. 1). A further elaboration of turret construction is seen in *E. linearis*, *E. bimaculatus* and *Augochlorella striata* (Fig. 2).



Figures 1–3. Fig. 1. Two unguarded nest "chimneys" of *E. marginatus*; Fig. 2. Female of *E. bimaculatus* entering turreted nest with pollen; Fig. 3. Nest of *E. malachurus* showing closed entrance, surrounded by the cement-like tube; irregular hole indicates the activity of parasitoids.

Free-lying nests or those surrounded with tumuli and turrets give better landmarks to homing foragers but must also facilitate the growth of a resident parasite population, which finds no hardship in locating suitable host nests. It is not surprising that many halictine species habitually hide their nest entrances under stones, dead leaves or among vegetation. *H. patellatus, H. rubicundus* and *H. confusus* slant their nest openings in a way to make recognition from above more difficult. *E. cinctipes* is very adept in this technique by starting a vertical burrow with a normal entrance but slanting a secondary tunnel towards the surface while filling in the original opening. The top portion of the burrow is almost parallel with the soil surface for several centimeters before it is terminated under a stone or a clump of plants. Some of the turret-makers have similarly camouflaged their nest openings by curving the above-soil structure so that it points toward the soil surface rather than the sky (e.g., *E. interruptus*).

NEST CLOSURE

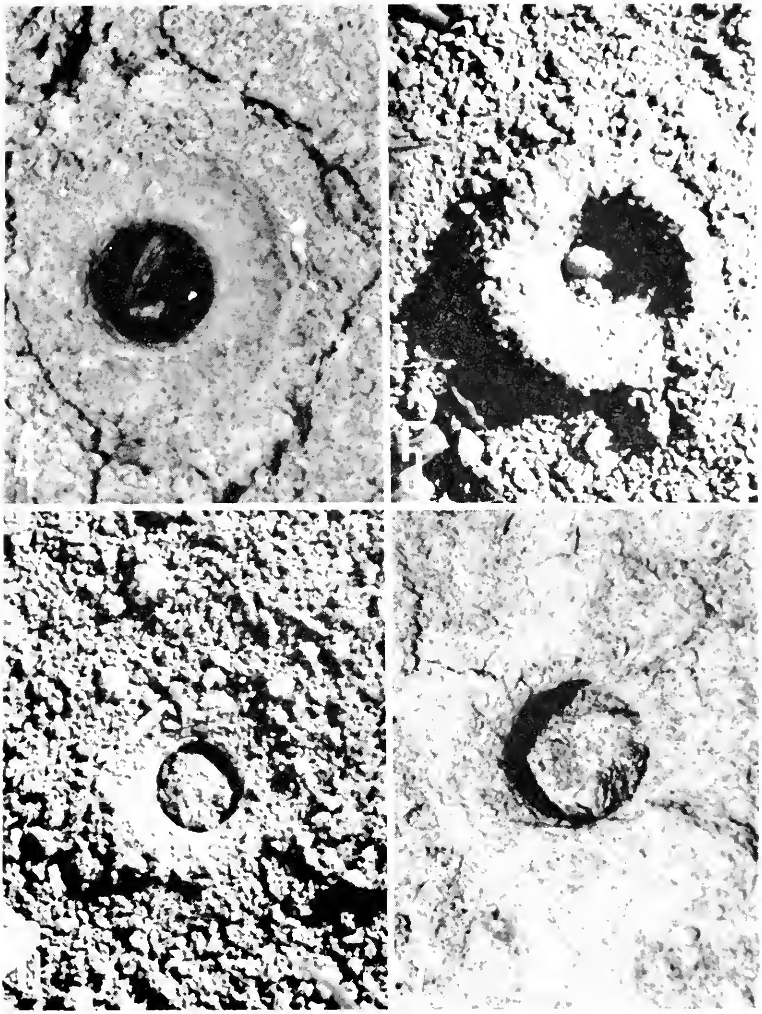
Almost all halictine bees close their nests during bad weather or at the end of a foraging period. The times at which the nests are sealed are different for the various species. The matinal *E. oenotherae*, for example, has most of the nests closed as early as 8.00 A.M., whereas *L. leucozonium* keep theirs open until around noon. Summer nests of the social species *H. ligatus* are rarely with a plug before 2.00 P.M. The halictines of hot climates have often two activity periods in the cooler parts of the day and close their nests after each session (e.g., *H. cochlearitarsis, H. holtzi* and *H. patellatus*). Nest closure and its element of camouflage seems to be effective against visual parasitoids as the cuckoo-bee *Sphecodes*, and the various flies of the genera *Bombylius, Leucophora* and *Glyphotriclis* but are less of a bonus against mutillid parasitoids. Females of the genus *Myrmilla* attack a great variety of halictine nests, but these are located by olfactory rather than visual cues.

The temporary sealing of nests after a day's foraging is not as elaborate as the closure at the end of a provisioning phase, especially in social species. There, a period of spring activity is separated from the matrifilial social phase in summer by several weeks of rest. The nests are deliberately closed before the inactive phase and plugs range from a few millimeters in *E. linearis* to 50 mm or more in *E. nigripes* and *E. cinctipes*. *E. malachurus*, which produces at least three distinct broods of workers during a Mediterranean summer, seals the nests after each provisioning phase: but the closures are progressively more imposing and range from 5 mm in April to over 200 mm in August.

Most of the closures are made with loose soil, brought up from the depth of the nest and pushed into place by the bee's abdomen. Several species seemed to have changed the type of plug and the way of procuring it. *E. nigripes*, for example, brushes loose soil particles into the burrow before pushing them into position in the entrance. A variety of Mediterranean forms have replaced the dry soil by more substantial material, especially stones. *H. cochlearitarsis*, *H. holtzi* and *E. pauxillus* were regularly observed to keep a fairly large stone at the bottom of the burrow, with which they plugged the entrance following periods of activity (Figs. 5, 6, 7). One female of *H. cochlearitarsis* used the same distinctive blue stone for five weeks, until the nest was excavated (Fig. 7). If the stone was pushed into the nest, the female would replace it within 20–30 seconds, rotating it for a perfect fit. All of the stones used were larger than the opening of the nest and could therefore not be removed without destroying the nest. Finally, the dimorphism of the nest closure of *H. maculatus* should be mentioned here. The overwintered females of this species close their nests with plugs of loose soil before the provisioning of cells has started. After that, a thin disc of moist soil, laid down in concentric rings is used for the nest closure, which blends very well into the surrounding soil.

Nest guarding

Architectural modifications are usually not effective in denying access to host-specific parasites and many industrious species protect their young by guarding the nest. The solitary *L. leucozonium* fiercely defends her nest against any intruders. Continued irritation is met by abdominal presentation and finally by nest closure. Blocking the nest opening with the abdomen is a common defensive pattern in many nearctic halictines (e.g., *H. ligatus*, *E. cinctipes*, *D. imitatus* and *D. rohweri*), but is rare in palearctic species which keep their head in the entrance or present the nape (e.g., *E. malachurus*). The overwintered females of *H. scabiosae* and *E. malachurus* show agonistic behavior towards usurping conspecifics during the solitary spring phase (Knerer and Plateaux-Quénu, 1967). Continuous guarding is only possible when more than one female is in a nest, either in the pleometrotic spring associations or the matrifilial summer societies. Nonreproductive workers show often "altruistic" behavior when they sacrifice their lives in an attempt to save the attacked colony. However, guarding behavior appears scattered over many species without regard to their social status. *H. ligatus*, *H. cochlearitarsis*, *H. rubicundus*, *E. malachurus*, *E. pauxillus*, *D. imitatus* and *A. striata* have guarding of summer nests in common despite large differences in their levels of social



FIGURES 4–7. FIG. 4. A dead *malachurus* worker rests on top of the nest closure; the entrance is protected by the hard tubular structure; FIG. 5. Nest entrance of *H. holtzi* closed with one large and a few small stones; FIG. 6. Closed nest entrance of *E. pauxillus;* a single large stone is wedged into the constricted part of the burrow; FIG. 7. The "blue stone" of the *H. cochlearitarsis* nest observed for five weeks.

evolution. On the other hand, the advanced social *E. marginatus, E. linearis* and *E. nigripes* never guard the matrifilial nests although the pleometrotic nests of *E. linearis* are defended effectively.

NEST AGGREGATION AND POPULATION DYNAMICS

The trend towards hidden entrances is probably adaptive against parasitization by a wide variety of parasitoids. Specific parasitoids have to match every behavioral innovation of their hosts to remain successful. Bee nests are either located by following a pollen laden host to the nest (e.g., *Leucophora* and *Glyphotriclis*) or by searching suitable terrain systematically. *Sphecodes monilicornis* appears to do very well with the second method, although the females seem to miss the odd nest amongst vegetation. But many nests of *E. malachurus*, its main host, are placed conspicuously in large aggregations and are impossible to miss. This is an odd situation for an otherwise very adaptable and highly successful bee, and it seems paradoxical that this flippant behavior pattern can defy such intense evolutionary pressure. It can be argued, however, that camouflaged nests with their higher survival rate have become secondary in this species, and succumbed to more important mechanisms. There is a strong inference that the losses inflicted by the parasitoids can be made up quite easily, as a consideration of the species' bionomics indicates. *E. malachurus* raises 2 to 3 progressively more populous worker broods during the summer and a mature nest can produce over 100 future queens. This rate of growth is many times that of solitary and primitively social halictines and the problem of overpopulation and overexploitation of limited resources has replaced that of mere survival. Observations on *E. malachurus* in various parts of Europe and by different investigators have shown that breeding activity is limited to a certain portion of the female population, and this seems to be quite constant from one year to the next (Knerer, 1969). The "surplus" females were physiologically inhibited from starting nesting activities, probably by some visual cues emanating from the density of the aggregation; these potential queens died without leaving a progeny, unless they could usurp a nest which was already established. It seems clear that only well marked nests, visible to the whole population could meet the requirements for a density dependent mechanism, which would then explain the selective value of overly conspicuous nest entrances in *malachurus* and a few other common social species.

Appropriate defensive adjustments have seemingly been made to partly counteract the disadvantages of conspicuous nests. Guarding in this species reached a high level and it is not rare to see a small colony completely eradicated before the parasitoid can gain entry into the nest. By the same token, both *Sphecodes* and *Myrmilla* can gauge the strength of a colony and leave populous nests alone. The thorough nest closure after each provisioning phase reduces the vulnerability of the nests still further and a barrier of soil can be built up quickly even after the attack had begun. The success of all defensive manoeuvres clearly depends on a unique structural feature of *malachurus* nests. It makes its appearance after the first worker brood emerged and consists of an extremely hard tube, 2 mm thick and 20 to 30 mm deep (Figs. 3, 4). It completely surrounds the entrance and protects the guards by its sheer hardness from the mandibles of the attackers. The ontogeny of the structure is not known but it is probably formed from a mixture of soil and saliva. Parasitoids are usually forced to excavate their own tunnels to bypass the cement tube or wait until rain renders the structure more soft and pliable (Fig. 3).

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Paper Wasp nest in Pitcher Plant, *Sarracenia purpurea* L.[1]

GARY L. BERNON[2]

On August 1, 1968, a living pitcher-plant leaf, *Sarracenia purpurea* L., was found to contain an active nest of the common paper wasp, *Polistes fuscatus pallipes* Lepeltier. The observation was made at a typical bog habitat near Ashburrham, Massachusetts. A small hole located near the base of the swollen portion of the leaf prevented retention of water which is normally found in the leaf base, thus making this particular leaf a suitable microhabitat for the nest. Although Lloyd (1943) listed many species of insects associated with the pitcher-plant, the *Polistes* nest in the modified leaf is apparently a unique occurrence.

The nest was suspended from the top part of the leaf and completely filled the leaf opening, forcing the wasps to enter through the basal hole. Because of the small spherical shape of the hole which served as an entrance to the nest, it is conceivable that it was cut by the wasps. The leaf containing the nest was brown in spots and appeared to be dying but was still alive, as were several normal leaves on the same plant.

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[1] Accepted for publication June 25, 1969.

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Observations on Predation by the Wasp Anoplius ithaca (Pompilidae) on the Wolf Spider Pardosa groenlandica (Lycosidae)

David Ricards [1, 2]

This account is based on observation made in the summers of 1964 to 1966 while I was conducting an intensive investigation of a population of *P. groenlandica* on the shore of Flathead Lake, Montana, at a location two miles north of Yellow Bay. Spiders of this species are very conspicuous along the lake shore in this locality and I wished to establish a measure of their population density and related considerations including natality, dispersion, movement, mortality and/or disappearance rate. I have recorded the complete details of this study elsewhere (Ricards, 1967).

During the course of my investigation I had many occasions to observe *A. ithaca* wasps grasping *P. groenlandica* victims and dragging them to their nest-cells. I first noted this at midday on 4 August, 1964, when I noticed a wasp dragging a *P. groenlandica* among and over the rocks. The spider appeared completely immobile and made no resistance while I watched it being transported a distance of approximately two feet. Once the wasp left the spider while it flew ahead in a circular route appearing to reconnoiter so as to orient itself with its destination. The wasp then recovered the spider after appearing to make a search to locate it. The destination proved to be a burrow excavated under a flat rock beneath which the wasp disappeared with its victim. I then covered the rock with a net, anchoring the edges with rocks, and proceeded to await the reappearance of the wasp. This occurred after an interval of between five to ten minutes, but the wasp immediately disappeared again under the rock. After waiting another five minutes, I began to remove the smaller rocks from under the net in an attempt to dig out the wasp and spider. After the surrounding rocks and dirt were removed in a circle approximately eight inches in diameter and to a depth of about two inches, the wasp emerged from the dirt at the bottom of the excavation—no distinguishable burrow entrance was apparent—and was eventually captured in the net. It was subsequently identified by Dr. H. E. Evans of the Museum of Comparative Zoology, Harvard University.

Further excavation of the soft, moist dirt between the rocks uncovered a total of five *P. groenlandica*. Although the spiders were alive only one made any active effort to escape; the others were only able to move their

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legs very lethargically. Close examination revealed an oval white egg attached near the left anterior margin of the abdomen of three of the spiders. Further digging uncovered the apparent remains of disintegrated spiders such as carapaces and leg segments. These and the other spiders were collected in a separate bottle with a small amount of soil for further examination.

Two days later the attached egg on one of these spiders appeared withered. The spider itself was apparently normal. Three days later the egg could not be detected. There was no apparent difference in the spider and it appeared to behave normally for four more days, when it was preserved in ethanol. The second spider when examined two days after its capture did not respond but no noticeable development of the wasp egg occurred.

The third spider when examined the second day after its capture also was alive but a larva had emerged from the egg and had grown to a size of 3 or 4 mm in length. It remained attached at the same location on the front left side of the spider's abdomen. Three days later (9 August, 1964) the larva had consumed the spider's abdomen and grown to about 10 mm in length by 4 mm in diameter. Its color was also noticeably darker. On 10 August, 1964, a second spider was placed in the container but was ignored as the larva later that day was observed to have commenced spinning a cocoon. This was completed by the following day. I kept this cocoon in its container until the next spring, but nothing emerged.

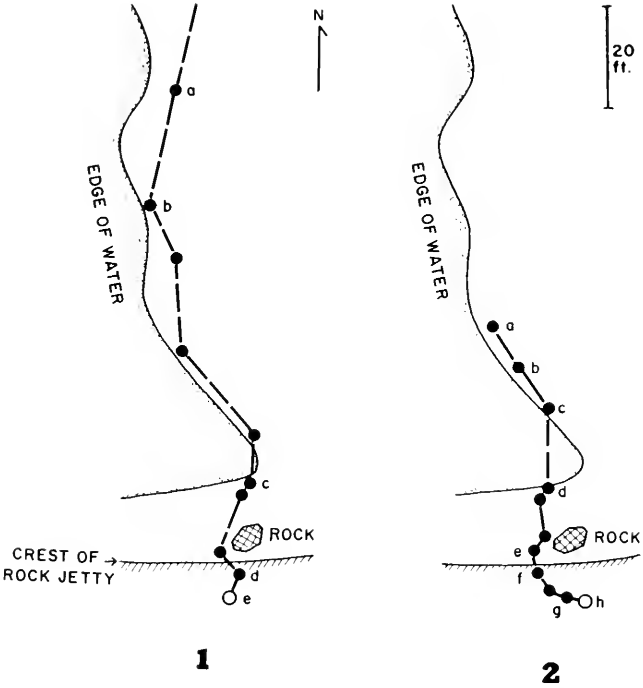
I was able to establish further details of the nature of this wasp/spider relationship on the occasion of second observation on 31 July, 1965. On this date I noticed a digger wasp dragging a female *P. groendlandica* along the lakeshore. This was accomplished by the wasp grasping the spider with its mandibles and dragging the spider backwards over and among the rocks. At intervals of one or two minutes the wasp would release its prey and fly away apparently reconnoitering its route as it flew from rock to rock along the lakeshore or in a couple of five to six feet circles around its victim, each time returning to regrasp its victim and continue its journey. Also, the wasp was observed to lie on its side on the upper surface of the rocks and rub its hind legs together several times and repeatedly flick its wings in a nervous fashion. When the march was resumed the route was continued, always in a nearly straight line along the beach crest to the location of the concealed burrow. Upon arrival the wasp clambered around in a small circle before grasping the spider to pull it underground beneath the concealing rock. About an hour later the wasp was observed to have emerged into the net I had placed over the rock.

That same afternoon I began the excavation of the burrow. This had been prepared in a location distant enough from the water's edge to have allowed soil to accumulate among the rocks. The soil was removed by brushing away the uppermost layers little by little in a six inch circle surrounding the burrow entrance. At a depth of about 1.5 inches a female spider was uncovered buried in moist soil beneath two rocks directly beneath the location where the wasp originally disappeared. The spider was alive and active and attempted to escape when uncovered. A white egg was noticed attached to the front left dorso-lateral margin of the abdomen.

Additional digging revealed a second spider, a juvenile, also alive but immobile except for an occasional twitching in the forelegs which with the other appendages were drawn alongside the body. It also had an egg attached in the same location on the abdomen. No further spiders were recovered. The spiders recovered were placed with some of the soil in a collecting bottle for subsequent examination. The next day both spiders were observed to be apparently normally active and sought to avoid the grasp of the forceps when examined. No observations were made for the next two days but on 3 August, 1965, both parasitized spiders were dead. Within a few days both spiders showed signs of decomposition, and in neither case did the wasp larva develop successfully.

The behavior of the wasp in transporting its victim was investigated further on three subsequent occasions on 16 and 17 August, 1965. Each time careful measurements of the distance, direction, and time were noted for the wasp's route in transporting its victim. Two of these routes are recorded in Figs. 1 and 2. The straight line routes the wasps followed are noteworthy. The wasps maintained these by clambering up and down the sides of rocks in the route rather than seeking what would seem to be a less strenuous path among them. A random sample of twenty rocks selected at this location ranged in volume as determined by liquid displacement from 13 cm^3 to 507 cm^3 with an average volume of 108 cm^3. The wasp commonly would move backwards along its route pulling the spider, grasped by its mandibles, behind it. On two of these occasions the route proceeded for a distance of 7½ and 15 feet over water. This was accomplished by the wasp flying and dragging the spider along the surface. Flying to transport a victim was also observed for about one to two feet distance over the rocks.

The effort exerted by the wasps in their task is impressive. The longest observed route was measured to be approximately 111 feet, and this does not account for the distance traversed before the observations began



Routes of two female *Anoplius ithaca* dragging *Pardosa groenlandica* (16 August, 1965). Fig. 1. Total observed distance: 111 feet; *a*, 12:51, released spider and circled on ground; *b*, 12:52, flew south and returned; *c*, 12:56, circled on ground, then flew to crest and returned; *d*, circled on ground; *e*, 12:59, arrived at burrow. Fig. 2. Total observed distance: 53 feet; *a*, 18:58, flew in circle; *b*, circled on ground; *c*, 19:02, departed over water; *d*, circled on ground, then flew to crest and returned; *e*, circled on ground; *f*, flew in circle; *g*, circled on ground; *h*, 19:31, arrived at burrow. Flight over water indicates that wasp is orienting to something besides the water's edge.

nor for the vertical distance involved in clambering up and down the sides of the rocks along the route. The wasp completed its task in 9½ minutes.

Further evidence of the impressive effort exerted is in a comparison of the weight of the spider and wasp. These weights had been determined on a previous occasion for the specimens collected 31 July, 1965, one of which was a large female spider with attached egg which had been uncovered in excavating the wasp burrow on that date. The day following the spider's capture it was weighed on a Fisher analytical balance and measured as 83.5 milligrams. The wasp that had been captured emerging from that burrow weighed 25.0 mg, less than one-third as much.

Another aspect of the wasp's behavior meriting consideration is the manner of its locating and recognizing its victims. These wasps are most commonly observed flying erratically back and forth along the lakefront crest. They frequently alight on the rocks but never stop their constant activity as they will groom themselves by stroking their antennae and rubbing their hind legs together and then scramble around the margin of the rock, flit to an adjoining rock a couple of feet away and duck underneath, to reappear a moment later at the top of the next neighboring rock where the grooming process is repeated before the wasp takes to the air again. In this fashion an area about two feet square will be visited for perhaps a minute or two before the wasp moves further along the beach.

Such behavior gives the impression of a purely random, trial and error search. I have noted occasions when immediately following the departure of a wasp, spiders have appeared from underneath rocks in the immediate locality, suggesting that if the wasp had been relying upon some special sensory ability to detect its prey, it could not have done so. Indeed, I have recorded observations of wasps flying directly over exposed male spiders and even alighting on the same rock with no apparent reaction by either.

This indifference is not restricted to male spiders as the same lack of reaction has been observed regarding a female with attached egg-sac noted in full view at approximately two inches distance from a wasp that only a moment later was noted to fly in pursuit of a spider flushed from under a rock. This wasp was observed on this same occasion to completely ignore a juvenile spider immobile in full view on the top of a rock past which the wasp flew within about half an inch.

This is not invariably the case, however. On 19 July, 1966, I witnessed an encounter between a wasp and a female *P. groenlandica* with attached egg-sac. The female was sunning herself alongside a wood chip and had just moved about two inches to the edge of the top of the rock when a wasp alighted on an adjacent rock. There was no immediate reaction by either the spider or the wasp. The latter, however, by moving about on the rocks appeared to encounter seemingly by chance the location the spider had just a moment earlier occupied alongside the wood chip. At that moment the wasp appeared to become aroused and began to move about the spot in a more agitated fashion, frequently testing the rock surface at that location with her antennae. In the course of these movements the wasp was observed to encounter and actually make contact with the spider which had made no effort to escape nor any other obvious reaction. In response to the actual contact, however, the spider raised her two pairs of forelegs in the customary defensive attitude. The wasp continued to advance, and, although contact was again noted, the wasp did not persist in her approach and broke off contact to fly away. The spider then resumed her resting atitude in the sun.

I witnessed another encounter on 9 August, 1966. On this occasion a struggle ensued lasting approximately three minutes and was initiated by the spider, an unmarked female, running forward to encounter the wasp which had alighted on the rock during its search along the lakeshore. The spider grasped the wasp with her chelicerae and the wasp responded by bending her abdomen forward to sting the underside of the spider when they disappeared over the edge of the rock in each other's grasp. A moment later the wasp reappeared over the edge of the rock leaving the spider immobile on the ground. The wasp proceeded to groom herself before starting to clamber south over the rocks, a distance of about a foot. Next the wasp flew back to grasp the spider to begin dragging it away.

Four minutes later, as the wasp continued dragging the spider along the lakeshore, her route brought her to an encounter with an adult male *P. groenlandica*, which at the approach of the wasp and her burden was observed to move to make contact with his extended forelegs. At this the wasp retreated but without any pursuit occurring. A minute later the wasp again approached the male spider and contact re-occurred. At this the spider was seen to raise his right leg-III, wherewith the wasp withdrew under an adjoining rock and the spider abandoned his position and disappeared from view among the rocks. Two minutes later the wasp was seen to emerge grasping a marked female *P. groenlandica*. The original victim which the wasp had abandoned on encountering her new prey was subsequently located and preserved in ethanol.

This new victim was then transported southward along the lakeshore to the water's edge at the location of the inlet alongside the rock jetty. Here the wasp was observed to lose her grip on the spider as she clambered along a log extending into the water; and her victim slid off the log into the water. The wasp was seen then to fly circles in an apparent search for her victim, which although floating on the surface, had in the meantime been washed among some rocks along the water's edge a couple of feet from where it fell into the water. After approximately five minutes the wasp was lost from view as she appeared to abandon her search for the spider.

One remaining incident of special note was witnessed on 15 August, 1966, when a wasp dragging an immobilized spider along the lakeshore was robbed of its prey by another spider which was seen to rush forward, grasp the wasp's victim and snatch it away beneath an adjoining rock. The wasp subsequently recovered its victim which had apparently been abandoned by the robber spider. This incident bears a close resemblance to that observed on 9 August, 1966. On both occasions wasps dragging their victims were approached by another spider which appeared to initiate the actual encounter.

DISCUSSION

There are several noteworthy aspects to the last two mentioned incidents. On both encounters it was the spider which was observed to approach the wasp to initiate actual contact between the two. This suggests that the spider apparently approaches the wasp mistaking it for a more easily subdued prey and that the wasp's role is more to lure the spider to attack than to be the aggressor herself.

Secondly, although the same wasp was involved in the two encounters observed on 19 July, 1966, in the first encounter the wasp persevered in the conflict and in the second it withdrew. It may be significant that the first encounter was with a female *P. groenlandica* whereas the second was with a male. I suspect that the wasps are able to distinguish between the two sexes, because I have never identified a male victim in the eight instances for which I have records. Moreover, in neither encounter actually observed between wasps and male spiders did the male fall victim; and on two different occasions I have noted male spiders in full view to be ignored by apparently searching wasps. As males have a proportionately very small abdomen and in all cases I have noted the parasitizing egg has been fixed at the same location on the abdomen, I feel there is cause to suspect a possible limiting factor restricting the wasp parasitism to females and immature spiders. This suspicion is reinforced in the incident in which the wasp withdrew from engaging with the male but was observed immediately afterwards with a second female victim.

I believe the routes observed demonstrate that the wasps were orienting themselves to their destination. This is most likely to be to visual landmarks along the lakeshore such as the large rock which was exposed prominently and past which each wasp traveled, although the position of the sun or polarized lighting of the sky as is known to function in the orientation of beach spiders (Papi and Tongiorgi, 1963) could equally be operative in this instance. Tsuneki (1950) has shown that in fact pompilid wasps are able to utilize the direction of solar light in orientation.

Finally there is the question of prey recognition. Wasps, while transporting their prey along the lakeshore, will regularly release them and fly unburdened ahead to orient themselves with their destination. During her reconnaissance a wasp will travel several yards away from where the spider has been left and be gone for as long as a minute or two, yet return with only momentary hesitation to recover her victim. This apparently would demonstrate that the wasp is not limited to responding purely to recognizable movement, yet I have noted several instances when spiders in full view of apparently searching wasps have been ignored. The incident in which the floating spider was washed away and lost to the wasp would appear to demonstrate that the wasp places major reliance upon the immediate topography of the locality rather than the form or possible odor of her victim. Although the wasp never located her prey, she did return several times to the location at which she last grasped it, and if she was relying upon odor to do so it would seem she could have as equally well detected the odor of her prey floating nearby on the surface of the water.

It is difficult to assess the effect of wasp predation on the *P. groenlandica* population. The wasps are active all summer long. The earliest I have had occasion to notice them searching along the lakeshore is 27 June, the latest, 16 August. I am certain that their activities commence much before this (perhaps in April) and persist until probably October. I would judge their activities to be most intense during the first half of August.

Although the wasps begin their daily activities with the first sun to light the lakeshore and continue until sunset, their greatest activity is concentrated at midday.

These studies concord well with previous observations on *Anoplius ithaca*, as summarized by Evans and Yoshimoto (1962), although providing more detail than any previous studies. This wasp ranges widely in North America and is restricted to the shores of lakes, streams, and occasionally the sea. Most records are from rocky shores, with species of *Pardosa* as the major prey, but there are a few records from sandy shores with the sand-loving *Arctosa littoralis* as prey. Carriage of the prey over the surface film has not previously been reported for *Anoplius ithaca* although it has been reported several times in the related species *A. depressipes*. Also, preparation of several nest-cells in one restricted area has not been reported for *ithaca*, although several related species are known to do this. The European species *Anoplius atricolor*, for example, makes multicellular nests much like those of *ithaca*, and in fact Grandi's (1961) figure of the nest of this species is highly suggestive of that of *ithaca* (*atricolor* is also a predator on *Pardosa*). A number of species of this subgenus (*Anoplius s. str.*) are semiaquatic and it is not surprising that they share some of the same adaptations for exploiting this habitat.

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The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

HEMIPTERA

The collection of Hemiptera (Heteroptera) of the Museum of Comparative Zoology, Cambridge, Mass., has been transferred permanently to the American Museum of Natural History in New York. In the future requests to study this material should be addressed to Dr. Pedro Wygodzinsky at that institution. This collection contains relatively few types, but it does contain several primary types of species described by N. Banks, H. G. Barber, C. J. Drake, R. C. Froeschner, H. B. Hungerford, H. H. Knight, J. Maldonado C., H. M. Parshley, E. L. Todd, R. L. Usinger, and P. Wygodzinsky. The American Museum has deposited a synoptic collection of identified Heteroptera at the M.C.Z.—H. E. EVANS, *Museum of Comparative Zoology, Cambridge, Mass. 01238.*

HOMOPTERA

Membracidae: *Cyrtolobus funkhouseri* Woodruff. New records: Mazomanie, Dane Co., Wisconsin, June 24, 1965 (T. R. Yonke); Rockport, Boone Co., Missouri, June 16, 1966, orchard (S. Poe). Previously known from Connecticut, Indiana, Massachusetts, New Jersey, New York and Pennsylvania. (Ref.: Woodruff, L. B., 1924. Critical observations in the membracid genus *Cyrtolobus* Goding (Hemip-Homop.). Journ. New York Ent. Soc. 32:14–16.) Also known from Oklahoma. (Ref.: Dennis, Clifford J., 1965. Oklahoma treehoppers (Homoptera, Membracidae). Proc. Oklahoma Acad. Sci., 45:57, 62.)—CLIFFORD J. DENNIS, *Wisconsin State University, Whitewater, 53190* and DENNIS D. KOPP, *University of Missouri, Columbia, 65201*

Notes on Insects Infesting Pine Cones in Mississippi[1]

W. W. Neel[2] and C. F. Sartor[3]

Two species of the genus *Dioryctria* Zeller (Lepidoptera: Phycitidae) feed on the first- and second-year cones of the genus *Pinus* in Mississippi and are considered major pests of these reproductive structures. The larvae of *D. amatella* (Hulst.) infest the cones of longleaf pine (*P. palustris* Mill.), loblolly pine (*P. taeda* L.) and slash pine (*P. elliotii*) var. *elliotii* Little and Dorman. The larvae of *D. disclusa* Heinrich infest the cones of longleaf pine, loblolly and shortleaf pine (*P. echinata* Mill.).

The genus *Dioryctria*, according to Heinrich (1956), is represented by 4 species in the southeastern United States and only one of these species, *D. amatella*, is listed for Mississippi. This species is considered by Craighead (1949) as the most common insect pest of first- and second-year cones of "yellow pines" in the Gulf States. Pistilate flowers, cones and seeds of longleaf pines as well as cones and seeds of slash pines have been observed by Wakely (1931) to be destroyed by this insect. In Arkansas *D. amatella*, *D. clarioralis* (Walker) and *D. disclusa* are considered primary pests of loblolly and shortleaf cones (Yearian and Warren, 1964 and Yearian, 1968); in Georgia the first 2 named species and *D. zimmermani* (Grote) are considered the primary pests of shortleaf cones (Coulson and Franklin, 1968). All 4 species of *Dioryctria* listed above infest loblolly cones in Virginia and are responsible for approximately 25% cone mortality (Morris and Schroeder, 1966–67). *D. amatella* is listed as one of approximately 26 species of insects represented by 7 orders affecting seed production of slash and longleaf pines in Florida (Ebel, 1963). Merkel (1962) determined the number of larval instars of *D. abietella* (D. and S.). The parasitic insect species associated with *D. amatella* and *D. clarioralis* in Arkansas have been listed by Yearian and Warren (1964). Five insects are known to parasitize *D. amatella* in North Carolina (Neunzig *et al.*, 1964a).

Oscinella conicola (Greene) (Diptera: Chloropidae) is also considered a primary pest of loblolly and shortleaf pine cones in Arkansas (Yearian and Warren, 1964).

One of the primary insect seed destroyers of longleaf pine is *Laspeyresia ingens* Heinrich (Lepidoptera: Olethrentidae). A detailed life history study of this insect has been reported by Coyne (1968). Wahlenberg (1960) reported loblolly seed losses of 9 to 42% from cones infested with

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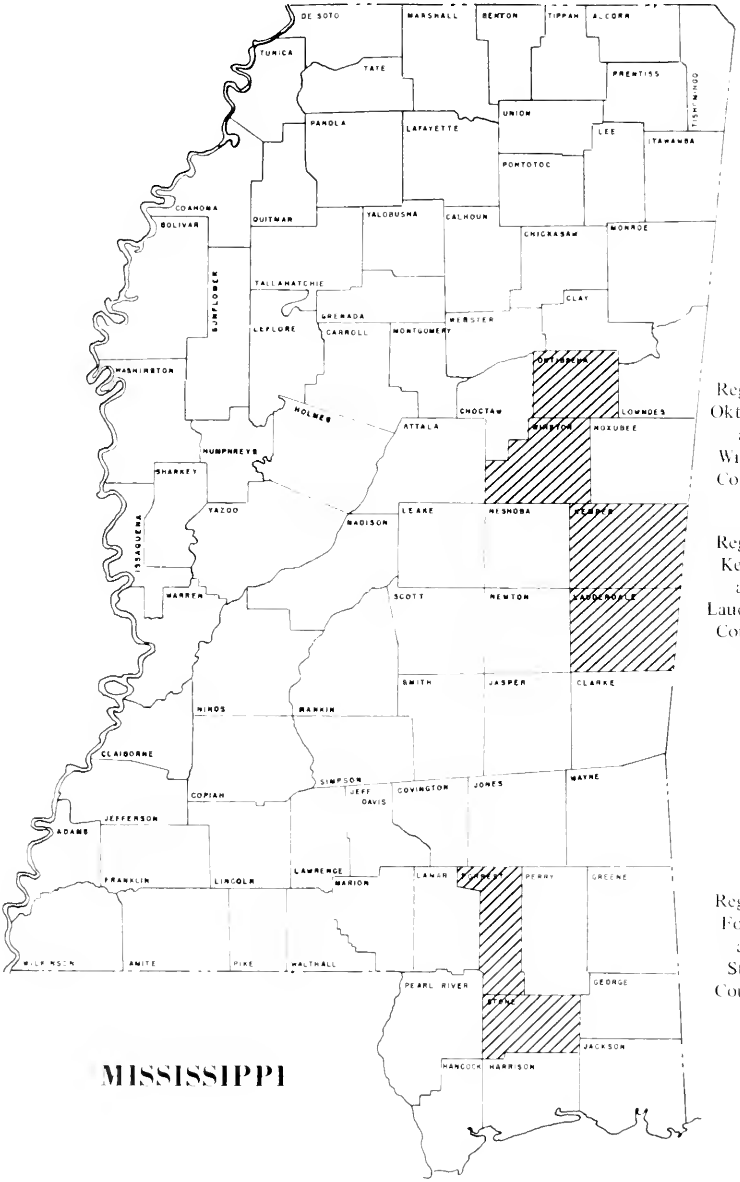

Region 1
Oktibbeha
and
Winston
Counties

Region 2
Kemper
and
Lauderdale
Counties

Region 3
Forrest
and.
Stone
Counties

FIG. 1. Map of Mississippi showing the 6 counties where pine cones were collected for this study.

L. torenta Grote and *D. amatella*. Merkel (1963) found that the slash pine seedworm, *L. anaranjada* Miller, occurs in the United States throughout the natural range of slash pine. In a life history study of *L. anaranjada* Merkel (1967) estimated that seed losses caused by this insect on open grown slash pines in northeast Florida vary from 2 to 10% annually.

Representatives of 3 genera, *Hyperdiplosis*, *Lestodiplosis* and *Mycodiplosis* of the family Cecidomyiidae are considered to be secondary pests of shortleaf pine cones in Georgia, for they caused only moderate damage directly to seed (Coulson and Franklin, 1968).

Pomphopea polita (Say) (Coleoptera: Meloidae) were observed to consume pollen catkins of shortleaf pine in Mississippi (Allen and Coyne, 1956).

Eucosma sp. near or *cocana* (Lepidoptera: Olethreutidae) was found to infest 20.4% of the second-year zones of 2 shortleaf pine trees in South Carolina (Ciesla *et al.*, 1968).

PRESENT STUDY

This study was initiated in an effort to learn the extent of insect damage to second-year pine cones of loblolly, slash, longleaf, and shortleaf in Mississippi. Another objective was to learn the identity and seasonal occurrence of all insects affecting these cones.

Procedures: The collection of cones was confined to the commercial pine timber lands in the following 3 localities in the state: Region 1, Oktibbeha and Winston Counties; Region 2, Kemper and Lauderdale Counties; Region 3, Forest and Stone Counties (Fig. 1). The cones collected in Regions 1 and 2 were loblolly and shortleaf; those collected in Region 3 were slash and longleaf. An attempt was made to select areas in each county where logging operations would be in progress from the beginning of the cone collections in March until the termination of the collections in September. The reason for this procedural step was to insure the collection of cones from the same vegetative type cover area during the entire 7–9 month period. Cones were collected only from felled trees.

Trees were randomly selected at five locations in a logging operation area as follows: (1) A straight course (compass line) was selected for transversing the area. (2) At a distance of 2 chains length cones were sampled from one loblolly and one shortleaf tree or from one slash and one longleaf tree. (A total of 5 trees of each species was sampled on each designated date.) (3) If no specified trees were found within 50 feet of a sampling spot the collector proceeded 2 chains to the next sampling spot. Samples were taken from trees with a DBH of 10 inches or larger. Counts of the total number of cones on each tree selected were made but collections were made of only those cones suspected of being infested. A record was kept for each tree examined. This included date, tree species, total number of cones and total number of suspected (infested) cones. Trees were sampled once per month during March, April, June, August and September except in Oktibbeha and Winston Counties where samples were taken more often. Cone samples were taken from trees which had been felled no longer than 2 weeks.

RESULTS

Region 1 (Oktibbeha and Winston Counties): The insect causing the greatest damage to loblolly cones was *D. disclusa*. Moths from infested cones (collected in April and May) emerged as adult moths during May and June. The largest number of moths (64 out of a total of 84) emerged during a 2-week period extending from the third week of May to the first week of June.

No other moths of this species emerged after this time although damaged cones were collected at weekly intervals in Oktibbeha County until October. Once the larva began its feeding attack inside the cone, no further cone development occurred.

A small moth belonging to the family *Blastobasidae* emerged from loblolly cones collected on June 12. Also several small moths, *Battaristis* spp. (family, Gelechiidae) emerged from a June 15 loblolly pine cone collection. These cones were dead or dying at the time they were collected but the inner cone destruction was not as great as that caused by *D. disclusa*.

Some of the loblolly cones collected during the first part of May were infested with *Asynapta* near *keeni* Foote (Diptera: Cecidomyiidae). The damage caused by this cecidomyiid is limited to the inner surface of the cone scales and to young succulent seed. A heavy infestation with excessive resin flow in the affected areas prevents the normal opening of the cone and consequent loss of seed. Some of these emerged as adults from May 15 through 22. A wasp, *Bracon gelechiae* Ashm., (Hymenoptera: Braconidae), emerged from an infested loblolly cone on May 20. This wasp, in all probability, had been parasitizing a *D. disclusa* larva. On October 6 one moth, *D. amatella* emerged from a loblolly cone collected on July 18.

No insects emerged from shortleaf cones held in the laboratory.

The average number of loblolly and shortleaf cones destroyed chiefly by *D. disclusa* larvae in Oktibbeha County was, respectively, 23.8 and 15.8%. In Winston County the average number of loblolly and shortleaf cones destroyed by this insect was, respectively, 13.0% and 6.4%.

Region 2 (Kemper and Lauderdale Counties): A few shortleaf cones were found infested with cecidomyiid maggots, *Asynapta* sp., and *Dioryc-*

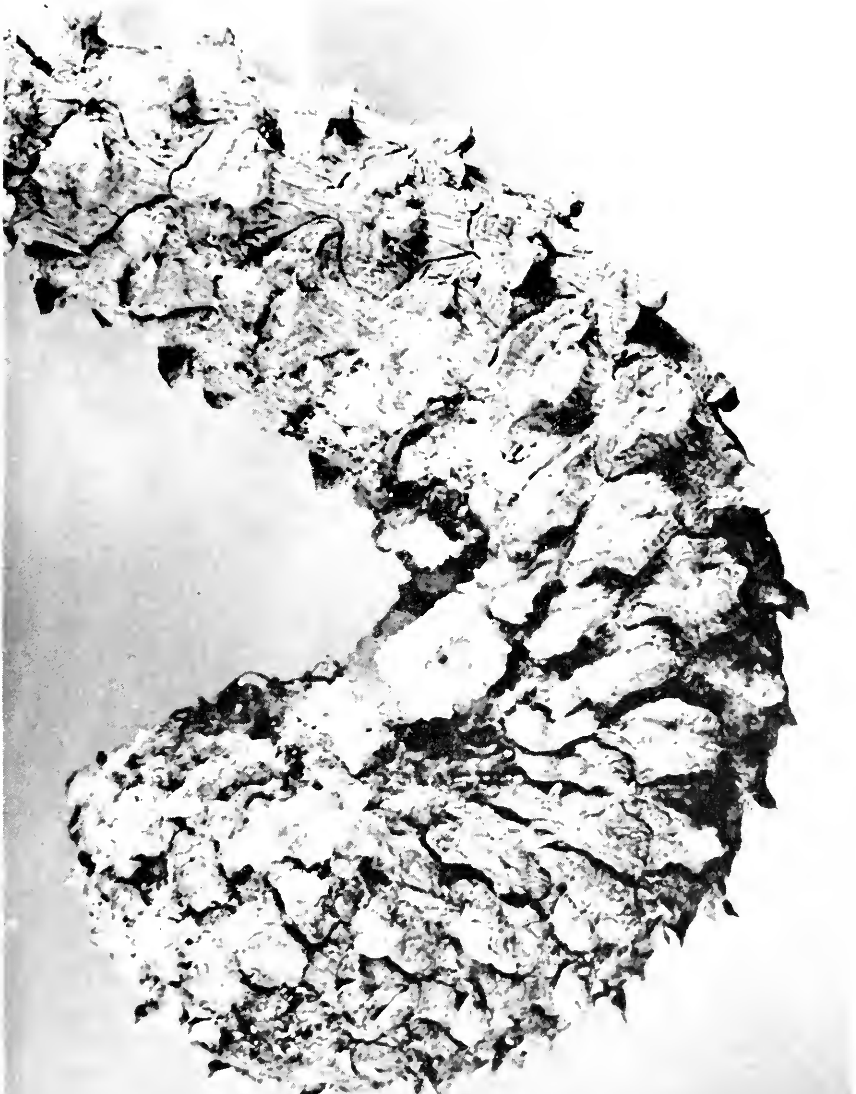

FIG. 2. Longleaf pine cone infested with *Dioryctria* sp. showing typical curled appearance.

tria spp. larvae; no adult insects emerged from these cones (April 27 and 28 collections). Several loblolly cones were infested with *D. disclusa* larvae which emerged as adult moths during late May.

Only one adult moth *Duvita* (Battaristis) *vitella* Bsk. (Lepidoptera: Gelechidae) emerged from the June 26 collected cones. Some *Dioryctria* spp. moths had probably already emerged from many of these cones which appeared to have harbored an infestation.

No insects emerged from loblolly and shortleaf cones which were collected on August 17.

The average number of loblolly and shortleaf cones damaged by *D. disclusa* larvae in Kemper County was, respectively, 3.3 and 0.1%. In Lauderdale County the average number of cones damaged by this insect was, respectively, 13.9 and 3.8%.

Region 3 (Forest and Stone Counties): No insects were found infesting the slash and longleaf cones collected on March 9.

Many of the fresh green longleaf cones collected on April 27 were infested with red cecidomyiid maggots *Asynapta* spp. Three adult cecidomyiids emerged from these infested longleaf cones on May 23. *Dioryctria* spp. larvae were found infesting some of the slash cones on arrival. A month later 7 scolytids, probably *Pityophthorus pulicarius* Zimm., emerged from these slash cones as well as several small wasps, *Platygaster* sp. No adult *Dioryctria* spp. emerged from these cones. The exact role of these wasps is not known. They may have been parasitizing the developing *Pityophthorus* larvae. Several small moths, *Battaristis* spp., emerged from the slash cones.

Several *P. pulicarius* and *Ernobius granulatus* Lec. adults emerged from slash cones (May 26 collection). Also several *Platygaster* spp. adults emerged from these slash cones.

One cecidomyiid (probably *Asynapta* sp.) emerged on July 17 and two *D. amatella* adults emerged on September 22 from the longleaf cones collected on June 26. No slash cones were collected on this date.

One *D. amatella* adult emerged from a longleaf cone on October 21 and 2 ichneumonids, *Exteristes comstockii* emerged from slash cones on September 7 (September 1 collections).

Two *D. amatella* moths emerged from slash cones on October 21 (September 7 collection).

A few individuals of *Laspeyresia ingens* emerged in the spring of 1968 from longleaf cones collected the previous September.

For the period of inspection (April until September) second-year slash and longleaf cones collected in Region 3 were infested, respectively, at the rate of 20.7 and 20.1%.

A longleaf cone collected in September (Figure 2) shows the abnormal curled distortion caused by a *Dioryctria* larval infestation.

To summarize these findings a list of insects that were found to emerge from infested cones are listed below:

Loblolly pine:
- Primary insects—*Dioryctria disclusa*, *D. amatella* and *Asynapta* near *keeni*.
- Secondary insects—*Battaristis* spp., *Duvita vitella*.
- Parasites—*Bracon gelechiae*.

Shortleaf pine:
- Primary insects—*D. disclusa*, *Asynapta* sp.
- Secondary insects—none recorded.
- Parasites—none recorded.

Longleaf pine:
- Primary insects—*D. amatella* and *Asynapta* sp., *Laspeyresia ingens*.
- Secondary insects—none recorded.
- Parasites—none recorded.

Slash pine:
- Primary insects—*D. amatella*.
- Secondary insects—*Pityophthorus pulicarius*, *Ernobius granulatus* and *Battaristis* spp.
- Parasites—*Exeristes comstockii* and *Platygaster* sp.

SUMMARY

Collections of infested pine cones from eight counties in Mississippi revealed that 7 common species of insects infest second year pine cones. *Dioryctria amatella* (Hulst.) was found to be a primary pest of loblolly longleaf and slash pine cones; *Asynapta* near *keeni* (Foote) was found to be a primary pest of loblolly and longleaf cones. *D. disclusa* Heinrich and *A.* near *keeni* have been found to be primary pests of loblolly and shortleaf pine cones. *Laspeyresia ingens* Hein. has been found to be a primary seed destroyer of longleaf pine. *Pityophthorus pulicarius* Zimm., *Ernobius granulatus* Lec. and *Duvita* (Battaristis) *vitella* Bsk. appear to be only secondary pests of pine cones.

Several species of parasites emerged from pine cones infested with the primary and secondary pests. Hymenopterans belonging to the families Ichneumonidae, Braconidae and Platygasteridae are apparently parasitizing one or more of the cone insects.

Acknowledgments

The collection of cones from the 3 localities in the state except those made locally was a voluntary operation carried out by certain staff members of the Mississippi Forestry Commission. Without the Forestry Commission's assistance, the sampling from these different geographic areas of the state would have been impossible.

The cooperation of the following foresters is hereby acknowledged: O. C. Tissue, K. Burchfield, B. S. Butler, J. Prescott, L. L. Sanford, R. T. Purvis and T. H. Davies. Acknowledgment is also made of the services of Dr. David Young for taking the photograph used in this article.

The authors wish to thank R. T. Gagne (Cecidomyiidae), P. M. Marsh (Braconidae and Platygasteridae), L. M. Walkley (Ichneumonidae), D. M. Anderson (Scolytidae), E. R. White (Anobiidae), D. R. Davis (Olethreutidae) and R. W. Hodges (Blastobasidae and Gelechiidae), Insect Identification and Parasite Introduction Research Branch, U.S.D.A., Beltsville, Maryland, for insect species identification.

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The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

MOSQUITO SYSTEMATICS NEWS LETTER

Edited by Kenneth L. Knight. Published by South East Asia Mosquito Project, Department of Entomology, U. S. National Museum, Washington, D. C. 20560. Vol. 1, no. 2 issued May 1969. [Processed.]

I am sure that once upon a time colleagues said that a special journal for just entomology would never survive. I know that colleagues have said that a special journal for an order would never survive. Now we have several special journals for families, and of course, many many journals for a single species.

The really surprising thing about this journal is the information that there is still so much to be done with mosquito taxonomy. Those of us who once worked with mosquitoes, and there are many World War II people in that category, have the idea that mosquito taxonomy twenty years later is merely a matter of refinement. Such is not the case. It will pay any taxonomist well to examine the publication we are referring to and learn what is yet to be done in this group that we, most of us at least, think as being to nearly "done" taxonomically.

The most discouraging thing about this review of mosquito taxonomy is to compare this with the relatively unorganized work going on in other groups. The mosquito taxonomists are organized, with projects carefully planned so that they know fairly well at least where they are going. How many other taxonomists can say this?—R.H.A.

SYSTEMATIC BIOLOGY

National Academy of Sciences, 1969. 648 pp. Cloth, $15.00.

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SIGNALS AND SYSTEMATICS OF JAMAICAN FIREFLIES: NOTES ON BEHAVIOR AND ON UNDESCRIBED SPECIES (COLEOPTERA: LAMPYRIDAE) [1]

JAMES E. LLOYD [2]

The island of Jamaica is presently credited with at least 50 species of fireflies (McDermott and Buck, 1959), a number that seems truly remarkable when compared with present counts for other areas of similar size. I believe that this is a conservative estimate and that many more are present. In a recent two-week study (16–28 Nov. 1968) I observed the behavior of numerous populations throughout the island and found direct and indirect evidence of the presence of several additional species.

1. *Photinus leucopyge* Barber and *P. melanopyge* Barber: After naming these species Barber (1941) decided they were conspecific and later (McDermott and Buck, 1959) synonomized them. They are distinct morphologically and behaviorally, and are valid species.[3] The signal of *leucopyge* is composed of two rapid pulses although in the field it appears to have 3 or 4 modulations (McDermott and Buck's illustration of this signal, based on visual impressions, shows 4 modulations). It is emitted at intervals [4] of 1.7–2.1 sec (70° F) as the insect flies in rapid and irregular flight 2–4 ft above the ground. Pulse duration is 0.06–0.08 sec and the pause [4] between the two pulses in a signal is about 0.05 sec (71°). Both pulse and pulse-pause duration are more variable than pulse interval, and each pulse has an unusual intensity increment (Fig. 1).

The flash pattern of *melanopyge* is 1–5 pulses, each with a duration of 0.09–0.10 sec and emitted at 0.28–0.30 sec intervals (71°, Fig. 2). The pause between flash patterns is 1.4–1.9 sec. It was probably this species that Seliger *et al.* (1964) recorded and identified as *leucopyge*.

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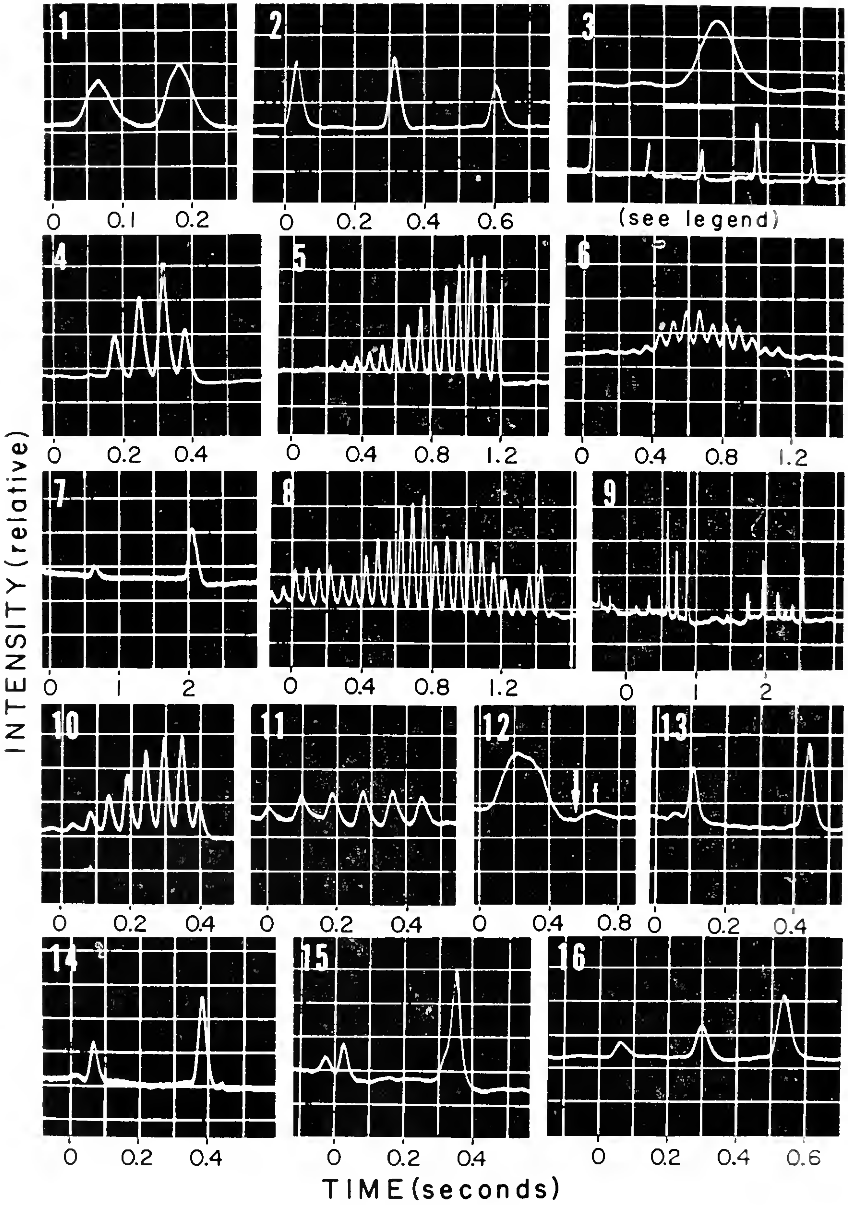
[3] I compared behavior vouchers of *leucopyge* and *melanopyge* with Barber's holotypes. Vouchers of several species have been placed in the collections at Cornell University, the United States National Museum, the Florida Collection of Arthropods, the Museum of Comparative Zoology, and the Institute of Jamaica.

[4] Interval is here defined as the period of time between the beginning of a flash unit (pulse or phrase) and the beginning of the next consecutive unit. A pause is the period from the *end* of one unit to the *beginning* of the next unit.



FIGURES 1–16.

FIGURES 1–16. Oscillograms of firefly flashes; flash patterns of flying males unless otherwise noted. For recording technique see Lloyd, 1968. FIG. 1. *Photinus leucopyge* (71°, Worthy Park). FIG. 2. *Photinus melanopyge* (71°, Ecclesdown). FIG. 3. *Pho-*

Morphologically *leucopyge* and *melanopyge* can be separated with the following couplet:

Ventral abdominal segment 5 with large, white, rectangular or trapezoidal area; pygidium dark............................**melanopyge**
Ventral abdominal segment 5 black or brown throughout; pygidium pale, pale with median infuscation, brown or infuscate with pale areas laterally, or completely dark........................**leucopyge**

2. *Photinus lobatus* Barber was originally described with four subspecies. McDermott and Buck elevated a pale form, *P. l. morbosus*, and *P. l. lobatus*, to species rank and reduced the darkly pigmented *P. l. obscurellus* and *P. l. rapidus* to varieties of *P. lobatus*. I found two darkly pigmented species that morphologically may be distinguished by Barber's couplet (no. 33) that separates *obscurellus* and *rapidus*. For convenience I will use Barber's epithets although I did not compare my vouchers with the holotypes. When the taxon *obscurellus* Barber is formally given species rank the name *obscurellus* will be unavailable because it is preoccupied by *Photinus obscurellus* LeConte (1852). Actually *obscurellus* Barber was a junior homonym when originally published, so the taxon in question has never had a correct name (Lloyd, 1969).

The signal of *rapidus* is a continuous train of single pulses; pulse length is about 0.15 sec and pulse interval 0.83–0.90 sec at 72° (Fig. 3). One courtship was seen in this species. A perched female responded to the flashes of a flying male by flashing single pulses at the rate (occasionally skipping flashes) at which the male flashed and possibly in phase (synchrony) with his flashes. The male swerved in flight and landed 8 inches from the female.

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tinus lobatus rapidus (72°, Worthy Park). Upper trace shows enlargement of fourth pulse of lower trace. Time scale: bar indicates 0.1 sec in upper trace, 1.0 sec in lower trace. FIG. 4. *Photinus lobatus obscurellus* or possibly *Photuris jamaicensis*—see text (fourth pulse is distorted, 71°, Ecclesdown). FIG. 5. *Photinus* (midnight) *commissus* (72°, Worthy Park). FIG. 6. *P. commissus* male in spider web (72°, Worthy Park). FIG. 7. *Photinus* near *blackwelderi* (72°, Worthy Park). FIG. 8. Portion of flicker of *Photinus* near *ceratus, morbosus* (71°, Worthy Park). FIG. 9. Landing flashes of male *P.* near *ceratus, morbosus* (72°, Worthy Park). FIG. 10. *Photinus* (18 cps) *evanescens* (71°, Wilmington). FIG. 11. *Photinus* (11 cps) *evanescens* (71°, Ecclesdown). FIG. 12. Flash pattern and female response (f) of perched *Photinus "synchronans"* (71°, Worthy Park). Arrow indicates beginning of female flash. FIGS. 13–15. *Photinus amplus* (three different males) (72°, Worthy Park). Each flash is composed of two and sometimes three modulations. The first flash in Fig. 15 could have resulted from a twig momentarily obscuring the flash. The second flash in this signal is unlike the flashes of other individuals recorded. FIG. 16. Portion of flash pattern of *Photinus melanuris* (71°, Ecclesdown). Intensity variation among flashes due to changes in recording distance and flight angle of insect.

Three specimens of *obscurellus* were collected (Ecclesdown). Their flash was a short flicker that *appeared* to have 7–9 modulations and was repeated at estimated intervals of 1.2–1.5 sec. The flicker of another specimen was recorded (Fig. 4) and it had 5 modulations with a frequency of 13.8–14.3 cps (71°). However, this individual could not be collected to verify identification and it is possible that it was instead *Photuris jamaicensis* E. Olivier, a species that sometimes flashes in this manner.

McDermott and Buck report a short, single flash at 2–3 sec intervals for lowland *lobatus* and Seliger *et al.* a four pulse flicker (15 cps) at 1.4 sec intervals.

The color of the elytra in *rapidus* is black and in *obscurellus*, dark brown. As a result, in McDermott and Buck's key the two are separated very early (couplet 24) and *obscurellus* will be identified as *lobatus* but *rapidus* will not.

3. Shortly after sunset in a mature mangrove swamp on the southern coast *Photinus commissus* E. Olivier was seen emitting a flickering flash each 1.7 sec (80°). Flicker and pause durations were similar. Another *P. commissus* began flying and flashing 6 hours after sunset in a sugar-cane field adjacent to a stream and small woods at Worthy Park in the central highlands (1,200′). The flashes at these two localities appeared to be identical, but only those from the highlands were recorded and analyzed. Flicker frequency is 12.7–15.3 cps (10 males, 72°) and each flicker has 13–15 modulations. Modulations gradually increase in intensity during the flash until the last one or two, which decrease (Fig. 5). Flicker interval is 1.8–2.2 sec (72°). The flash of one male was recorded while he was caught in a spider web (Fig. 6) and his flicker frequency was similar to that of free males.

The signal McDermott and Buck associated with *commissus* was a short flicker with 4 modulations in about one-quarter sec. They also noted a seasonal difference in flicker interval and the presence of four genitalic forms. One of these, their illustration No. 99, matches the genitalia of the *commissus* I collected at both localities. Such differences in signals, ecology, diurnal periodicity, and morphology suggest that *commissus* is a complex of species.

4. At 1:30 one morning at Worthy Park, fireflies were flashing near the top of an African Tulip Tree, about 60 ft above the ground. Generally this hour and area of activity would not seem unusual but these fireflies had not been seen previously and subsequent observations disclosed that they did not *begin* activity until about 1:00 A.M.; more than 7 hours after sunset! The signal of these fireflies is composed of two flashes; the second is about 0.25 sec in duration and the first is less intense and perhaps shorter

than the second (Fig. 7). Flash interval is 1.4 sec (72°), and flash pattern interval, 3–5 sec.

These fireflies are similar to *Photinus blackwelderi* Barber in size and coloration but the genitalia are more elongate. Their unusual hour of activity suggests that an earlier-flying species with otherwise similar behavior is present in Jamaica. It would seem that only in the tropics where nocturnal temperatures remain high, could a species confine its activity to the hours after midnight.

5. One Jamaican species emits a signal that is reminiscent of the "tic-tic-tic-buzz" calling songs of the meadow-grasshoppers (*Conocephalus* and *Orchelimum*, Tettigoniidae); 4–8 flashes and then a 1–3 sec flicker. This signal is emitted as the insects fly twisting, downward courses, 1–4 ft above the ground, and 3–6 ft in length. Sometimes the preliminary flashes are omitted, and occasionally two series of flashes are produced before the flicker. Perhaps these function in illumination or inhibit other males from flashing in the immediate area. Because of the variability of the preliminary pulses, and the distance flown during the entire signal, I do not believe they function in sexual communication. Flicker frequency is 13.1–14.9 cps (21 males) and flash pattern interval 10–15 sec at 70–72° (Fig. 8). Landing males emit a ragged series of flashes (Fig. 9).

Morphologically this species is similar to *Photinus ceratus* Leng and Mutchler and *Photinus morbosus* Barber. The genitalia are like *ceratus*'s but the signal is not like that described for either of the above. It is perhaps the same as that given by Seliger *et al.* for "*ceratus-morbosus*." The preliminary flashes (tics) they recorded were short flickers, and they noted the discrepancy between visual impressions and recordings since McDermott and Buck reported unmodulated preliminary flashes in a species in this complex. I did not record these "tics."

6. *Photinus evanescens* Barber is a complex that has been troublesome for taxonomists. Buck (1942) made a statistical analysis of male genitalia and found significant differences among several populations. Barber recognized four subspecies; McDermott and Buck reduced these to varieties. I observed two species in this complex and have been unable to morphologically associate them with Barber's infra-specific categories. Their signals are short flickers that are emitted at 2–3 sec intervals and electronic analysis is usually necessary to distinguish between them. The flicker frequency of one is 18–19 cps (26 males, 71–72°). In each flicker there are 8–10 modulations (Fig. 10). The flicker frequency of the other is 10.5–11.5 cps (4 males, 71°). These signals contain 6–8 modulations (Fig. 11). Seliger *et al.* recorded flickers of 12.5 and 16.7 cps for *evanescens* with 3 and 5 modulations, respectively. Some of my recordings show similar num-

bers and I believe this is because sometimes the recorders failed to detect the dimmer modulations at each end of the signals.

Morphologically the two are distinct and can be separated with the following couplet.

Pygidium pale; tergites pale; sternites 2–4 fuscous; length 6–7 mm. . . . . **18 cps flicker**

Pygidium fuscous or dark; tergites dark; sternites dark; length 7–8 mm. . . . . **11 cps flicker**

7. In most species of fireflies there are individuals whose flash mechanism functions improperly and light is continuously emitted from the lantern. Usually the species-specific flash pattern is superimposed upon this glow. At a site on the southern coast near Morant Bay a number of fireflies were observed emitting light in this fashion. Their glow was brighter than usually observed in aberrant individuals and there was no discernible pattern in the timing of their superimposed pulses. They flew slowly 5–40 ft above the ground while emitting the sputtery glow. Since many were seen behaving in this manner, presumably this is a mating signal. These fireflies are *P. synchronans* Barber on the basis of genitalia (but the tergites are dark rather than pale or light brown, see below). At Worthy Park I found a large population of "*synchronans*" whose behavior was different from that described above. The male flash pattern was a single 0.43 sec flash and its interval was about 3 sec (71°). Courtship was observed in this species. A perched female answered the flash of a flying male with a single flash at a delay of 0.52 sec (Fig. 12). After the third signal exchange the male landed 5 inches from the female and after 4–6 more exchanges reached and mounted her.

Tergite coloration has previously been used as a key character to separate *sychronans* from *melanuris*. While this character is unsatisfactory for separation, they can be distinguished by genitalia (McDermott and Buck), behavior, and the presence of rosy pigment on ventral segment 5. I have been unable to distinguish morphologically between the two "*synchronans*" mentioned above.

ADDITIONAL NOTES ON BEHAVIOR

The signal of *Photinus amplus* Barber appears to be composed of two flashes and similar to that of the nearctic species *Photinus consanguineus* LeConte. Actually the flashes are bimodal and some may be trimodal (Figs. 13 and 14). The second modulation in most recorded flashes is much brighter than the first, although one recording shows peculiar intensity relationships (Fig. 15); the first flash of this pattern may have been occluded by a twig. Flash pattern interval in this species was 2.8–3.8 sec (72°).

The signal of *Photinus melanuris* Barber is similar to that of *melanopyge* (Fig. 16) but its phrases are composed of 4–11 (rarely 15 or more) pulses. My recordings of this species are similar to that illustrated by Seliger *et al.*

Pyractomena (= *LeContea*) *gamma* Jac. Duval males emit a three-quarter sec. amber flicker that appears similar to that of the nearctic species *Pyractomena angulata* (Say) in flicker frequency (ca 9 cps), each 1.6 sec of flight (75°). The recordings of Seliger *et al.* for "*LeContea*," perhaps this species, show a frequency of about 7 cps but the flicker is much shorter. *Photuris jamaicensis* E. Olivier, if it is but one species, emits single flashes, combinations of single flashes, and slow and fast flickers. Females emit flashes when landing as in nearctic *Photuris* (Lloyd, 1968) and are probably also aggressive mimics; one ate a *Photinus* male that was caged with her (T. J. Walker, pers. comm.) and another was observed repeatedly answering the flash pattern of a *commissus* male. *Photinus pallens* Fabricius (coastal, near Negril) emits phrases composed of 1–6 (3 most frequent) (fused?) pulses at 6–10+ sec intervals. In multipulse phrases, pulse intervals are 0.2–0.3 sec and each pulse is brighter than previous ones in the same phrase. This species is sedentary, and lengthy periods of perched flashing occur between flights. *Robopus* (= *Diphotus*) *montanus* Barber is also sedentary and both males and females emit continuous glows while perched. The glow of one male was recorded and was without high frequency modulations.

Flashing activity in the following species begins 15–35 min after sunset; *evanescens* (both species), *leucopyge*, *commissus* (Milk River, mangrove), *melanuris*, *Pyractomena gamma*, and *Photuris jamaicensis*. Worthy Park *synchronans* started 90 minutes after sunset and a single flash, upland *pallens* began one hour after sunset.

ACKNOWLEDGMENTS

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The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

New Synonyms of *Asphondylia betheli* Cockerell (Diptera: Cecidomyiidae).—Two papers have recently appeared which concern, at least in part, the biology and the effect on prickly pear cactus of the western North American gall-midge, *Asphondylia betheli* Cockerell, 1907. These are by M. N. Ganz on ovule abortion and fruit proliferation instigated by this gall midge on *Opuntia macrorhiza* Engelm. (Cactaceae) (1968, Cactus & Succulent J., Cactus & Succulent Soc. Amer. 40(6): 249–252) and by J. Mann on cactus-feeding insects and mites (1969, U. S. Nat. Mus. Bull. 256: x & 158 pp.) In the latter, the name *Asphondylia opuntiae* Felt, 1908, is used instead of *A. betheli*, and both papers note the fact that three species of *Asphondylia*, the two aforementioned species and *A. arizonensis* Felt, 1907, are recognized as occurring on *Opuntia*. Felt (1908, N. Y. State Mus. Bul. 124: 377; 1916, *ibid.*, 186: 116) separated his two species from *A. betheli* on the basis of an alleged difference in the number of palpal segments and from each other on the basis of color differences. I have seen the type series of all three species and find that each specimen has three-segmented palpi. The short first segment is almost hidden from view in the slide preparations of *A. betheli* and is presumably the reason Felt counted only two segments. The color of the insects is not of specific value as it is usually a function of the time the sclerites are allowed to harden and darken after eclosion before the insects are killed. No other differences on which to separate these three taxa are apparent, and I am here synonymizing *A. arizonensis* and *A. opuntiae* under *A. betheli*. The description of *A. betheli* (1907, Can. Entomol. 39(9): 324), which appeared IX-16-1907, antedates that of *A. arizonensis* (1907, *New Species of Cecidomyiidae II*, Albany, N. Y., 23 pp.) which appeared X-26-1907.—Raymond J. Gagné, *Systematic Entomology Laboratory, Entomology Research Division, c/o U. S. National Museum, Washington, D. C. 20560.*

Lipids of the Mutant Bronze Mosquito, Aedes aegypti (L.)[1]

WILLIAM J. YURKIEWICZ[2] and SATISH C. BHALLA[3]

ABSTRACT

There were no differences in neutral lipid or phospholipid content and composition between mutant bronze and wild-type mosquitoes, *Aedes aegypti* (L.). However, fatty acid composition within some of the lipid fractions was found to vary. The bronze mosquitoes contained more saturated and less unsaturated fatty acids than wild-type in free fatty acid, mono- and diglyceride, phosphatidyl choline, phosphatidyl ethanolamine, and phosphatidyl serine fractions. In the sterol ester fraction the wild-type contained more C-18:1 (oleic) than C-18:2 (linoleic), while the reverse was true for bronze.

The importance of fatty acids as components of cuticular lipids, as necessary constituents for egg viability, and as integral parts of phospholipid molecules is discussed in reference to the sterility of the mutant bronze. It is hypothesized that alterations in fatty acid composition could be at least partially responsible for the failure of the bronze eggs to hatch.

INTRODUCTION

Females of the mutant bronze of the Yellow Fever Mosquito, *Aedes aegypti* (L.), are sterile because their eggs fail to hatch (Bhalla and Craig, 1967). The females mate normally and fertilization occurs but embryonic development proceeds for only about six hours after fertilization. Bhalla and Craig suggest that the absence of melanin formation and normal tanning of the egg shell might be responsible for the failure to complete embryonic development. However, when egg shells of the mutant bronze were tanned artificially with benzoquinone so they could not be differentiated from wild-type eggs, only a slight enhancement in embryonic development occurred and the eggs still failed to hatch.

A recent paper by Jackson *et al.* (1968) points out that unsaturated fatty acids may play a vital role in insect metabolism and that a rather exact fatty acid composition may be necessary for egg viability. With this in mind we have completed a study of the lipids of mutant bronze and wild-type *Aedes aegypti* in an attempt to detect alterations in lipid metabolism which might account for the failure of the eggs to complete embryonic development.

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MATERIALS AND METHODS

The colonies of the two strains of *Aedes aegypti*, wild-type and bronze, were maintained using standardized rearing methods (Bhalla, 1966; Bhalla and Craig, 1967). The larval food consisted of Gaines dog food and yeast. Pupae were sexed and placed in screened cups for emergence. One to two-day-old unfed adults were used for lipid analysis.

Total lipids were extracted with chloroform-methanol, 2:1 (v/v) and purified by the method of Folch *et al.* (1957). The total lipid extract was placed on a silicic acid column and neutral lipids were eluted with chloroform, while the retained phospholipids were eluted with methanol-chloroform, 9:1 (v/v). Neutral lipids were fractionated by thin layer chromatography on silica gel plates (Merck) using a solvent system of petroleum ether-ethyl ether-glacial acetic acid, 85:15:1 (v/v/v) (Kinsella, 1966). The fractions were identified by co-chromatography with known lipids (Applied Science Labs.) and by gas-liquid chromatography. The area of silica gel containing each fraction was scraped from the plate and the lipids were eluted with chloroform-methanol, 2:1 (v/v), dried, and weighed. A portion of each fraction was quantitated by the sulfuric acid colorimetric method of Marsh and Weinstein (1966) as described previously (Yurkiewicz and Whelchel, 1969). Sterols were also quantitated by the method of Sperry and Webb (1950). No significant differences were found in the data from the two methods of sterol quantitation.

Phospholipids were fractionated on glass fiber-silica gel sheets (Gelman Instrument Co.) as reported earlier (Yurkiewicz, 1967) and an aliquot was quantitated by direct phosphorus analysis (Chen *et al.*, 1953). Identification was by co-chromatography with known phospholipids (Applied Science Labs.) and by hydrolysis of the individual fractions followed by paper chromatographic examination of the hydrolytic products (Dawson, 1960).

The lipid fractions were saponified in 10 per cent ethanolic KOH for 20 min. at 55° C. After acidification with 50 per cent HCl, the free fatty acids were removed with hexane. Fatty acid methyl esters were prepared using the boron trifluoride method of Metcalfe and Schmitz (1961) and were analyzed by gas-liquid chromatography (Yurkiewicz, 1969). Standard chromatographic techniques, including the use of diethylene glycol succinate columns and hydrogen flame detectors, were employed.

The mean values from two to three determinations on single pooled mosquito samples are presented in the tables. In those cases where standard deviation is included four determinations were made.

TABLE 1. Neutral lipid content and composition of mutant bronze and wild-type *Aedes aegypti*

Insect	Total Neutral Lipid (mg/g live wt)	Per Cent Composition				
		Triglyceride	Mono- + Diglyceride	Free Fatty Acid	Sterol	Sterol Ester + Hydrocarbon
Wild-type ♂	34.5 ± 3.3[1]	76.2	10.9	3.3	3.1	6.5
Bronze ♂	31.2 ± 2.7	73.7	13.4	2.8	2.9	7.2
Wild-type ♀	37.8 ± 4.7	81.4	8.2	2.5	2.3	5.6
Bronze ♀	36.1 ± 3.9	78.9	9.7	2.2	2.4	6.8

[1] Mean ± Standard Deviation.

RESULTS AND DISCUSSION

The neutral lipid content and composition of wild-type and bronze mosquitoes are shown in Table 1. No differences in neutral lipids are obvious between the two strains of mosquitoes, but females of both strains appear to contain slightly more lipid than males. Triglyceride is the major lipid fraction and accounts for over 70 per cent of the neutral lipids in all insects. This is in agreement with Van Handel and Lum (1961), who found mainly triglycerides and traces of sterols, free fatty acids, and hydrocarbons in *Aedes sollicitans*.

Phospholipid content and composition are shown in Table 2. The total phospholipid content is similar to earlier reports on *Aedes aegypti* (Khan and Brown, 1966; Fast and Brown, 1961); but the per cent composition differs because the total phospholipid sample was fractionated into

TABLE 2. Phospholipid content and composition of mutant bronze and wild-type *Aedes aegypti*

Insect	Total Phospholipid (mg/g live wt)	Per Cent Composition (lipid phosphorus)				
		Lysophosphatidyl Choline + Sphingolipid	Phosphatidyl Choline	Phosphatidyl Serine + Phosphatidyl Inositol + Lysophosphatidyl Ethanolamine	Phosphatidyl Ethanolamine	Cardiolipin
Wild-type ♂	6.9 ± 1.2[1]	3.1	12.2	11.3	68.9	4.5
Bronze ♂	7.6 ± 0.9	1.3	17.7	8.5	66.8	5.7
Wild-type ♀	8.1 ± 2.2	2.5	16.1	12.9	62.5	6.0
Bronze ♀	7.4 ± 1.7	2.7	15.0	9.0	68.4	4.9

[1] Mean ± Standard Deviation.

TABLE 3. Fatty acid composition of neutral lipids in wild-type *Aedes aegypti*

Lipid Fraction		Per Cent Composition of Fatty Acids								
		12	14	14:1	16	16:1	18	18:1	18:2	18:3
Triglyceride	♂	2.9	1.7	6.8	27.3	21.2	2.5	32.0	5.1	0.5
	♀	1.5	2.3	7.3	25.6	24.5	2.5	30.4	5.0	0.4
Mono- and diglyceride	♂	t[1]	3.0	3.7	29.6	15.9	5.3	28.3	9.9	4.1
	♀	t	4.5	3.8	34.2	17.0	6.8	24.0	7.4	2.1
Free fatty acid	♂	0.3	1.0	2.5	25.6	21.4	3.3	20.2	26.0	0.6
	♀	0.5	1.2	2.1	31.2	20.4	4.2	22.2	18.1	0.4
Sterol ester	♂	t	1.3	2.9	18.1	22.2	2.6	31.7	19.6	1.5
	♀	t	1.5	2.7	19.4	25.4	2.8	31.1	16.3	0.5

[1] t = trace, less than 0.1 per cent.

a greater number of components in this investigation and thus the per cent contribution of any single phosphatide is lessened. Khan and Brown (1966) and Fast and Brown (1961) both reported only cephalin (mostly phosphatidyl ethanolamine), lecithin (mostly phosphatidyl choline), and sphingolipid. The phospholipid composition as reported here is very similar to that of the housefly, *Musca domestica* (Crone and Bridges, 1963; Crone, 1964) and blowfly, *Phormia regina* (Bieber *et al.*, 1961).

The fatty acid composition of the various neutral lipid fractions in

TABLE 4. Fatty acid composition of neutral lipids in the mutant bronze of *Aedes aegypti*

Lipid Fraction		Per Cent Composition of Fatty Acids								
		12	14	14:1	16	16:1	18	18:1	18:2	18:3
Triglyceride	♂	0.5	1.9	10.5	27.6	18.4	2.7	28.5	9.4	0.2
	♀	0.7	2.0	7.1	28.9	20.1	3.2	29.4	8.4	0.3
Mono- and diglyceride	♂	t[1]	3.5	4.4	43.1	7.9	3.1	28.3	7.8	2.1
	♀	t	3.7	1.2	38.7	5.0	1.1	37.6	7.5	5.0
Free fatty acid	♂	0.3	0.7	0.6	72.6	2.7	15.4	4.7	3.6	t
	♀	0.2	2.7	1.7	68.4	1.0	21.4	3.3	1.5	t
Sterol ester	♂	t	0.8	2.5	20.7	20.1	1.8	25.8	26.6	1.7
	♀	t	0.8	1.9	22.5	19.2	3.3	20.9	29.7	1.6

[1] t = trace, less than 0.1 per cent.

wild-type and bronze mosquitoes is shown in Tables 3 and 4. The fatty acid composition of the wild-type is similar to the total lipid or neutral lipid fatty acid analyses of earlier workers (Barlow, 1964; Fast and Brown, 1962), but the bronze differs from the wild-type especially in the free fatty acid fraction. In this fraction the bronze contain considerably more of the saturated fatty acids C-16 (palmitic) and C-18 (stearic) than the wild-type strain. The higher amount of C-16 in the bronze is also apparent in mono- and diglycerides. There are also differences in the sterol ester fraction. The wild-type contains more C-18:1 (oleic) than C-18:2 (linoleic), while the reverse is true for the bronze.

The significance of the differences in fatty acid composition is not clear but the possible ramifications are interesting. Insect cuticular lipids contain free fatty acids (Bursell and Clements, 1967; Gilby and Cox, 1963) so perhaps the inferior water-proofing (Bhalla and Craig, 1967) of the bronze eggs may somehow be related to the free fatty acid differences in the bronze insect. This is especially significant since Bhalla and Craig emphasized that the egg shell is deposited by the maternal parent and hence represents the phenotype of the mother and not the offspring. Moreover, they have also shown through appropriate crosses that even the embryos with dark phenotypes within bronze shells die, thus indicating that the bronze females depositing the egg shells must have the metabolic deficiency. Bhalla and Craig hypothesized that a lack of melanin formation and failure of the egg shell to tan and harden might result in abnormal osmotic relations or in an imbalance of embryonic material and, subsequently, death. However, when they tanned the bronze eggs artificially with benzoquinone so the bronze eggs could not be differentiated from normal eggs, the embryos still died after a slight enhancement in development. This failure could have been due to a toxic effect of benzoquinone as suggested by the authors or possibly the fatty acid differences in the bronze mutant reported in this paper might be altering the water-proofing characteristics of the bronze egg. Another factor is the fatty acid complement provided to the embryo by the bronze female. Gilbert (1967) indicates that unsaturated fatty acids may be of great importance to the growth of insects. Jackson *et al.* (1968) suggest that a rather exact fatty acid composition is necessary for egg viability. Furthermore, they feel that the amount of fatty acid present as free fatty acid, methyl ester fatty acid, or sterol ester fatty acid may be equally important in determining egg viability. Thus, it is possible that the bronze female due to some metabolic alteration does not provide the embryo with the fatty acid composition necessary to complete embryonic development. This again could explain the failure of the artificial tanning to enhance egg hatching.

TABLE 5. Fatty acid composition of phospholipids in wild-type *Aedes aegypti*

Lipid Fraction		Per Cent Composition of Fatty Acids							
		14	16	16:1	18	18:1	18:2	18:3	>18:3
Lysophosphatidyl choline + sphingolipid	♂	7.6	31.8	14.7	9.5	22.1	14.3	t[1]	t
	♀	6.3	31.3	14.8	13.6	19.1	14.9	t	t
Phosphatidyl choline	♂	1.4	25.4	18.1	9.6	22.4	21.7	1.4	t
	♀	3.1	21.5	15.3	9.1	21.7	21.5	5.5	2.5
Phosphatidyl serine + phosphatidyl inositol + lysophosphatidyl ethanolamine	♂	t	17.0	22.4	8.7	19.7	32.1	t	t
	♀	t	12.9	25.0	5.5	14.7	31.8	6.4	3.4
Phosphatidyl ethanolamine	♂	1.9	23.4	8.9	6.8	26.9	32.1	t	t
	♀	2.6	25.4	12.2	6.3	26.8	24.4	2.8	t
Cardiolipin	♂	4.5	47.1	11.7	10.9	17.6	7.8	t	t
	♀	3.5	33.9	15.8	11.6	21.0	11.3	3.0	t

[1] t = trace, less than 1.0 per cent.

Fatty acid composition of the various phosphatides is shown in Tables 5 and 6. Here again the bronze mutant differs from the normal mosquito in that it contains considerably more of the saturated fatty acids (C-16 and

TABLE 6. Fatty acid composition of phospholipids in the mutant bronze of *Aedes aegypti*

Lipid Fraction		Per Cent Composition of Fatty Acids							
		14	16	16:1	18	18:1	18:2	18:3	>18:3
Lysophosphatidyl choline + sphingolipid	♂	6.6	32.5	13.9	13.1	19.5	14.3	t[1]	t
	♀	3.9	35.8	15.1	11.2	18.8	13.9	1.1	t
Phosphatidyl choline	♂	3.9	39.5	9.6	14.2	16.3	15.3	1.2	t
	♀	4.7	38.6	10.8	16.9	14.5	13.2	0.8	t
Phosphatidyl serine + phosphatidyl inositol + lysophosphatidyl ethanolamine	♂	8.8	40.0	13.1	13.6	17.2	4.1	3.4	t
	♀	1.8	36.1	16.1	11.3	18.6	11.4	4.5	t
Phosphatidyl ethanolamine	♂	7.3	47.5	10.2	14.6	13.1	4.5	2.7	t
	♀	1.6	36.0	11.3	9.1	23.3	17.3	1.3	t
Cardiolipin	♂	5.2	38.1	15.4	12.2	18.3	9.1	1.5	t
	♀	3.0	33.8	17.5	11.2	19.1	13.5	0.8	t

[1] t = trace, less than 1.0 per cent.

C-18) and less of the unsaturated. This is obvious in the phosphatidyl choline, phosphatidyl ethanolamine, and the phosphatidyl serine (plus other phosphatides) fractions. Phospholipids have been shown to play a variety of roles in a cell (Gilbert, 1967) including cell membrane structure, ion transport, active transport, mitochondrial activity, and nervous integration. Gilbert also feels that the low solubility of phospholipids in water makes them ideal substances for use in membranes that are vital for both the partitioning of separate cells and the micro-compartmentalization of the cytoplasm. Thus, it is possible that the differences in fatty acid composition in bronze phospholipids may be responsible for the improper osmotic relations suggested by Bhalla and Craig (1967).

In summary, the bronze mosquito differs from wild-type *Aedes aegypti* in that it possesses more saturated fatty acids and less unsaturated fatty acids in a number of the neutral lipid and phospholipid fractions. These findings do not explain the failure of the bronze eggs to complete embryonic development, but an alteration in fatty acid metabolism in the bronze female could be at least partially responsible since previous work indicates that fatty acids (1) are components of cuticular lipids, (2) are thought to be necessary in specific amounts for egg viability, and (3) are integral parts of phospholipid molecules. Further work, including lipid analyses of eggs and fatty acid tracer experiments using a number of different strains of this mosquito, is necessary to explain sterility in the mutant bronze.

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Notes on the Male Germ Cells of a Beetle, Leptinotarsa decemlineata [1]

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ABSTRACT

The morphology of the male germ cells in *Leptinotarsa decemlineata* (Say) as studied by correlative microscopy (bright field, phase contrast, and electron microscopy) has been presented. Since relatively little information pertaining to spermatid maturation in this species is available, these aspects of spermatogenesis have been emphasized. Techniques for locating germ cells within the adult beetle and general techniques of tissue preparation have been included.

INTRODUCTION

Studies of the male germ cells of the Colorado potato beetle *Leptinotarsa decemlineata* (Say) were made by use of the light microscope (both bright field and phase contrast) and by use of the electron microscope. Descriptions of the male reproductive tract and the female spermathecae are included. This article attempts to demonstrate the usefulness of correlative instrumentation in our studies of insect spermatozoa and to present some of the techniques utilized in our investigations. It is assumed that the reader is familiar with the terminology involved in insect spermatogenesis (cf. Breland *et al.*, ENTOMOLOGICAL NEWS, October 1968) and the paper is directed toward the entomologist for whom we feel a basic understanding of spermatogenesis could be helpful as a research tool in cytological and taxonomic studies.

Material and Methods: Adult Colorado potato beetles were collected at the University of Texas Brackenridge Field Laboratory in Austin, Texas; and were usually found on nightshade plants. The testes and spermathecae were dissected and studied with light microscopy and with electron microscopy.

Light Microscopy: BRIGHT FIELD—Dissection were accomplished by sagittally cutting the abdominal sterna; the prominent orange colored testes were removed and placed in Bauer's Fixative (1931) for twelve hours. The tissue was dehydrated in successive ethanol concentrations, transferred to an equal mixture of absolute ethanol and xylene for fifteen minutes and then placed in 100% xylene for fifteen minutes. Small pieces

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of paraffin were then added to this solvent for a period of two hours; after which the tissue was placed in plastic tissue molds and embedded in 100% paraffin. Sections were cut at approximately ten microns, mounted on egg albumen smeared slides, and stained with safranin-fast green following the technique of Jensen (1962). Cover slips were then mounted on the sections with Canadian balsam. The slides were then examined on a Ziess microscope utilizing the bright field objective.

PHASE CONTRAST—For phase contrast microscopy a small portion of the testes was removed and placed on a slide with a small amount of Belar's insect saline (Breland, 1961). After gently teasing the tissue with insect pins, a cover slip was added and moderately squashed to facilitate spreading, and sealed with Kronig cement. A Zeiss phase contrast microscope was used to examine the various stages of sperm development and photographs were taken using Kodak contrast process ortho 4 × 5 film with a Leitz camera.

Electron Microscopy: For electron microscopy the male Colorado potato beetles were placed on dry ice, which temporarily immobilized them so that the testes could be excised. Before the testes were actually removed, the body cavity was filled with glutaraldehyde to reduce the amount of tissue damage. After excision the tissue was cut into approximately $\frac{1}{2}$ mm cubes, placed in $2\frac{1}{2}$% glutaraldehyde in Sorensen's buffer for one hour and then placed into 1% osmium tetroxide in Sorensen's buffer for one hour. After staining in 0.5% uranyl acetate overnight, the tissue was dehydrated rapidly in successive concentrations of ethanol placed in 100% acetone for an hour and then embedded in a plastic mixture of 70% dodecyl succinic anhydride (DDSA), 20% Araldite 6005 and 10% Epon 812 with one drop from a capillary pipette of accelerator DMP-30 added per milliliter of plastic.

A Sorvall (Porter Blum MT-1) microtome with either a glass or diamond knife was used to cut sections 500–800 A thick, which were spread with toluene vapors. The sections were placed on grids and were then post-stained with lead citrate (Reynolds 1963) for five minutes and examined on a Siemens Elmiskop I electron microscope.

Observations and Discussion

Historical: The male germ cells in *Leptinotarsa decemlineata* were originally investigated by Stevens (1906) and by Wieman (1910) These early studies emphasized meiosis and were not concerned with spermiogenesis (the maturation of the spermatid into the mature spermatozoon). To the best of our knowledge no investigator has published any aspect of spermiogenesis in this common beetle which has prominent reproductive organs, is easily identified, and is widely distributed.

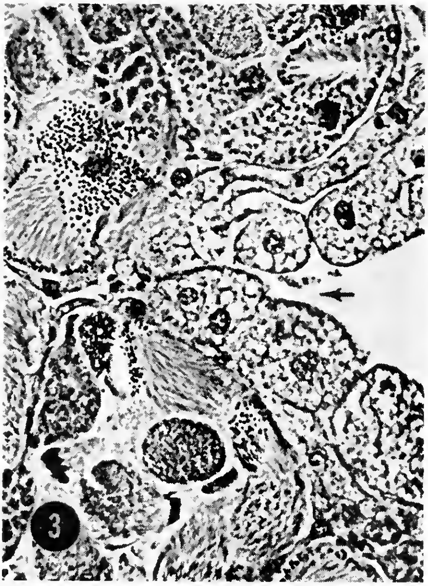
Gross morphology of the male reproductive tract: Upon opening the abdominal cavity in male Colorado potato beetles, the entire reproductive tract can be seen. Attempts to remove the entire reproductive system were successful but efforts to photograph these dissections proved disappointing. Such a system is perhaps best explained by line drawing as in Fig. 1.

FIGURE 1. Diagram of male reproductive system.

The prominent, individually bilobed bodies located in the anterior portion of the abdomen are the testes. Each testicular lobe is connected to a minute vas efferens which joins the vas deferens. Proximal to the testis the vas deferens unites with an accessory gland before joining with the other vas deferens which connect with the common ejaculatory duct. Posteriorly, the ejaculatory duct passes into the sclerotized aedeagus (penis).

Gross morphology of the female spermatheca: The spermatheca is a diverticulum of the female reproductive tract connected to the posterior portion of the common oviduct and it is the storage organ for the spermatozoa which are received during copulation with the male. In *Leptinotarsa decemlineata* the spermatheca is approximately 0.5 mm wide and heavily sclerotized. The spermatheca is a good source of mature spermatozoa which cannot always be found in testicular tissue. Attempts to observe mature spermatozoa in embedded spermathecae with the electron microscope were only partially successful due to the small size and heavy sclerotization of the storage organ. However, dissections for phase contrast microscopy were successful and frequently used when male specimens were not available.

Light microscopy of the testes: The testes are located in the anterior portion of the abdomen and are easily identified by their bright orange pigmentation. Each testis has two groups of follicles surrounded by ensheathing epithelial cells which cause them to appear non-divided and kidney shaped (Fig. 3). The follicle groups are made up of many individual follicles or sperm tubes (Snodgrass, 1935) which radiate from a central "hub" termed the cap region (Wieman, 1910). Sperm cells develop in sperm cysts within each follicle and mature in successive stages from the periphery to the cap region which is directly connected to the vas efferens (Fig. 3).



FIGURES 2–4. FIG. 2. Excised spermatheca from female, × 160; FIG. 3. Paraffin section of a testis. Note bilobed follicle groups (arrow) surrounded by ensheathing epithelial cells (EC), × 256; FIG. 4. Paraffin section revealing vas efferens (VE) and radial appearance of individual follicles, × 128.

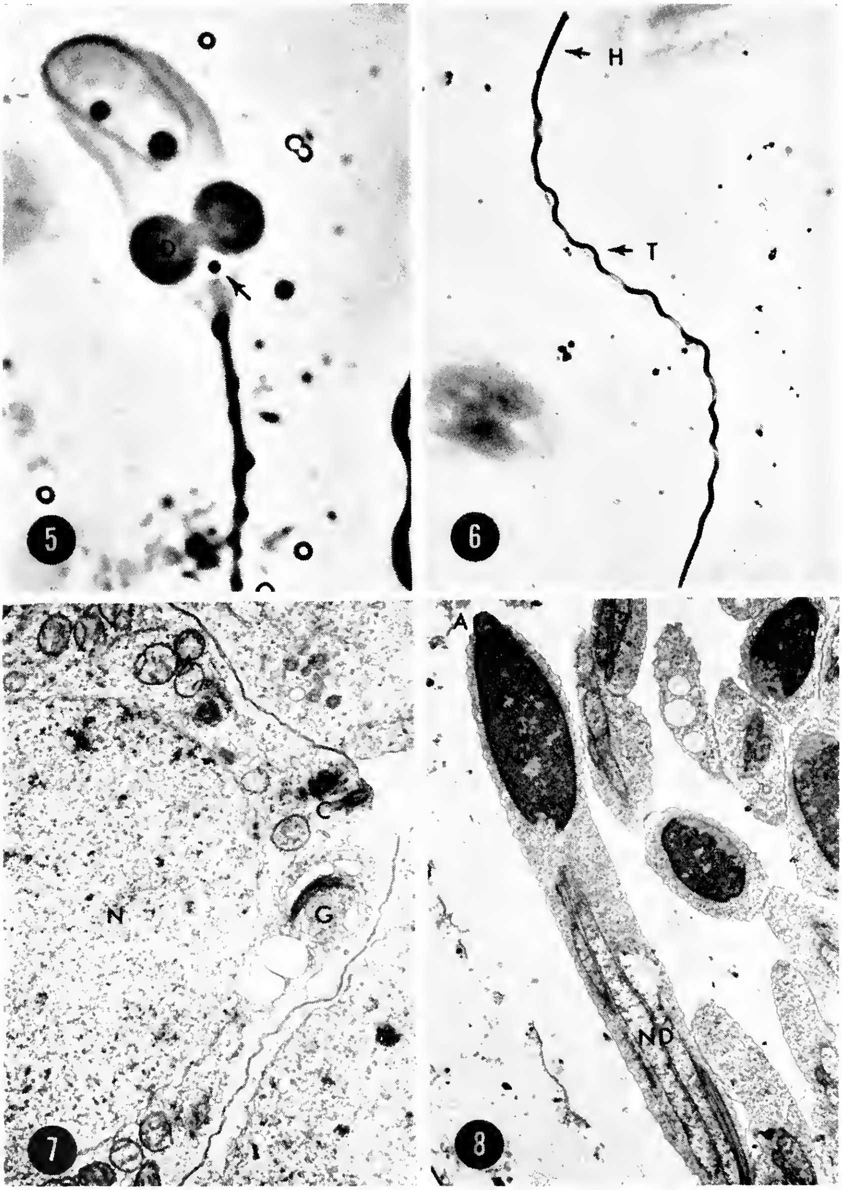
Within any given cyst the germ cells were all at approximately the same stage of development and oriented in a specific polarity with respect to their anterior-posterior axis (i.e., nuclei were all together).

Phase contrast microscopy: The morphological changes during spermiogenesis in *Leptinotarsa decemlineata* were studied with phase contrast microscopy. In electron microscopy and paraffin sectioned bright field microscopy, the tissue is usually fixed, stained and sectioned before examination (usually a lengthy process) but in phase contrast microscopy the tissue is examined immediately after excision. There are many advantages of correlating phase contrast microscopy with electron microscopy and it should be remembered that even though electron microscopy has certain resolution advantages, it does not enable the investigator to observe the living cell.

Phase contrast microscopy is especially useful for observations of flagellar motility and for observing different mechanisms by which round spermatids differentiate into long, slender spermatozoa. Figure 5 is a spermatid beginning to elongate. The mitochondrial nebenkern has split into the two apparently spherical mitochondrial or nebenkern derivatives which will elongate on each side of the axial filament. Note a possible centriole (arrow) lying directly beneath the mitochondrial derivatives. Figure 6 is a phase contrast micrograph of a mature spermatozoon which measures approximately 100 micra in length.

Electron microscopy: We have investigated many aspects of spermiogenesis in *Leptinotarsa decemlineata* with the electron microscope and a recent article concerned with the subunits in each of the 9 + 9 + 2 flagellar tubules has recently been completed (Shay *et al.*). These subunits measure approximately 35–40 angstroms which represents a considerable increase in resolution when compared with phase contrast microscopy.

Figure 7 is a low magnification micrograph of an early spermatid. Note the two centrioles, early acrosome formation and mitochondria which will eventually coalesce to form the nebenkern. Figure 8 is an elongating spermatozoon which shows the acrosome, nucleus, mitochondrial derivatives and axial filament (flagellum). There have been many statements published regarding the number of centrioles in the spermatids in insects, and Friedlander and Wahrman (1966) have stated that only one typical centriole occurs in the spermatids of all species of insects that have been studied with the electron microscope. Breland *et al.* (1968) have demonstrated the existence of two centrioles in many of the insect spermatids they studied and Fig. 7 clearly shows two centrioles in *Leptinotarsa*. Shay and Biesele (1968) have stated that even though only one centriole was observed in spermatids of the cave cricket (*Centhophilus secretus*) there



FIGURES 5–8. FIG. 5. Phase contrast photomicrograph of elongating spermatid. Nebenkern dividing into two Nebenkern derivatives (ND) and arrow indicates possible centriole, × 1,900; FIG. 6. Phase contrast photomicrograph of mature spermatozoon (H = Head, T = Tail), × 1,130; FIG. 7. Electron photomicrograph of young spermatid. Note mitochondria (M), Golgi (G), nucleus (N), and two centrioles (C), × 9,900; FIG. 8. Electron photomicrograph of elongating spermatid. Note acrosome (A), nucleus (N), and Nebenkern derivatives (ND), × 4,500.

still remained the possibility of the existence of a second one and that perhaps they were not fortunate enough to cut sections showing both centrioles.

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The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

VIRUSES, VECTORS AND VEGETATION

Edited by Karl Maramarasch. John Wiley and Sons, Inc., 1969. vii + 666 pp. Cloth, $29.95.

Viruses, Vectors and Vegetation is the direct outgrowth of the United States-Japan Conference on Interactions between Arthropods and Plant-Pathogenic Viruses. Since the Tokyo conference was limited to participation by only nineteen Japanese and U. S. scientists, the subject matter covered during the conference was somewhat limited. This limitation has been overcome in the book by the addition of a dozen chapters prepared by experts not participating in the conference. The topics discussed in Tokyo were brought up to date and broadened for inclusion in this comprehensive treatment of the interactions involved with viruses, vectors, and plants. Only certain groups of vectors have been omitted where less progress has been made in the past decade and where adequate reviews already exist.

It was the Editor's intent to provide self-contained chapters describing subject matter of a particular interest with some unavoidable overlap in certain cases. The Editor justifies this duplication on the basis that completeness of coverage of the subject matter is most desirable. Each of the 29 chapters is a detailed description of the work conducted, interpretation of results, and a report of advances in the field.

For me, the chapters concerned with the localization and fate of viruses in cells and tissues of the vector, pathologies caused by viral agents in the vector, and the two chapters covering the methodology employed in isolation and purification of viruses and RNA were most rewarding.

A liberal use of illustrations may be found throughout the text and the electron micrograph are of good quality.

This book fills a void not previously filled as a single collective volume. It may prove rather costly to the individual, but it most certainly belongs in the reference libraries of entomology and plant pathology departments.—J. D. Paschke, *Laboratory of Insect Pathology, Department of Entomology, Purdue University, Lafayette, Indiana 47907.*

Cercyonis pegala abbotti, New Subspecies (Lepid.: Satyridae)[1]

F. MARTIN BROWN[2]

ABSTRACT

Misidentification of *Papilio pegala* Fabricius 1775 has led to transfer of that name to an unnamed taxon in the same genus, *Cercyonis*. The error is corrected and the unnamed taxon dubbed *abbotti*. True *pegala* is restricted to sedge marshes along the coast from South Carolina northward to southern New Jersey and possibly (as *maritima* Edwards) Massachusetts. The newly named *abbotti* appears to inhabit xeric grasslands associated with woodlands in northern Florida and southern Georgia.

In the course of studying the Fabrician butterflies found in North America it has become evident that the name *pegala* Fabricius has been improperly applied for some years. I do not know who first made the error but it was fostered by W. H. Edwards in his "Butterflies of North America." In Volume 3, part 9, issued in 1890, Edwards figured on plate "Satyrus I" examples of what he called *pegala* and "*alope* var." These figures have become the standard interpretation of Fabricius's name. Actually what Edwards called "*alope* var." are good examples of true *pegala* Fabricius, 1775. What Edwards called *pegala* I am now naming *abbotti*.

Fabricius's types of *pegala* are in the University Museum, Glasgow, Scotland, and I figured them in [1966]. Edwards's figure 7 on the plate noted in the preceding paragraph is a perfect match for the lectotype of *pegala*, both in pattern and size. Edwards's figure 6 matches the upper side of the lectoparatype. In fact so good are these matches that Edwards's figures could be used as figures of the types! The text that accompanies this plate suggests that the specimens figured came from Cape May, New Jersey. On the previous page he assigned to this "variety of *alope*" the "diminutive *pegala* (as if from a starved caterpillar)" from Charleston, South Carolina, noted by him in 1880, p. 52. The Fabrician types of *pegala* came from Charleston, South Carolina (Brown, [1966] p. 135.) Other South Carolina specimens before me are the same size and coloring as *pegala* Fabricius and none look like *pegala* Edwards (*nec* Fabricius).

The radius of the left fore wing of the true *pegala* male is less than 30 mm and usually about 27 mm. The same dimension on *abbotti* males is over 30 mm and usually over 32 mm. The females are somewhat larger, usually by 3 to 5 mm.

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Generally speaking, in the Carolinas *pegala* males have one eyespot and the females usually have two. As you travel northward the second eyespot on the males increases in frequency until north of the mouth of Chesapeake Bay only rare individuals carry one eyespot. Thus northern *pegala* and *maritima* Edwards become indistinguishable, except by locality label. In Florida and southeastern Georgia *abbotti* very rarely shows a trace or more of the second eyespot on the males. This mark always is present on the females.

Perhaps one of the most telling differences between *pegala* and *abbotti* is habitat. The Fabrician species is associated with coastal and fluvitile sedge marshes. *abbotti* inhabits xeric grasslands in and at the edges of the woods.

Clark's (1951, pl. *2* figs. *h, i*) figures of *pegala* are of that taxon. Holland's (1931, pl. *26*, fig. 18) figure of "*pegala*" represents an aberrant female *abbotti* which lacks the anterior eyespot of both trios on the under side of the hind wing.

Cercyonis pegala abbotti NEW SUBSPECIES

Male: Radius of left fore wing is 32 mm. Upperside: The light field in the limbal portion of the forewing is a slightly orangy yellow. It extends from the radius to just beyond the anal vein. Between M_1 and M_2 there is a small eyespot—a dark circular band surrounding pale shining blue scales centered with a white point. The amount of blue and black scales in this spot varies among the syntypes. On the hind wing there is a trace of an eyespot in Cu_1-Cu_2—a tiny black dot surrounded by a narrow burnt orange ring. On other syntypes this spot ranges from lacking to 2.5 mm in diameter. It may be wholly black except for the ring or it may be almost entirely shining blue with the ring.

On the under side the fore wing pattern is repeated with the eyespot somewhat larger and the ground color lighter and irrorate with short dark lines. On the hind wing there are two groups of three eyespots, rarely only two in one or the other or both groups, set in a small brown field. On *pegala* these eyespots are in an irrorate field. The anterior trio is composed of elongate spots, sometimes so strongly so that the blue "pupil" is linear. The posterior spots are more nearly circular on specimens before me.

Female: Radius of left fore wing is 35.5 mm. The ground color is slightly greyer than on the male and there is an additional eyespot in Cu_1-Cu_2 on the fore wing. Occasionally there is a trace of a spot in M_2-M_3 on the hind wing. Under side as in the male with the additional eyespot on the fore wing.

Holotype: (Fig. 1) A male in the Carnegie Museum, Pittsburgh, Pa. labeled "Chipley/Florida" in manuscript, "Markoff Coll'n./Carn. Mus./Acc. 8992" a printed label, and "Cercyonis/pegala/Fabr." in manuscript.

Allotype: (Fig. 2) A female in the Carnegie Museum with identical labels to those on the male.

Paratypes: Four males and two females with the same labels as the holotype.

Other specimens of *abbotti* have been seen from the northern half of Florida and from southeastern Georgia.

I suspect that sibling species may be involved in the complex now lumped under *pegala* in the East. It would be worth investigating the life histories of the woodland versus the meadow forms. It should be born in mind that the descriptions of mature larvae of *pegala alope* presented by Edwards in 1882 (B.N.A. 2:[263–5], Satyrus II, III) and Boisduval and LeConte's ([1834], p. 228, pl. 59) larva based on Abbott's original plate are sufficiently different to represent different species in this genus. The figure (p. 59) called *alope* by Boisduval & LeConte is a good one of *abbotti* and matches Florida material.

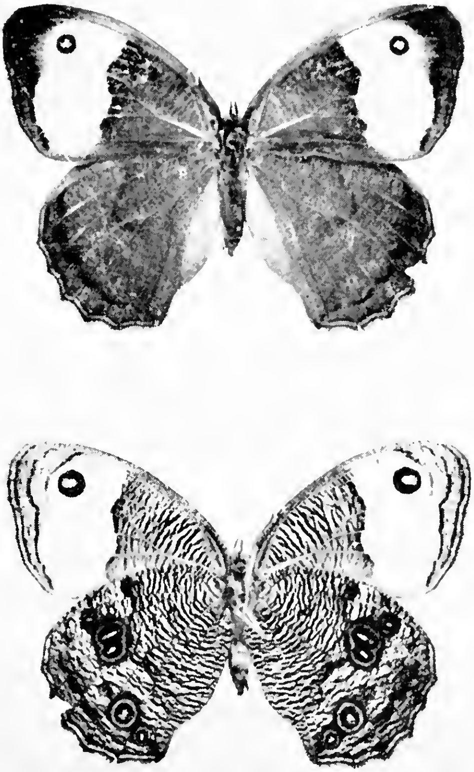

Fig. 1. Holotype, ♂, of *Cercyonis pegala abbotti*, new subspecies.

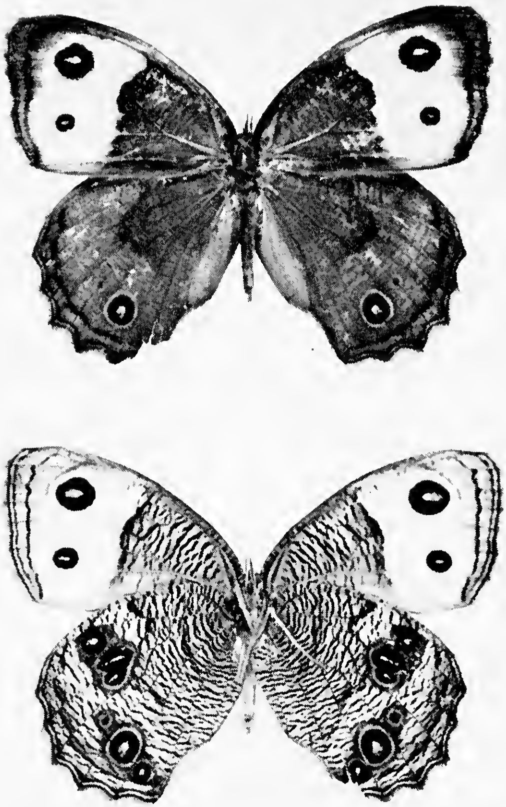

Fig. 2. Allotype, ♀, of *Cercyonis pegala abbotti*, new subspecies.

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ENTOMOLOGICAL NEWS

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THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS

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STORAGE AND RETRIEVAL OF INFORMATION FROM INSECT SPECIMENS[1]

Ross H. Arnett, Jr.[2]

The crux of taxonomy is the name of the organism, for with it, whether accurately or inaccurately determined, one stores, associates, and retrieves information. The name, therefore, serves as the turnstyle, and often the bottleneck, of information flow. Taxonomists long ago devised their own rigid system for uniformly storing information for easy retrieval, i.e., the binomial system of nomenclature. The storage procedure is controlled by the generally accepted International Code of Zoological Nomenclature (hereafter referred to as the Code). The *only* bridge between the system and biological data is the type specimen, the holotype, the lectotype, or the neotype.

Much confusion in the presentation of taxonomic data is due to the failure to conceive of the Code as an information storage and retrieval program. The program requires only name data to operate, but too frequently the input lacks accurate and detailed information associated with names and specimens, and fails to associate biological information with names correctly associated with types.

This paper deals specifically with the problems resulting from the use of insect specimens stored in collections as a source of information. I hope that it will stimulate improvement of collections and the more critical use of the data obtained from them.

The procedure discussed below concerns three stages termed: input, flow, and output. Input is concerned with the gathering and processing of taxonomic documents. Flow involves the sorting and storage of these documents through the use of names and type specimens. Output from the properly functioning system returns these information documents associated with the correct name. Systematists then use this information.

Today's possibilities for scientific crescendos through information storage and retrieval using data processing machines makes it imperative for one to understand some of the theory and nature of information storage. This introduction is not intended to be a source for storage and retrieval

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technique, but rather a discussion of the nature of insect specimens and associated data in terms of modern information theory. Because the systematic entomologist depends upon others for many of his data, the validity of the information he must use should be examined.

THE PROBLEM

Errors in labelling, distortions through preservation, and lack of detailed data aossciated with the specimens, contribute errors in systematic studies. An awareness of this will serve to improve the recording of data in the future as well as to help the proper handling of existing information. Due mainly to the requirements of the Code, taxonomists are prone to publish too much information too quickly, well before it has been processed sufficiently for use by others. Therefore, a large amount of erroneous information may be passed from publication to publication as fact, for the Code has no article that requires that published information be demonstrable as fact! A statement printed on a locality label and attached to a specimen is not sufficient evidence of data validity.

Two terms are frequently used as if they were synonyms: data and information. Data pertains to facts or statistics, either historical, or derived from calculations or experimentation. Data may be processed in a computer and retrieved in a form that differs from that stored. Information refers only to documents communicated or received concerning a particular fact or circumstance. Information is stored and retrieved without change. We are concerned here only with information processing.

The scientific method requires that observations and experiments be repeatable. This means that, barring catastrophies of nature and man, samples of extant species, and information associated with these samples can be re-gathered by anyone given the proper circumstances. Failure to gather these data does not necessarily invalidate the original data. It may mean, however, that the original information was too scanty to meet scientific requirements. The time now has come for the development of a set of standards for acceptable specimens and associated data. Specimens not meeting these standards should be disregarded except under unusual circumstances.

Input.—Taxonomic input information consists of documents in the form of specimens, label data, observational and experimental data either associated with specimens or with names, and published information compiled from these data, the "raw" data of taxonomy. These are taken in order for further study and consideration to lead to a better system of information storage.

Single specimens in a collection have a 50% chance of having incorrect labels. Even a series of specimens bearing exactly the same label data may be incorrectly labelled. With the collection of two or more specimens in a single locality, one fact is established: some morphological variation of the species. When still more samples have been gathered in the same locality by the same person or different persons at other times or during the same season of other years, the chance of incorrect labelling is insignificant. Once the same species has been collected at other localities, the validity of the theory of the existence of the species is established.

Traditionally, collecting is a random but biased procedure. Seldom has the taxonomic entomologist set out in advance to discover the distribution of a population or a species. This is, like labelling, another weak part of our information gathering system because we are willing to accept the data we have. We grasp these meager data and rush them to the printer to be recorded as a taxonomic "first" without consideration of their true significance! Carefully planned collecting would improve even the first stages of taxonomy.

Insect specimens, to be scientifically useful, should represent samples of a breeding population or deme. This cannot be determined at the time of their capture, but if properly preserved and associated with the required data, this may make possible the determination and circumscription of the population at least as it existed for a particular period of time, recognizing, of course, the ebb and flow of populations. The addition of the collecting date tells others that the particular stage occurs during a particular season. The addition of the collector's name could lead the user to other records by the association of the collector with the specimens. Such records should be directly tied into the data label by reference, so the collector's name becomes more of a bibliographic citation than one of historical interest.

Unlike other scientists, insect taxonomists depend almost entirely upon stored preserved specimens. They rarely work with living cultures either in the field or in the laboratory. There are no insect zoos, no "type cultures," and no surveys of the "vanishing herds." It seems logical to assume that great scientific progress could be made if living material were included as an information source. Further consideration of this is beyond the scope of the present analysis except insofar as it explains the need for specimens.

Certain fields of organismic investigation no longer depend upon stored specimens except under special conditions, because these groups can be recognized to species and even deme without the study of preserved material. Birds of many species can be observed and accurate reports made without the need to collect and preserve specimens. Many other groups are well enough known so that experiments, as with many vascular plants for example, may be performed without the need to first work with the preserved specimens. In some groups, such as bacteria, stored specimens are of little value and the specialist must depend upon descriptions. One can use a manual or a similar source for the correct identification of the species of well known groups, as in the case of many economically important species. The information obtained from these observations or experiments is then stored for later retrieval by calling for the information by scientific name only. It follows then, that the primary reason for storing information in the form of specimens is to study the morphology of the species so that observational and experimental data may be associated with a species. Once a group is well enough known taxonomically this is no longer necessary.

Flow.—The processing of the information documents, or the flow of information through the system, involves the indexing of these documents. Taxonomists do this by making identifications. They use as the point of reference the holotype specimen, or its substitute. Through this name association, the documents are stored and retrieved.

Once a specimen has been accurately identified, thus providing a name, the most important step in the preparation of information storage has been completed. Accurate means should be devised to positively associate individual specimens with information because identification errors are made and the concept of the species involved may change. If data and specimens cannot be associated individually, the data are useless. This is true of any system. The need for a standardized format for information association has become acute. As the volume of data mounts, a higher percentage becomes inaccessible.

Output.—The system returns information documents only by the correct use of the name as the index. The information retrieved describes the variation, distribution, and biological knowledge about the species. Several uses of retrieved information have been pointed out previously (Arnett, 1967a). These are repeated here with the hope of encouraging a more general awareness of the need for this kind of information.

1. *Holotypes and topotypic populations.* A single specimen, we have concluded previously, does not provide enough information for scientific treatment. Holotype specimens are no exception and it has never been claimed that they served anything other than nomenclatural purposes. This being so, there seems to be no valid scientific reason for continuing to treasure poor holotypes, and there is no practical reason why neotypes should be restricted to replacing lost or destroyed holotypes, while retaining useless originals. As the taxonomist attempts to associate data with

names he may find a hopeless impass because the holotype does not provide the needed data.

Accepting the premise that the scientific method requires repeatability, it follows that specimens of extant species should be recoverable from the field. One way to demonstrate this is to match holotypes with specimens from the field. If, for example, a holotype lacks specific locality information, but can be matched with specimens from a restricted locality, that is, it agrees almost exactly with another variant so that there is little doubt that the extant deme represents a breeding population containing the same variants as the holotype, that population may be regarded as topotypic regardless of whether it is now at the same locality as it was when the holotype specimen was collected. Specimens studied from that population may then supply biological information attributable to the holotype. With these as the anchor for the name, it is a simple matter to continue studies on related populations to help understand the variation and perhaps even the speciation of the group.

Further study of the area surrounding the restricted "topotypic" population, and the gathering of information about these areas may serve to circumscribe a breeding population. It follows that by so doing, other such populations may be circumscribed, making possible the study of isolates if such exist. The holotype then serves as the link between biological data and the information storage and retrieval system.

2. *Variation, distribution, and biological information.* From the input information now associated with the proper species, detailed records of host, habitat, and habits for each sample may add valuable data to show variations within a single population: seasonal, genetic, environmental, and other variations.

Habitat descriptions that include weather data, altitude, slope, vegetation, and other information about the effective environment may be useful not only for the specimens collected at the time of the visit, but for the association of other collections made at other times when these details were not noted.

Information output is reused, added to, and stored back into the system. It is superfluous to say that the proper association of data and species is of paramount importance in the success of any information storage and retrieval system. It is not superfluous to emphasize that the only purpose of the Code is to provide an efficient program for the storage and retrieval of this information. Once a less cumbersome system has been devised, the Code is obsolete. Such a system is at least theoretically possible, so the Code is at least theoretically obsolete. We should work to develop a new system before someone else does it for us (see Mittman, 1968, for a possible system).

NEW METHODS POSSIBLE

Storage and retrieval of information documents can be easily and cheaply computer programmed. Several programs are now available. We could formalize a program for insect label data, but only when some general agreement has been reached with a large body of our taxonomists. Methods have been devised for the rating of the efficiency of an information storage and retrieval system (Lancaster, 1968). We are learning that no existing system is 100% efficient, but the gaining of the last few percentage points to make a system 100% efficient are too expensive in time and money with too little significance in results to make them a worthy goal. The trouble in the past has been in attempting to establish absolute priority for names thereby implying 100% retrieval. The Code has only recently relaxed this requirement by providing for the use of some names that may not be the oldest for the species.

The ability to store information in a system using computer equipment opens the way for new techniques and changes our views on many traditional procedures. For example, one of the primary reasons for the publication of data by printing is to file them in the libraries of the World where the information may be readily and rapidly retrieved. Here these data lie waiting to be used. In such cases it is doubtful if there is even a 1.0% retrieval. However, when the same data are stored in a central bank, if the one "copy" is used once, 100% retrieval is achieved. Time delay disappears once the user is hooked into a chain of data banks. Such a chain will become a reality soon. Thus, it is no longer necessary for many kinds of data to be reproduced by printing. This applies to much or all of the data recorded on insect data labels.

Many branches of biology have been able to quantify working data through the use of various measuring and recording instruments. Little attempt has been made to do the same for data associated with insect specimens. Although insect collections still bear the classical three-line data label—the place, the date, and the collector's name, some improvement has been made by a majority of collectors since the early 1940's. They have been careful to record localities more precisely, and most have included information that might be termed "ecological," but little else. Because of the requirements of the Code, specimens have "historical" value, so most specimens, once information about them has been recorded in print, must be kept regardless of their condition or sparsity of data.

Storage of undigested raw data as printed matter is wasteful. For example, the mere listing of locality records from insect specimen labels, arranged alphabetically or geographically, is still raw data. When printed and stored, ready for use by the next researcher, it is he who must do the actual research by interpretating as best he can the significance of the data. Lists of temperature recordings taken during some physiological experiment are comparable data and would not be published. We forget that we write primarily for the use of the non-specialist, not the one other specialist on our group. The work should be done for the user, not as a mere appraisal of the current status of the research, but as a finished working tool. The progress reports can be better distributed to the specialists. However, if a list of collecting sites is recorded, especially when it tells others the season during which to collect, what to expect, and provides information about the habitat, then a useful contribution is made.

Original descriptions and first revisions are information compiled from specimens and label data. These data are certainly most suitable information for punch cards or tape storage. The method of storing data is presently governed by the Code, but this need not be restrictive, for the Code is vague in its wording on this matter, and its writers were not considering the changes brought about by computer technology (for a discussion of how information may be treated validly under the Code and at the same time prepared for punch card storage, see Arnett, typescript on "Data Documents").

Endless amounts of information might be gathered and prepared for storage. A simple means of storing this might be to prepare a punch card for each information class, the cards coded to species and type of information. Arranged and stored, these may be changed at any time and are available for immediate printout. The following list suggests several information classes, some of which might be further subdivided:

1. Species card with classification code.
2. Preserved specimen (as individuals) cards keyed to lot records.
3. Literature reference cards (for taxa).
4. Locality data cards.
5. Field record cards.
6. Experimental data cards.
7. Measurement (individual) cards keyed to 2, above.
8. Ecological information cards (this item can be broken into many parts).
9. Photograph record cards keyed to 4 and 5 above.
10. Literature reference cards for ecological data and other information.
11. Cards showing the collection in which each vouchered specimen is stored, also keyed to 2 above.

The format for these cards, and indeed, the entire system, is being studied in several laboratories (Arnett, 1967b) to devise a functional arrangement.

Unfortunately little information on associated data other than that obtainable from the "standard" locality label is readily available with most collections. Some collections, particularly those closely connected with projects of an economic nature, have lot record systems so that many specimens have an abundance of associated information. Without doubt a great amount of data not keyed to the specimens is available from individual collectors. If collectors would prepare these data for distribution with loaned specimens, their research value would be increased greatly.

Meanwhile our current system should be reexamined for deficiencies. Some of the most obvious are summarized here with the hope that future records will be improved.

1. Lack of accurate locality information is a major deficiency. Enough information should be available so that one might return at any time to the exact collecting site to obtain additional specimens.

2. Since much more material is collected than is used by the collector, care should be taken to make sure information is gathered to render the specimens useful to others. For example, host records may be needed, and without them the specimens are merely useless additions to an already bulging collection. I believe these are often described as common "trash." Yet such material might be turned easily into valuable information records by the simple addition of the proper data.

3. The need for enough information so that the observation can be repeated has been mentioned already. The lack of these data is as frequent as the lack of precise locality data.

4. Observers fail to record in notebooks or by photograph many readily available information bits that might easily enrich a storage bank, not only by adding to the file on the particular species under study, but for other species as well. For example, ecological information on a type locality might be valuable data for use in sharpening the concept of the species even if additional specimens were unavailable at the time the observations were made. One should never presume that the information he may record is already available.

The continued collection of light attracted specimens, and similar mass collection procedures will serve as a valuable source of information for some time to come. Most of the specimens borrowed from the collections will be samples of this nature. With the modern techniques of information storage and the easy means this provides for retrieval, it seems clear that more detailed data will be associated with a greater percentage of material, readily available to all, in the very near future.

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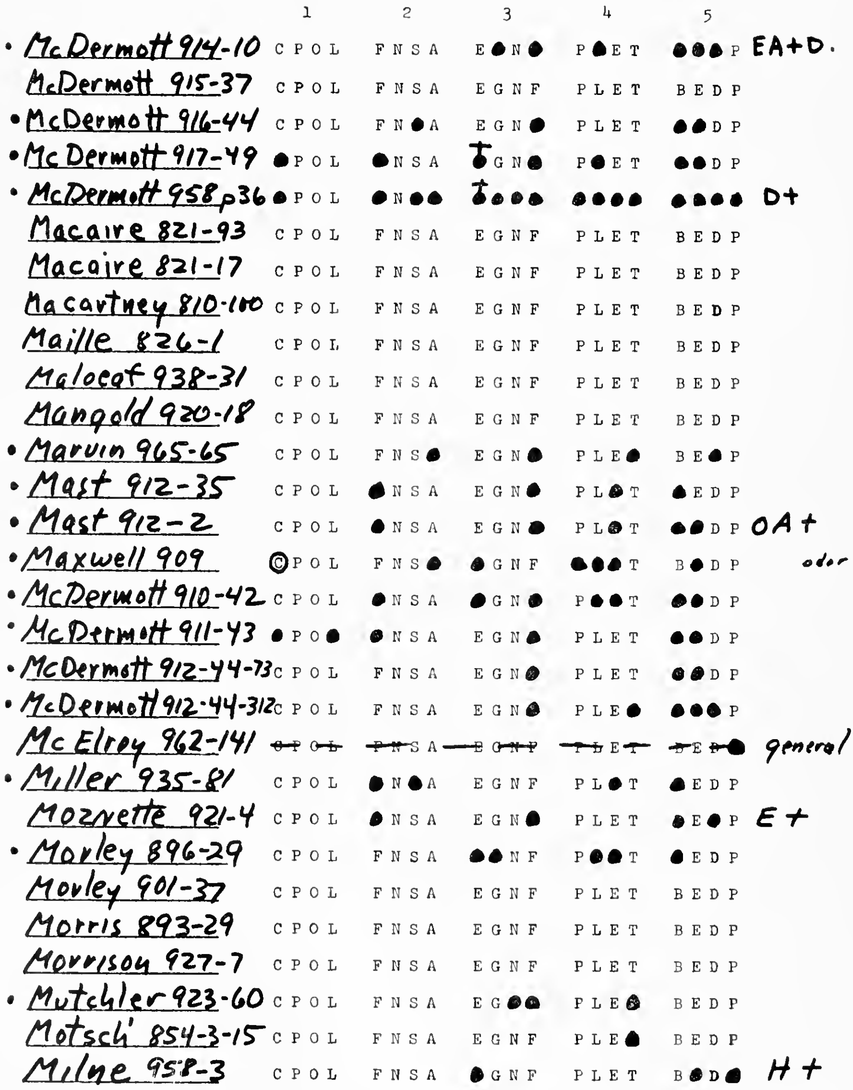
The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

A paper "computer" for Entomologists with limited recall.—From time to time I find it necessary to locate in once-read and since-forgotten articles information dealing with fireflies or other luminescent organisms. For the retrieval of this information I use what essentially amounts to a multiple-drawer card file housed in a single notebook. Since I started using this system my memory has given me much less trouble or concern. In addition to its data retrieval potential, the main advantage of this "paper computer" is that once in operation it requires but a modicum of attention to keep it going. This system has distinct advantages over notched card systems: it does not cost several cents per citation, or several dollars for a puncher; cards aren't turned, stacked, poked, shaken, restacked or bent out of shape; when entering data there are no annoying snaps or pops to acoustically stimulate irritable librarians; and the completed data storage file can be Xeroxed for insurance or by students who wish to take it along when they leave for positions elsewhere.

Figure 1 shows a sample page from the notebook. It contains 29 references and adjacent to each are 20 code letters, each of which represent some aspect of luminescent organisms in which I am interested and wish to isolate for retrieval. The first entry is interpreted as follows: McDermott in 1914 in volume 10 of some journal (a single master card file on 5″ × 8″ cards gives the complete citation) published an article that deals with (right-hand *margin*) Elateridae (E), Annelida (A), Lampyridae (+) (if no letters appear in this margin the article deals only with Lampyridae), Diptera (D), and Phengodidae (P). The black dots indicate the following: glowing (G) and flashing (F) lampyrids are discussed, larvae and/or lifecycles (L), behavior (B), evolution and/or function (E), and distribution and/or zoogeography (D). Other categories not marked for McDermott's paper include taxonomy (T), Ecology (E in letter group 4), physiology/biochemistry (P in letter group 4), flight and light emission in adults (F in letter group 2), and reproductive isolation (L in letter group 1). Small embellishments of the dots permit more subtle coding distinctions. For example, the dot with the cross over it that appears over the E in letter group 3 (predator/prey) indicates aggressive mimicry/cannibalism. A small dot to the left of an author's name is part of another reference system and indicates the entry of this reference on the "species cards" of all the species discussed in the article. Articles not read are immediately apparent since no code letters have been marked. It is not necessary that the authors' names be in alphabetical order since they are so arranged in the master card file.—JAMES E. LLOYD, *Department of Entomology, University of Florida, Gainesville, Fla. 32601.*



	1	2	3	4	5	
• McDermott 914-10	C P O L	F N S A	E ● N ●	P ● E T	● ● ● P	EA+D.
McDermott 915-37	C P O L	F N S A	E G N F	P L E T	B E D P	
• McDermott 916-44	C P O L	F N ● A	E G N ●	P L E T	● ● D P	
• Mc Dermott 917-49	● P O L	● N S A	†● G N ●	P ● E T	● ● D P	
• McDermott 958 p36	● P O L	● N ● ●	†● ● ● ●	● ● ● ●	● ● ● ●	D+
Macaire 821-93	C P O L	F N S A	E G N F	P L E T	B E D P	
Macaire 821-17	C P O L	F N S A	E G N F	P L E T	B E D P	
Macartney 810-100	C P O L	F N S A	E G N F	P L E T	B E D P	
Maille 826-1	C P O L	F N S A	E G N F	P L E T	B E D P	
Maloeaf 938-31	C P O L	F N S A	E G N F	P L E T	B E D P	
Mangold 920-18	C P O L	F N S A	E G N F	P L E T	B E D P	
• Marvin 965-65	C P O L	F N S ●	E G N ●	P L E ●	B E ● P	
• Mast 912-35	C P O L	● N S A	E G N ●	P L ● T	● E D P	
• Mast 912-2	C P O L	● N S A	E G N ●	P L ● T	● ● D P	OA+
• Maxwell 909	© P O L	F N S ●	● G N F	● ● ● T	B ● D P	odor
• McDermott 910-42	C P O L	● N S A	● G N ●	P ● ● T	● ● D P	
• McDermott 911-43	● P O ●	● N S A	E G N ●	P L E T	● ● D P	
• McDermott 912-44-73	C P O L	F N S A	E G N ●	P L E T	● ● D P	
• McDermott 912-44-312	C P O L	F N S A	E G N ●	P L E ●	● ● ● P	
Mc Elroy 962-141	~~C P O L~~	~~F N S~~ A	~~E G N F~~	~~P L E T~~	~~B E D~~ ●	general
• Miller 935-81	C P O L	● N ● A	E G N F	P L ● T	● E D P	
Moznette 921-4	C P O L	● N S A	E G N ●	P L E T	● E ● P	E+
• Morley 896-29	C P O L	F N S A	● ● N F	P ● ● T	● E D P	
Morley 901-37	C P O L	F N S A	E G N F	P L E T	B E D P	
Morris 893-29	C P O L	F N S A	E G N F	P L E T	B E D P	
Morrison 927-7	C P O L	F N S A	E G N F	P L E T	B E D P	
• Mutchler 923-60	C P O L	F N S A	E G ● ●	P L E ●	B E D P	
Motsch' 854-3-15	C P O L	F N S A	E G N F	P L E ●	B E D P	
Milne 958-3	C P O L	F N S A	● G N F	P L E T	B ● D ●	H+

FIGURE 1. A sample page from the data storage notebook.

Habitat Selection of Laboratory Populations of Tribolium [1]

MICHAEL T. MORGAN, O.S.B.[2]

PART I: REVIEW OF THE ECOLOGY OF FLOUR BEETLES

The effect of ecological factors, such as temperature, humidity, food and light on the metamorphic changes in mutants of two species of the flour beetle, *Tribolium castaneum* (Herbst) and *T. confusum* (DuVal) were investigated in this study. Of these factors, temperature and humidity were of prime importance since they greatly influenced the development of each metamorphic stage of the insects. The temperature preference of each stage was noted and recorded.

The three mutants of *T. castaneum*, "Jet," "Sooty," and "Pearl," followed a uniform pattern in temperature gradient analyses. The successive metamorphic stages from eggs to pupae were found to develop progressively from cooler to higher temperatures. The adults of all mutants of *T. castaneum* preferred a temperature lower than that at which pupae were to be found.

In *T. confusum*, the "Black," "Ebony" and "New York" beetles followed a different pattern from that of the mutants of *T. castaneum*. Both the eggs and larvae of these two beetles were found in a closely related mean temperature. The pupae and adults were found at a higher temperature than were the eggs and larvae. However, there was little difference between the preferred temperatures for pupae and adults. The mutant "Ebony" of this species followed a pattern similar to that for *T. castaneum* mutants in that there was an increase in temperature preference from eggs to pupae. As for *T. castaneum* mutants, the adults of *T. confusum* also preferred a lower temperature than that of the pupae.

Egg and pupal development among the mutants of both species were distinct in regard to temperature preferences. Egg deposition proceeded at a higher temperature in beetles of *T. confusum*.

The adult mutants of *T. castaneum* have a lower mean temperature preference than the beetles of *T. confusum*. The larvae of the mutants of *T. castaneum* developed at slightly higher temperatures than those of *T. confusum*.

It was determined from this investigation that a relative humidity lower than 70 per cent, in a temperature gradient ranging from 14° to 40° C, was

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a factor that accelerated the growth of *T. confusum* and retarded the growth of *T. castaneum* mutants.

No attempt was made to study the effects of food and light in any great detail.

INTRODUCTION AND HISTORICAL BACKGROUND

The wild types of the confused flour beetle, *Tribolium confusum* (duV.) and the red-rust flour beetle, *Tribolium castaneum* (Herbst) are destructive because they infest flour and other prepared cereal products. These insects are cosmopolitan in distribution and reported from almost every civilized country in the world. *T. confusum* is the more common pest in temperate regions while *T. castaneum* is a subtropical insect (11). The life cycles of the two parent types are well known. The time periods required for the development of various stages in the life cycle are as follows:

	Egg Stage (days)	Larval Stage (days)	Pupal Stage (days)	Total No. Days (to adulthood)
T. confusum	5.5	22.4	7.0	34.9
T. castaneum	3.8	22.8	6.2	32.8

From the data obtained from Good and Park several norms have been established, viz., 1) The life cycle of *T. castaneum* is shorter than that of *T. confusum;* 2) The life cycle for both species is shorter at higher temperatures; 3) The established period of time necessary for both *T. confusum* and *T. castaneum* to pass through their metamorphic cycle is roughly about one month at 29° C, but *T. castaneum* reaches maturity first. Environment factors affecting growth and development are temperature, humidity, and available food supply (11) (26).

Thus, the economic importance, worldwide distribution of the genus *Tribolium*, and the ease with which its natural habitat can be constructed under controlled environmental conditions make *Tribolium* spp. appear an important, practical and workable tool for studies of the geneticist and ecologist.

The genetics of *Tribolium* has been investigated by Sokoloff (32) Since the work reported here is primarily concerned with ecological factors, the review of literature will present only the background on these factors, such as light, temperature, humidity, water, food, and the general habitat.

Light: Light is a factor in the metamorphic cycle of *Tribolium* spp., but because of insufficient research, its importance cannot be established with any degree of certainty. Under laboratory conditions it was obvious that the adults are photo-negative; i.e., they are found loosely clustered in shaded portions of a container when subjected to direct light (16). Uncomfortable or undesirable temperatures and humidity will cause *Tribolium* spp. to move from the food medium into light but for the most part the beetles can be maintained indefinitely in complete darkness according to Chapman (5). Erdman studied the effect of X-Ray beams on these beetles to determine the sensitivity of *Tribolium castaneum* and *Tribolium confusum* at different stages in their life cycles. Also the destructive effects of X-Ray treatments have on *Tribolium* spp. has been investigated. A variety of wave lengths of the spectrum are being studied, but to date the flour beetle has not been subjected to their rays in a manner that could measure wave length effect on the organism.

Temperature and humidity: Early work on wood-ants by Herter (15, 16, 17) was conducted in an apparatus called a "Temperatureogel." Unfortunately the temperature gradient within the cage of the Temperatureogel varied with the room temperature. Some investigations of Bodenheimer and Schenkin (1) were undertaken with an apparatus similar to the one used by Herter. They repeated Herter's earlier experiment with the "flour weevil" *T. confusum.* They found that the beetle preferred a temperature of 24.7 to 26.5° C. if previously kept at a temperature of 15 to 18° C. However, beetles kept for a month in a constant temperature of 25° C preferred a zone between 9.11 and 10.74° C.

Following this early work several studies were made in the ensuing years of the relationships of temperature and humidity, the effect of constant and alternating temperatures, and the influence of temperature gradients on development of the various stages of *Tribolium.*

In 1930 Brindley (2) studied growth and development in *T. confusum* under controlled conditions of temperature and relative humidity. He used a temperature of approximately 30° C with a relative humidity of 73%. Under these ecological conditions he studied the weights and sizes (length and width) of 3 stages, namely, adults, larvae, and pupae. He also counted the number of eggs laid, as well as their length and width. From his observations the life cycle was found to be completed within 29 days at 30° C and 73% relative humidity.

In contrast to Brindley's findings, a Polish worker, Mikulski, (24) found errors in studies carried out at constant temperatures. In 1936 Mikulski studied the effect of constant and alternating temperatures on the survival of some developmental stages of *T. confusum.* He quoted Shelford (31) as having noted that different temperatures can have a different influence on an organism. Mikulski asserts it is an error to use a mean daily temperature as an index of the effect of temperature on development. Mikulski concluded that constant temperatures retarded development. Therefore, his experiments were undertaken to show the influence of alternating temperatures on survival and development, particularly with reference to (a) the mean temperature at different points on the thermometric scale, (b) the amplitude of the change of the temperature; (c) temperature limits. At extreme temperatures, i.e., in very low or very high temperature ranges, the behavior of the organism deviated from those expected for medial temperatures. For example, with a rise in temperature the rate of development increases up to a point, after which it decreases again. Mikulski concluded that *T. confusum* is a stenothermic animal, having a narrow, favorable thermal range which differs for each developmental stage and that this thermal range is better expressed by differences in survival. The optima are also slightly different, when comparing the constant and alternating temperatures. It is different for eggs and pupae. There is quite a narrow range in which development rises above 50%. For eggs this range lies above 25° to 30° C. At 32.5° C, 80% of the pupae survive. At a temperature of 22.5° C pupae developed well. 29.82% of the pupae survived at 22.5° C while only 25% of the eggs survived. Mikulski (24) found eggs of *T. confusum* and *T. castaneum* to be less resistant to constant temperatures, but *T. confusum* has a different resistance to symmetrical alternating and constant temperatures. Mikulski seems to think that *T. confusum* is insensitive to humidity and cites Holdaway (18) as his authority. In any case, the relative humidity fluctuated between 30 and 40% in his expeirment.

Howe's (20) work appears to verify Mikulski's conclusion that *T. confusum* is insensitive to humidity. Howe demonstrated that humidity has no effect on egg development of *T. confusum* and *T. castaneum*. He showed that eggs of *T. castaneum* did not hatch at 17.5° C or lower at any humidity, and that they did not hatch at 40° C at 10% relative humidity. *T. confusum* eggs did not hatch at 15° or 40° C at any humidity, but 60% of the eggs hatched at 37.5° C while the shortest period for egg duration in this species is at 35° C. The shortest period for egg duration in *T. castaneum* occurs at 37.5° C. In *T. confusum*, larvae failed to develop to pupae at 17.5° C with 10% R.H. and failed to develop in 20° C at 10% R.H., and also failed to develop in 37.5° C at 10% and 90% R.H. *T. castaneum* larvae failed to develop into normal adults at 20° and 40° C with R.H. at 30% and 90%. The larvae of *T. castaneum* produced pupae at 20° C and 70% R.H. but they do not become normal adults. In both *T. confusum* and *T. castaneum* larval development is affected by both temperature and humidity. *T. castaneum* larvae develop most quickly at 35° C in any humidity, but preferably at the higher humidities. The fastest larval development of *T. confusum* is at 32.5° C at highest humidities. The larval mortality is greatest at 37.5° C and 10% R.H. and at 20° C and 90% R.H. *T. castaneum* larval mortality is highest in situations of low humidity and low temperature. The pupal stage of this species while not affected by humidity is shortest at 37.5° C. *T. confusum* shortest period of pupal duration is the same as that of *T. castaneum* at 37.5° C. The optimum conditions for rapid development of *T. castaneum* is between 35 and 37.5° C and greater than 70% R.H. For *T. confusum* the fastest development lies close to 32.5° C at 70% R.H. and above. The life cycle is completed in about 25 days, while for *T. castaneum* the cycle takes 20 days. *T. castaneum* can complete its life cycle in a month at temperatures as low as 30° C, and at humidities of 30% R.H. Larval mortality was greatest at low temperature (22.5° C) and low humidity (10 and 30%) as well as at 40° C, and, in general, was highest at the lower humidities. At temperatures above 35° C mortality of *T. confusum* was more than 20% at all humidities and greater than 60% when R.H. was less than 50%. Mortality rate between 15–25% were recorded for *T. confusum* at low temperature and low humidity. The lower limits for complete development was between 17.5 and 20° C except at lower humidities where it rose above 20° C.

Holdaway (18) also studied the development of *T. confusum* at various relative humidities under constant temperature conditions. He found that the egg and pupal stages were almost the same duration throughout the entire scale of relative humidity. The length of the larval life, however, was shortened when humidity was increased. From the standpoint of percent mortality, however, he found that there was a greater survival of the larvae at high humidity but a reduced survival of eggs and pupae. The larvae, therefore, have their per cent survival increased and the length of time for development decreased by an increase of humidity, while the pupae and eggs do not have the time change but have the percentage greatly reduced by high humidity. However, the greatest difficulty in experiments using high humidities was controlling the growth of fungi. This could possibly have been avoided with use of silica gel.

The next reported work on temperature and humidity requirements of the flour beetle is concerned with establishment of a temperature "range" in which the insect prefers to live and can readily survive. This can only be established for the adult form *alone*. Deal (8) used a temperature gradient since he intended to prove that insects, given a preference will choose a "range" of temperatures rather than a "point." He stated that insects previously kept in a definite temperature for a given length of time with food available or not will choose a variety of "preferred temperatures." For example, an insect kept for a period of time, let us say a month, in one area at room temperature, when subjected to the temperature gradient area, will choose one temperature range. However, when kept in an environment at 27° C for a period of time previous to being subjected to the temperature gradient, the insect will choose an entirely different temperature. In each case the insects were without food which would be a factor influencing their physiological activities, since the normal metabolic functions of the insect may be hampered and its reactions thereby slowed. Food is no less an important factor than temperatures in altering the normal body activities of insects. *T. confusum*, when kept at room temperature, showed a definite preference for temperatures between 25–30° C but could be grown in temperatures as low as 10° C. In another experiment the beetles were kept for a month at a constant temperature of 27° C prior to going into the temperature gradient. The beetles were found in higher numbers at the cold end but some were found at ranges from 16° to 30° C. The greatest number of insects were found at a temperature 12° *lower* than room temperature. It is possible that the flour beetle, if kept for a period of time in a hot, dry environment, which is not exactly to its liking, would seek out an area which would first satisfy their greatest need, which would be moisture. Deal's results might be questioned as to the validity of his conclusions regarding the actual effect of his temperature gradient. Although his gradients were series of 5° C, he allowed stored beetles freedom of choosing the gradient, then proposed an explanation for their selection of the gradient. For instance, he says it is difficult to distinguish whether the flour beetles went to the cold end of the gradient because of preference or whether they wandered into the cold zone and were overcome, or trapped, before they could get away. He further states that insects go to a certain temperature in the gradient because they are attracted by the humidity there.

Graham (12) worked out temperature-preference determinations for adults of *T. castaneum* and *T. confusum*, using a temperature gradient ranging from 13.5° C to 30° C and a relative humidity gradient of 40 to 60%. He demonstrated that *T. castaneum* had a definite preference for warm temperature, the limit for migration seldom being beyond 29° C. The limit for distribution at the colder end of the trough was 14° C. Further, Graham stated that the intensity of reaction towards 28° C or 14° C is dependent upon the environmental temperature at which the population (*T. castaneum* and *T. confusum*) was previously kept and that a colder environment initiated a more intense warm-end reaction. He found that a *T. castaneum* population from a warm environment has a markedly more intense reaction toward 28° C than *T. confusum*. However, Graham made the assumption that temperature preference for both species was a transitory matter and at best preference for a temperature in which to live or to which to migrate was characteristic only for the particular population under investigation.

Temperature preferences varied according to sex, Graham (12) found that males had a slightly higher preference for the warm end of the trough, whereas females had a greater preference for 14° C. However, Graham stated that eggs are laid in appreciable numbers only when the female was at temperatures greater than 25° C so it was assumed that ovarian activity did not affect movement throughout the trough to other temperatures. But, since eggs are laid in greatest numbers when the female is at 25° C temperature, the species (*T. castaneum*) that has a greater preference for the warm end has the greatest potential for reproduction. When the total environmental average is 20° C, *T. castaneum* would have a greater advantage for survival over *T. confusum*. Also, according to Dick (9) movement of beetles (*T. confusum*) from various temperatures on a gradient, that is, from a colder to a warmer temperature, stimulated the production of ova.

Water: Roth and Willis (30) (35) have pursued extensive studies on water balance in *T. confusum* and *T. castaneum*. They found that *T. castaneum* lost water more rapidly than *T. confusum*. The females of *T. castaneum* reverse their dry reaction more quickly than the males; in other words, females lose more water than males. In *T. confusum* the dry reaction of males is reversed more quickly and the resultant wet reaction is more intense than that of females. Although both sexes of *T. confusum* lose water at about the same rate, the females tend to maintain a higher proportion of water to solids than the males from the 3rd to 7th days of desiccation. Given a choice, *T. castaneum* in normal physiological conditions will choose a lower humidity. It is further interesting to note that *T. castaneum* can lay eggs well at very low humidities.

Habitat, Food Sources: One of the major physical and chemical factors that operates to provide the complete environmental habitat for Tribolium spp. is food. The primary source of food is based on coexistence reactions, such as "cannibalism." But these are of relatively slight nutritional importance in terms of the complete population.

The beetle, Tribolium, can accommodate and adapt itself very readily to the available food. Chittenden (7) found Tribolium in snuff, baking powder, ginger, peas and beans. He found the insect in whole-wheat flour, bleached and unbleached white flour, rye, rice and barley flours, in corn meal and in oatmeal. Good (11) reported *Tribolium castaneum* and *Tribolium confusum* living in chocolate, spices (red pepper), various kinds of nuts and even feeding on specimens in an insect collection. However, Chapman (6) found that *Tribolium confusum* were not equipped to feed on whole grains since the mouthparts were not adapted to attack large, hard pieces of food. In studying the feed preferences of Tribolium, he observed that either coarse or fine flours were equally populated by the beetles. He further observed that wheat-germ satisfied the requirements for growth and transformation. Lerner, Sokoloff and Ho (22) did a food preference study for *Tribolium confusum* and *Tribolium castaneum* using a mixture of corn flour, rice flour, soy bean flour and whole wheat flour to which brewer's yeast was added. They subjected *Tribolium castaneum* and *Tribolium confusum* to each type of flour with and without yeast, as well as a mixture. The result was that both species preferred the mixed type containing the yeast. Their next preference was rice flour and whole wheat flour. The third preference was for corn flour, and the least chosen food was soybean flour.

Sweatman and Palmer (34) were the first to make a critical study of the vitamin requirements of *T. confusum*. They found that wheat embryo added to a synthetic medium consisting of casein, salts, fats and dextrine shortened the time of development of the organism considerably (from 65 days to 28 days).

The effect of temperature increase on the moisture content of the sub-strata in a closed container has been studied by a number of workers (1) (10) (21) (29). Several workers have determined equilibrium curves for grain moisture content (air Relative Humidity). In an open system, where nearly limitless quantities of air of a uniform R.H. are available, or where excess moisture is added or removed by chemical solutions, the per cent moisture content of the grain is determined only by air R.H. The moisture content (M.C.) is nearly unaffected by those temperature changes which are not accomplished by R.H. changes (12).

Rough calculations indicate that a closed system, containing flour of a moderate moisture content exposed to a temperature of 20° C in the region of 10° to 30° will react thus:

a) When the volume of air enclosed is 200 to 400 times the volume of the grain, the grain moisture content—air R.H. equilibrium is practically unaltered.

b) When the volume of air enclosed is approximately 500 times greater than the grain volume, the moisture content of the grain and the air R.H. are held at a comparatively lower state because of the increase in the air's initially large potential for water retention.

c) When the volume of air is less than approximately 100 times the volume of the grain, the point of equilibrium is increased because the moisture released by the grain is far in excess of that which the air can retain.

Most measures of grain greater than a few grams are of necessity enclosed with volumes of air much less than 100 times the grain volume. A possible example of the closeting of grain in storage, or in the laboratory, which results in the level of the R.M.-M.C. equilibrium being *raised* when the temperature is increased (12).

With the foregoing facts in mind regarding the effects of environmental factors on parent types of *Tribolium spp.*, the present study was undertaken to determine the preferred temperature for egg, larval, pupal, and adult stages of *Tribolium* mutants. This paper reports the establishment of the temperature range of each life form of three mutants of *T. castaneum* and for two mutants and one wild type of *T. confusum* and the deviations among these mutants from characteristics of their parent type.

PART II: ECOLOGICAL VARIATIONS OF MUTANTS OF TRIBOLIUM CASTANEUM, T. CONFUSUM AND A WILD TYPE

MATERIALS AND METHODS

For these experiments, four controlled environmental factors, as recommended by Park (27) were to be investigated: 1) Light; 2) Temperature; 3) Relative Humidity; 4) Volume, kind, and surface exposure of growth medium. Oxygen supply and CO_2 assimilation were not considered as necessary controlled factors in this study.

The growth chamber apparatus consisted of a pine-veneered rectangular box, 4′ × 4′ × 2′ in height. A fluorescent light attached to the ceiling was controlled by a timing device that permitted a 12-hour light period and 12-hour dark period. A piece of plexiglass 2′ × 4′, painted black, which was readily removable afforded easy access to the incubator. The floor of the box was covered with an asbestos sheet upon which there was a lead plate 3½′ long × 2½′ wide. The leaded plate was 1″ thick and had copper tubing embedded in it at one end. Six tubes, one inch apart, were supplied with flowing ice water from a refrigerator. At the other end of the plate two heat strips were soldered to the lead plate and electrically controlled by a simple thermostat. To prevent excessive heat loss the heating strips were covered with dry, flaked asbestos. With ice water flowing through one end of the lead slab and heat being supplied at the other end, a temperature gradient was maintained which ranged from 14° C at the cool end to 40° C at the heated end. The thermostat used to control the heat could be readily moved over the surface of the lead slab. Several preliminary experiments were made to determine the proper placement of the thermostat to ensure maintenance of maximum temperature levels at the hot end of the trough.

Relative humidity was maintained with glycerol and water. A small heat strip was soldered to the base of a metal container holding a glycerol-water mixture. An electric relay was used to maintain proper heat to control the evaporation of water. The water was stirred slowly but constantly. A small fan was placed in position to circulate the moist air but which would not disturb the flour and the insects. Using a hygrometer and a wet-bulb thermometer, readings were taken three times each day to determine R.H. Adjustments were made in the glycerol-water solution to elevate or lessen humidity percentage as needed.

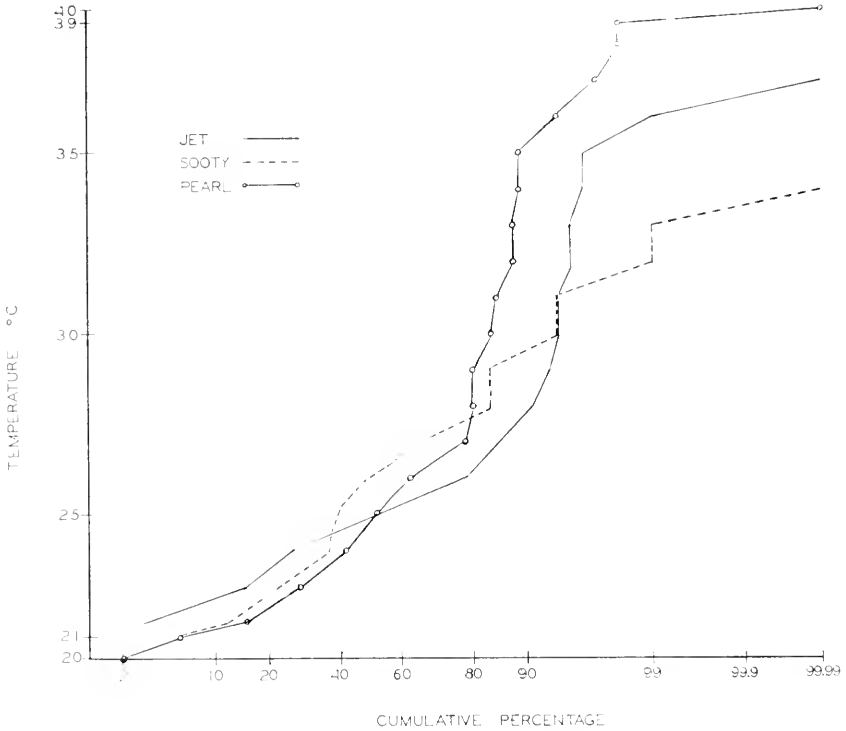

FIG. 1. Percentage deposition of eggs of three mutants of *Tribolium castaneum* at various temperatures.

When the proper R.H. was obtained and stabilized, copper food troughs less than 1 cm thick, 2″ wide and 2′ long were introduced into the incubator. Each copper trough was filled with food for the *Tribolium* spp.

This food consisted of 9 parts of unbleached flour and one part of powdered yeast. Periodic readings were made with an electronic thermometer to determine temperature gradient of food medium. For three days prior to the experiment, temperature and relative humidity were checked for reliability. The atmospheric temperature in the incubator was 27° C. The R.H. ranged from 55 to 75% within temperature ranges of 14° to 40° C with average R.H. being 60% immediately above the troughs.

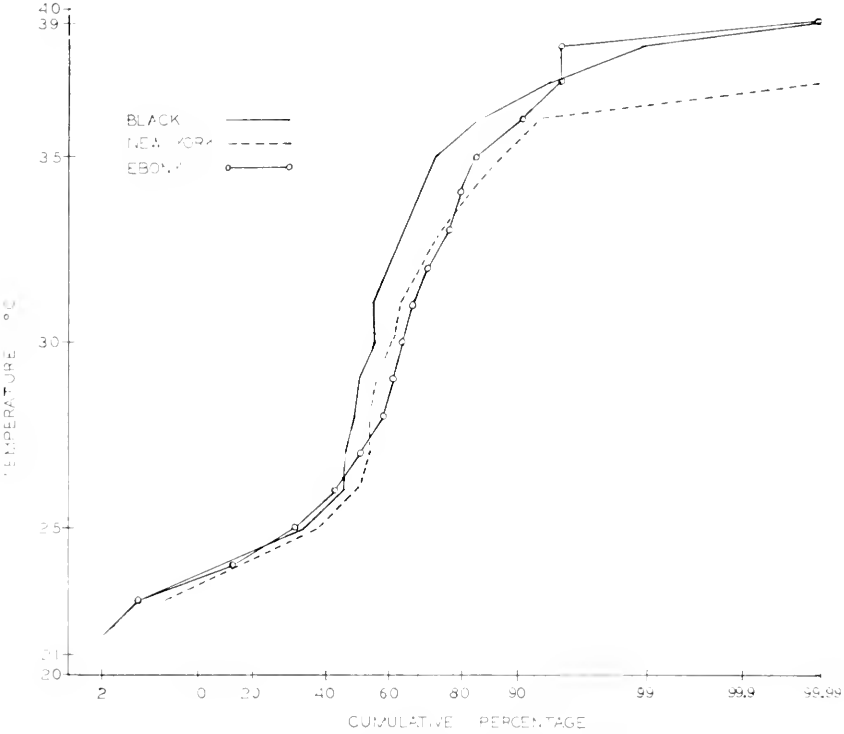

FIG. 2. Percentage deposition of eggs of three mutants of *Tribolium confusum* at temperatures ranging from 20° to 40° C.

When proper environmental conditions were established, populations of three mutants of *Tribolium castaneum* and 2 mutants and a wild type of *Tribolium confusum* were introduced in the incubator. Each genetic mutant population and one wild strain occupied a separate trough. Fifty males and fifty females comprised the initial population in each trough. After the mutants were placed in the feeding trough, the incubator was completely sealed and left undisturbed for one month.

At the end of the month flour samples from each trough were checked by means of an electronic thermometer to determine the temperature. At each degree of temperature in the food medium a sample of flour with its contents of *Tribolium* was taken with a small measuring spoon. The sample of flour was placed in a small jar. There were as many jars as degrees of temperature, each jar containing the measured flour sample. Counts of eggs, larvae, pupae and adult populations were made as follows: the contents of each jar was emptied into a sieve of No. 00 batting cloth (29 meshes/inch) which captured large larvae, pupae and adults of the insects. The small larvae and eggs were captured in a lower sieve. Using a dissecting microscope to examine the contents of the flour population in each stage in the cycle were counted.

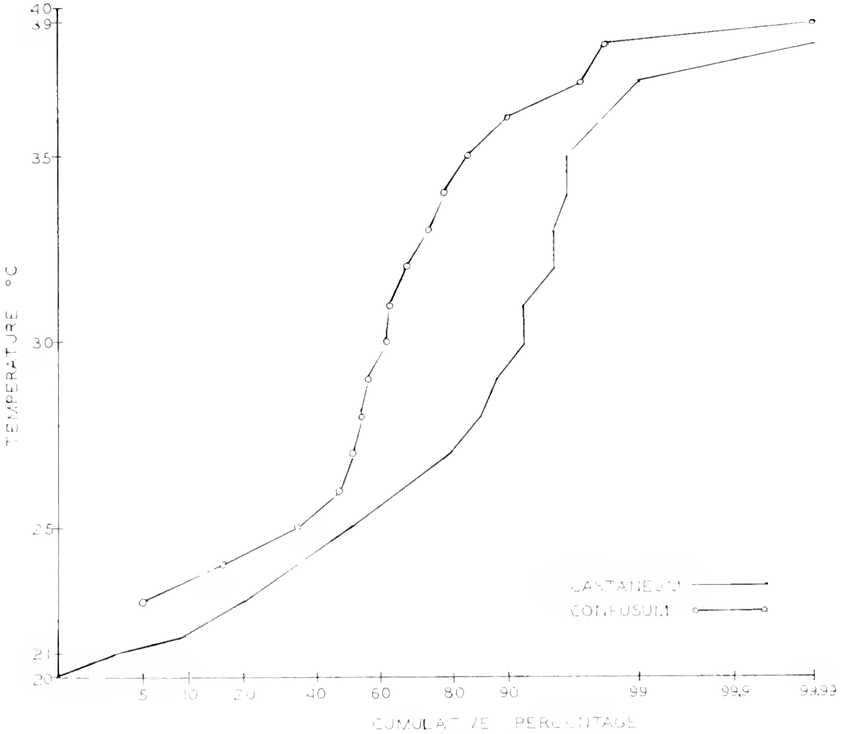

FIG. 3. Comparison of deposition of eggs of *Tribolium castaneum* and *Tribolium confusum* over a range of temperatures. Results indicate that egg deposition proceeded at a higher temperature in mutants of *T. confusum*.

This experiment was repeated three times. All conditions in each experiment were identical.

Results and Discussion

Temperature and humidity are two factors that influence the development of each metamorphic stage of *Tribolium* spp. A specific combination of these two ecological factors is necessary for the normal progressive development of each separate, metamorphic stage in the life cycle of the insect. However, temperature and humidity combinations that may be a means of acceleration for one may retard the development of another life stage.

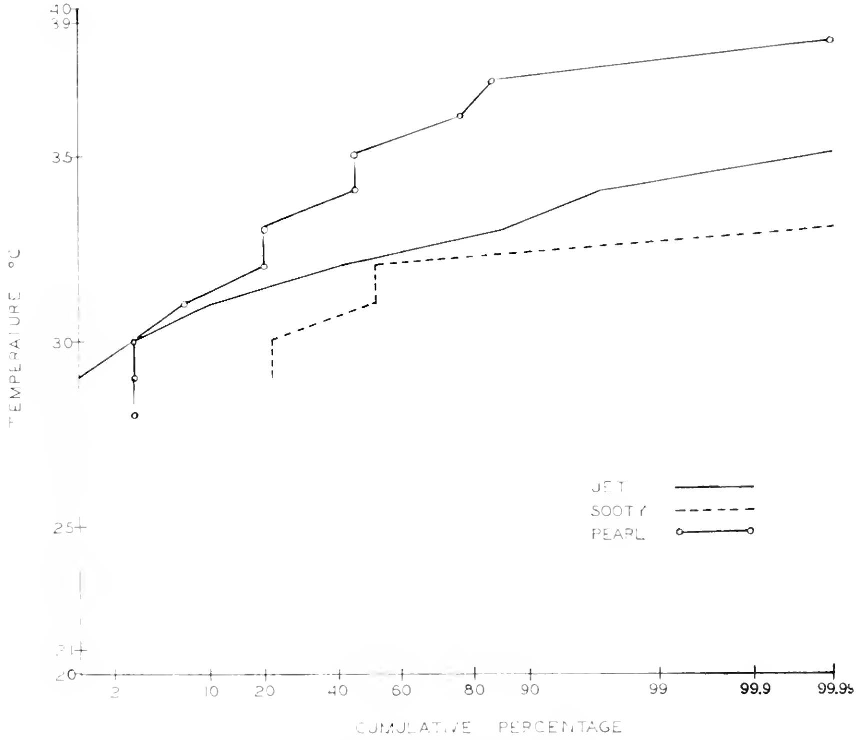

Fig. 4. Cumulative percentage deposition of pupae of mutants of *Tribolium castaneum* at various temperatures.

In this investigation humidity lower than 70%, with a temperature gradient ranging from 14° to 40° C was found to be the factor that accelerated the growth of *T. confusum* mutants and wild type strain but retarded the growth of the mutants of *T. castaneum*. All the data in this investigation were accumulated when the relaive humidity ranges from

40 to 60%. An approximate humidity of 60% was maintained throughout the investigation.

The temperature preference of the egg, the larvae, the pupa and the adult forms of six mutant beetles of *Tribolium* was the primary concern of this work. The mutants of *T. castaneum* were "Jet," "Sooty" and "Pearl." For *T. confusum* the two mutants & a wild type were selected and are identified as "Black," "New York" and "Ebony" (New York being the wild type). After a six-weeks interval from the time the adult imagoes were introduced into the troughs, data on life cycle forms found for each degree of temperature from 20° to 40° were recorded. These data are presented here.

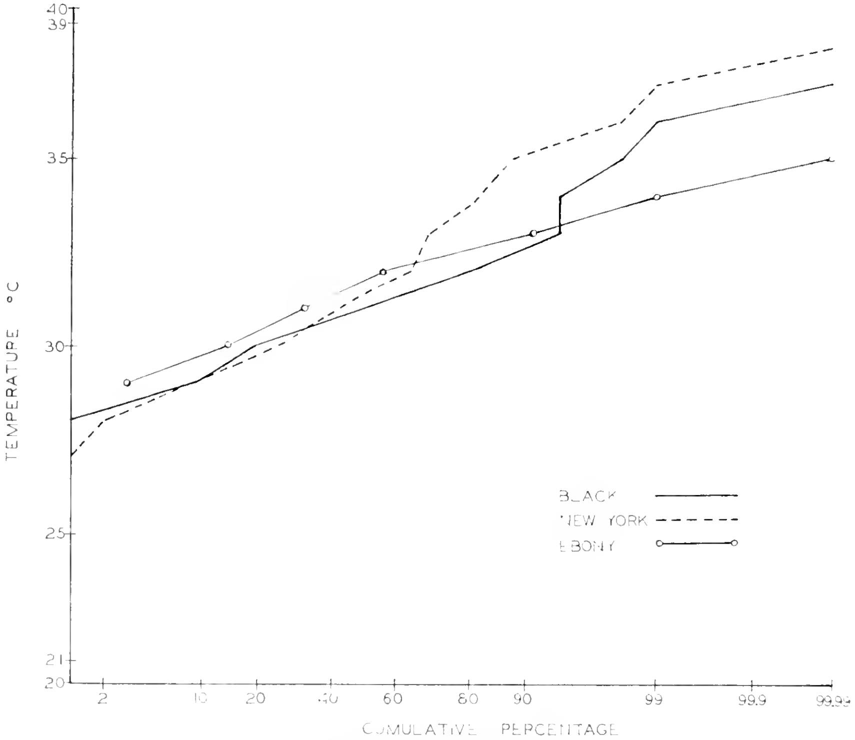

FIG. 5. Deposition of pupae of *Tribolium confusum* mutants over a range of temperatures from 20° to 40° C.

The most significant fact in the temperature-gradient analyses was found in observations on the mutants of *T. castaneum*. There was found to be uniformity of mean temperature preferences by the successive stages of metamorphosis (the egg to the pupa) but a decrease in temperature was preferred by the adult form. This was found to be true of all three mutants of *T. castaneum*.

The "Black" mutant and "New York" wild type of *T. confusum* followed a pattern unlike that of the mutants of *T. castaneum*. Both the eggs and the larvae of these two mutants preferred a closely related mean temperature. The pupae and adults of "Black" and "New York" chose a higher temperature than did the eggs and larvae but, as for the eggs and larval stages, there was but little difference between their preferred temperatures. The mutant "Ebony" of this wild type species *T. confusum* followed the pattern of the *T. castaneum* mutants with an increase in temperature from eggs to pupae. The adults chose a lower temperature than that of the pupae.

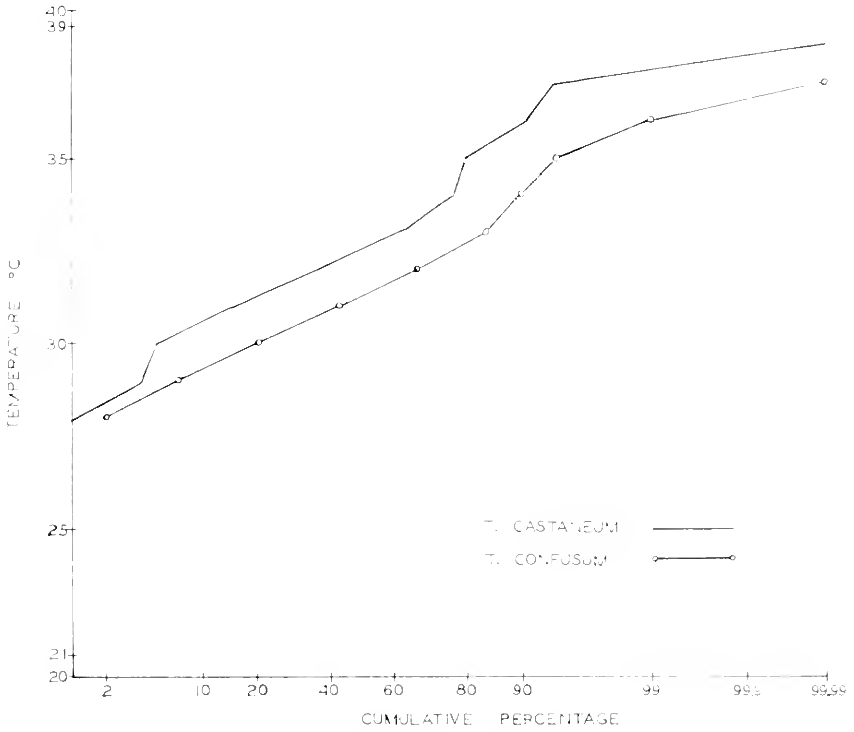

FIG. 6. Comparison of deposition of pupae of *Tribolium castaneum* and *Tribolium confusum* over a given range of temperatures shows that the pupae of *T. casteneum* prefer the higher temperature.

Temperature preferences for Egg and Pupae: The temperature preference of the eggs in relation to the temperature range of the pupae for all mutants of both *Tribolium* species is an important consideration. Egg and pupae states are immobile stages. It has been fairly well established that temperature is one of the ecological factors that determines their position *in situ*, especially for the pupae. What other factors are responsible for oviposition, other than temperature, have yet to be investigated.

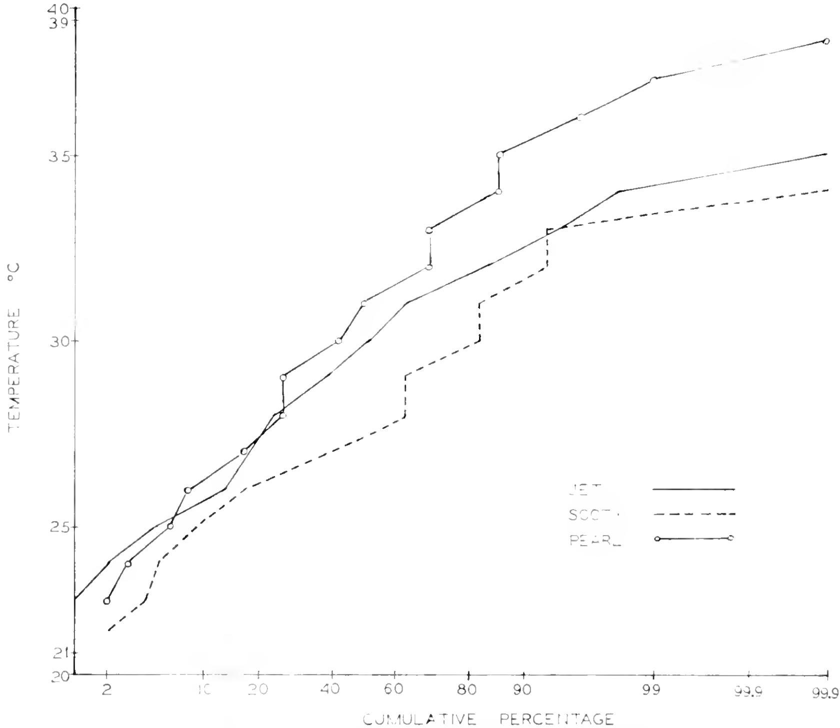

FIG. 7. Deposition of larvae of *Tribolium castaneum* mutants at various temperatures.

It would seem from the accumulated data-sheet that an analysis of their temperature differences was not necessary. There was very little overlapping of the minimum and maximum range in any of the mutants in these two stages of development. The mean temperature preference of the eggs of the mutant "Jet" was 25.82 + 2.81. The pupae of the same mutant was at 32.56 + 1.03. The mean temperature for the eggs of "Sooty," a *T. castaneum* mutant was 26.11 + 2.66; the pupae developed at 31.52

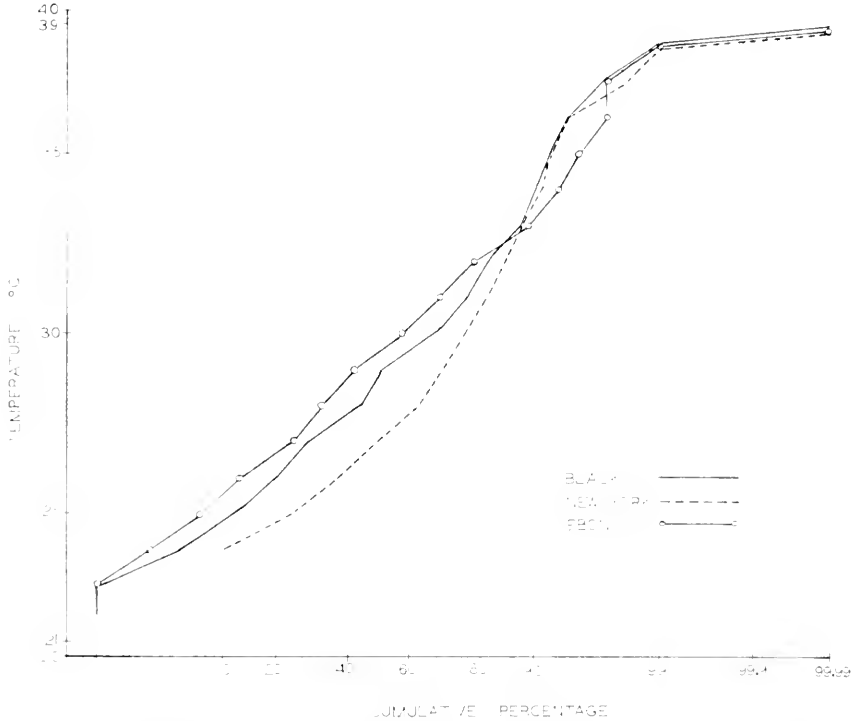

FIG. 8. Deposition of larvae of *T. confusum* mutants and wild type at various temperatures.

+ 1.62. The *T. castaneum* "Pearl" mutant had eggs at 26.39 + 4.60 with the pupae at 34.91 + 2.36.

The egg deposition for *T. confusum* beetles differed from the preferred temperature for the egg deposition for *T. castaneum* mutants in that eggs of *T. confusum* were all laid at a higher temperature. However, there was a distinct difference in temperature preference between eggs and pupae of *T. castaneum* (Table 1). The *T. castaneum* mutant "Pearl" had the widest temperature range variation of all the mutants studied.

TABLE 1. Temperature preferences for eggs and pupae of the T. castaneum mutants

Developmental Stage	Mutants		
	Jet	Sooty	Pearl
Eggs	25.82 + 2.81	25.11 + 2.99	26.39 + 1.60
Pupae	32.56 + 1.03	31.52 + 1.62	34.91 + 2.36

The greatest number of eggs of the *T. castaneum* mutant "Jet" were found at 25° C. "Sooty" laid the greatest number at 28° C and "Pearl" deposited the greatest number at 27° C. The beetles of *T. confusum* laid the greatest number of eggs at 25° C.

For the pupal stage of the mutants of *T. castaneum*, the greatest number of forms of "Jet" and "Sooty" were found at 33° C. The greatest number of pupal forms of the "Pearl" mutant were found between 35° and 36° C. The pupal range among the mutants of *T. castaneum* was from 28° to 38° C. The greatest concentration of pupae of these mutants were found to be between 31° to 34° C.

For the mutants & wild type of *T. confusum* the development of the pupal stage ranged from 26° to 39° with the greatest concentration of pupae between 30° and 34° C. This variation in number and temperature preference can be attributed to low relative humidity. This could account in part for the increased population of the mutants of this species as compared with the population number for the mutants of *T. castaneum* which thrives in an environment where the relative humidity is high. These data are in opposition to Mikulski's work (24) wherein he showed that *T. confusum* was insensitive to humidity changes.

The mutant "Black" (*T. confusum*) had the greatest number of pupae at 31° C; and "Ebony" had the greatest number of pupae at 33° C.

Although the prime purpose of this investigation was to establish the temperature preference of the four stages in the development of "mutant" insects of *Tribolium* species, one cannot overlook comparison of the results with work done with the wild-type insects of *Tribolium*. A search of the literature did not reveal that any temperature-humidity studies had ever been done using these mutant types. Of the mutants studied, "Black" (*T. confusum*) exhibited the highest mean-temperature preference, 29.93 + 5.26. This conforms closely to Mikulski's (24) findings in which he observed that the highest rate of survival of the eggs of *T. confusum* was between 25° and 30° C. He also noted that 80% of the pupae survived at 32.5° C, whereas egg survival at this temperature was zero.

However, contrary to Graham (12) who observed that eggs are laid at temperatures greater than 25° C, all the mutant beetles under consideration laid eggs in considerable numbers at temperatures between 23–24°. All the mutant beetles of *T. castaneum* deposited eggs in a lesser number in an area of 22° C. The mutants of the same species, "Sooty" and "Pearl," deposited eggs at a temperature of 21° C and the mutant "Pearl" deposited eggs at 20° temperature. The mutant "Black" of *T. confusum* also deposited eggs at 20° temperature.

(To be concluded in the September issue, p. 237)

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THE COLUMBIAN TIMBER BEETLE, Corthylus columbianus (COLEOPTERA: SCOLYTIDAE). IX. POPULATION BIOLOGY AND GALLERY CHARACTERISTICS [1]

D. H. Milne [2] and R. L. Giese [3]

Abstract

1965 and 1966 infestations of *Corthylus columbianus* Hopkins (Coleoptera: Scolytidae) were observed in Indiana. Three discrete generations of the insect were present in 1966. Male beetles initiated gallery excavation. Second generation beetles attacked the lower stem; third generation beetles attacked relatively higher portions of trees. Broods of up to 30 beetles were observed; life cycle duration varied from 21 to 71 days. Adults overwintered in short tunnels under loose bark on trees.

Mycetobia divergens (Diptera: Anisopodidae) and *Aulacigaster leucopeza* (Diptera: Aulacigastridae) use abandoned beetle galleries for rearing young. Larvae of *Odinia meijerei* (Diptera: Odiniidae) and *Odinia* n. sp. prey upon those of *C. columbianus, A. leucopeza,* and *M. divergens.* Mites (genus *Leptus*) were seen sucking adult *C. columbianus* body juices.

Deformations in wood structure about gallery mouths may reveal dates of gallery formation precisely.

Introduction

Previous papers by workers at the Purdue Forest Entomology Laboratory (Kabir and Giese, 1966; McManus and Giese, 1967; Crozier and Giese, 1967a, 1967b; White and Giese, 1968; Giese, 1966) and others (Wilson, 1959; Schuder, 1960; Hopkins, 1894a, 1894b) have described many features of the Columbian timber beetle, *Corthylus columbianus* Hopk. (Scolytidae). These studies have made clear the exceptional nature of this insect as a subject for the study of population dynamics. This native North American beetle rears its young in tunnel systems (galleries) bored in hardwood trees without harmfully affecting the host trees. Subsequent tree growth seals the galleries into the trees, preserving them as an indicator of the former presence of adult beetles. Since each gallery contains

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a notch or "cradle" for each egg laid, inspection of a preserved gallery reveals the number of young beetles reared. Thus, the galleries of *C. columbianus* preserved in the annual growth rings of large trees provide unusually precise yearly population density and natality data for a span of decades or centuries.

The purpose of the present paper is to describe aspects of the biology of *C. columbianus* not previously recorded and to draw attention to features of the gallery system which may prove useful in interpreting former beetle population histories.

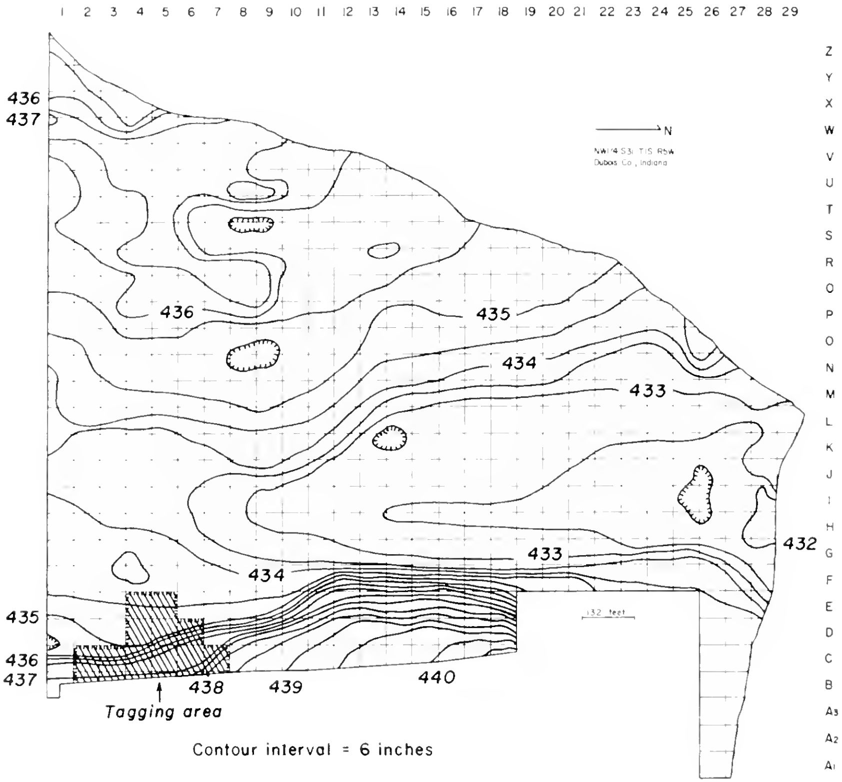

FIGURE 1. Topographic map of study site.

METHODS

A fifty acre woodlot southwest of Jasper, Indiana (Fig. 1, described by Crozier and Giese, 1967b), served as a study site. Records in the growth rings of trees there indicate that it has been sporadically invaded by *C. columbianus* since 1888, and that the beetle first established permanent populations there in 1940 (Crozier and Giese, 1967b). The site is 70 miles south of the northernmost periphery of the beetle's known range in Indiana (as of 1966; Kabir and Giese, 1966; Milne, 1967). The trees most predominant in the study area are silver and red maples, which were the only species attacked by *C. columbianus* in this area.

In the spring of 1965, a program of trapping *C. columbianus* began in the study area. On April 24, 1965, and at weekly intervals thereafter, the woodlot was examined for signs of timber beetle infestation. As newly excavated gallery systems were discovered, trapping and weekly inspections of the traps were begun. Occasional surveys of the entire woodlot were made to determine the extent of the overall infestation. These observations were continued through November 21, 1965.

Sporadic observations were made through the winter of 1965–1966. On May 7, 1966, weekly observations similar to those of 1965 were again begun, and were continued through October 29, 1966. In addition, every gallery initiated in 1966 within a heavily infested 1.2 acre section of the study site ("tagging area," Fig. 1) was identified by tacking a numbered tag to the tree near the gallery entrance immediately upon discovery. The dates of establishment of all trapped and tagged galleries, as well as their heights upon the tree trunks, were recorded.

The traps were transparent plastic cylinders with detachable lids. Holes were drilled in the walls and bottom of each cylinder and were covered with plastic screen to allow circulation of air. The traps were placed, open end toward the bark, over holes bored by beetles, were sealed with nontoxic modelling clay and tied firmly in place with string. Newly initiated galleries were usually enclosed by traps a day or so after discovery, to allow time for the beetle within to be joined by a mate. Inspection of the traps usually revealed whether or not beetles had emerged from the enclosed gallery without the necessity of removing the trap from the tree.

Once in place the traps were inspected weekly. Live beetles found in the traps were released after their sex was determined (see Hopkins, 1894a and 1894b); dead ones were collected. All other insects and arthropods found in the traps were collected, as were those frequently seen near untrapped galleries. Traps established in 1965 were left in place until the summer of 1966; those established in 1966 were removed in January 1967.

Plastic cylinders were occasionally sealed in place over galleries and filled with water, in order to observe the beetles' response to flooding (which is frequent in the woodlot). Blocks of wood containing newly initiated galleries were removed from one tree and dissected while the beetles were active, in an attempt to observe gallery excavation directly. Holes of the same diameter as beetle galleries (2 mm) were occasionally drilled into trees and inoculated with microflora from genuine galleries, in an attempt to attract insects associated with *C. columbianus.*

In January, 1967, thirteen trees in the tagging area (Fig. 1) were removed for examination. In ten of these, all galleries established in 1965 and 1966 were dissected. Three of the thirteen trees were totally dissected. That is, information was recorded for every gallery found in these trees, including those established prior to 1965. The years of establishment of these galleries, as determined by dendrochronology, were recorded.

The largest and most interesting of the totally dissected trees, designatured 3–5B, was chosen because it was one of the few in the woodlot which had been relatively heavily infested in both 1965 and 1966. A fuller analysis of aspects of the population dynamics of *C. columbianus,* based upon data from this tree, is presented elsewhere (Milne and Giese, 1969).

RESULTS

Spread of the Infestation in Time and Space.—Throughout 1965, infestation of the study area was sparse. A female beetle was observed at rest on a silver maple in sector 10R (Fig. 1) on May 8, after which no sign

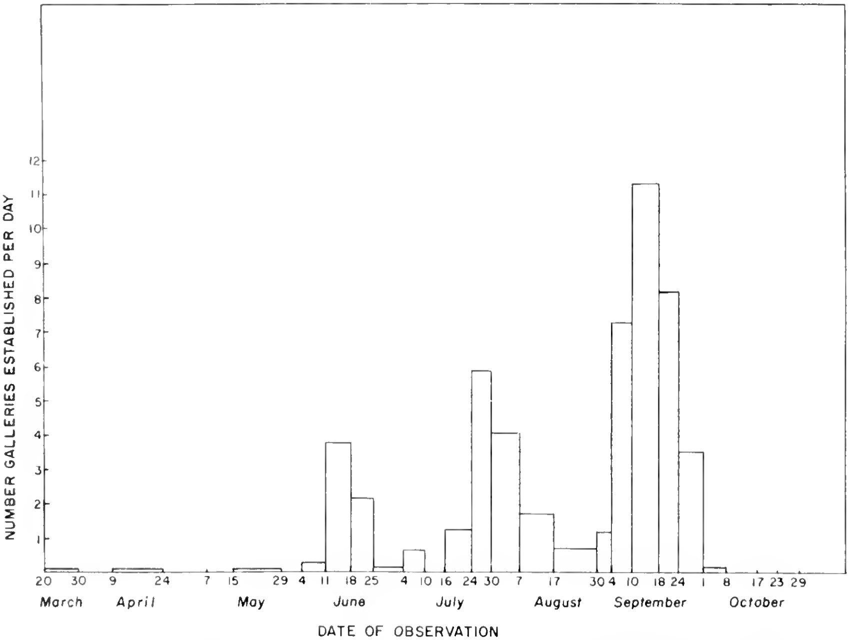

FIGURE 2. Weekly rates of gallery establishment in the tagging area, 1966.

of the species was detected until a single fresh attack upon a silver maple in sector 16S was observed on June 19. In the week ending July 17, galleries were established in a silver maple in sector 22J, and in two red maples in sector 5B. Throughout the remainder of the season, infestation became heavy in the trees in sectors 5B and 22J, spread to eight additional trees in sectors 6C, 3B, 4B, 5B and 5D, and vanished in the tree in 16S. Inspection of the woodlot in early spring, 1966, revealed two other trees, in sectors 2B and 16R, which showed signs of timber beetle attack in 1965. Thus, the 1965 summer population was harbored by only fourteen trees.

The infestation of 1966 began with the appearance of single galleries in single trees in sectors 5D, 5B and 3B in March, April and May, respectively. Beetle activity became intense during the week ending June 11 and increased in tempo in the manner shown in Figure 2 throughout the season. Until the week ending September 10, virtually all beetle activity detectable in the study area was confined to thirty trees within the southeast corner of the woodlot (tagging area, Fig. 1). On September 10, trees bearing signs of beetle infestations were found in sectors 6E, 7E, 8E, 9E, 6G, and 1F, and in the woodlot adjoining the study area to the south. By the end of the season, additional infested trees were scattered widely throughout the study area (sectors 1E, 3F, 4G, 5G, 1I, 20J, 10K, 5L, 11P, 1Q, 3R, 17S, 5T, 4U, 3X), as well as throughout the woodlot to the south. In general, beetles remained most abundant within the tagging area, and tended to avoid trees which had been infested there in 1965.

Overwintering.—Most of the newly mature beetles which emerged from typical galleries in the last weeks of the 1965 and 1966 seasons were observed to bore short upward oriented tunnels in the outer bark of their host trees (Fig. 3). These tunnels were usually initiated in crevices, or under loose bark flakes. Beetles in these tunnels usually continued to bore slowly until immobilized by cold weather. Only one of approximately 20 beetles known to have overwintered in such tunnels (winter of 1965–1966) survived to the following spring. The latter, a male, emerged during the period April 9–April 24 and began excavating a gallery, which was found deserted after being covered by floodwaters in early May.

In one instance beetles were observed to survive the winter of 1965–1966 in a typical reproductive gallery. This gallery was established the week ending September 5, 1965, under a trap, by several beetles which had just emerged from the original trapped gallery. A brood of newly mature beetles issued from the new reproductive gallery during the period March 20–April 24, 1966. This practice, considered normal for *C. columbianus* (Kabir and Giese, 1966; Hopkins, 1894a) was thus rare in the Jasper population in comparison with that of adult overwintering in cavities in outer bark.

Brood production.—Figure 4 summarizes the timing of the 1965 trapping program, and the results observed. Each arrow in the figure represents one trapped gallery. Each solid arrow spans the time from the date of placement of a trap over a gallery to the date of discovery of a brood of newly mature beetles in the trap. The number accompanying each arrow represents the total number of beetles (dead plus alive) found in the trap; "F" denotes the discovery of a fly, *Odinia*, n. sp., in a trap. Arrows accompanied by dotted lines represent traps over galleries whose dates of initiation are unknown; all other galleries were excavated within the week before trap placement.

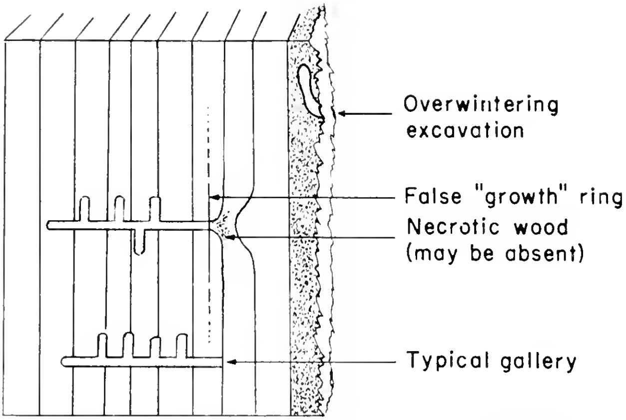

FIGURE 3. Gallery types constructed by *C. columbianus.*

In Figure 5 (the 1966 counterpart of Figure 4) lines continued to the right of the figure and accompanied by "7X," "F," etc., represent galleries trapped in 1966 which were found, when dissected, to contain either dead timber beetle larvae or living *Odinia* larvae. The four lower lines portray galleries established in the week ending September 18, 1966, from which no living beetles emerged; three of the upper four complete the histories of galleries trapped earlier.

Trapping results from 1965 suggest emergences of broods of beetles during the two week period centered on August 26, and during the week ending October 24 (Fig. 4). Trapping in 1966 revealed the widespread emergence of broods of beetles within the two week periods centered upon July 24 and September 10 (Fig. 5). The 1966 emergence dates coincide closely with the dates upon which the most intensive boring activity was observed in the latter half of the season (Fig. 2). Beetles which initiated the intense boring activity in June, 1966, almost certainly emerged from overwintering galleries, only one of which was successfully trapped. Thus, three generations of beetles formed the galleries bored in 1966, and the two emergences indicated by the 1965 trapping program suggest that at least three generations of beetles were present in that year, also. Previous workers (Hopkins, 1894a; Wilson, 1959; Kabir and Giese, 1966) reported two generations per year.

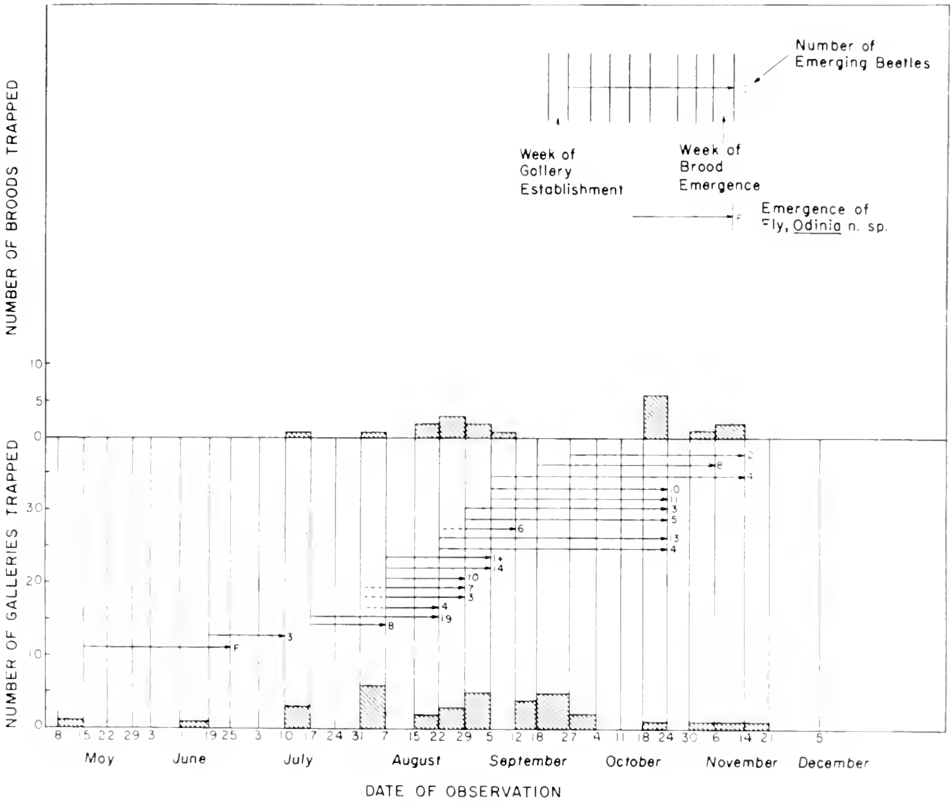

FIGURE 4. 1965 trapping results.

The number of offspring reared per gallery (Figs. 4 and 5) ranged from few to 30. Broods of from 13 to 24 offspring (larger than those reported by Chamberlin, 1939) were frequently observed. Later dissection of the galleries show that each egg cradle produces no more than one offspring beetle. Galleries were never observed to produce two or more consecutive broods.

Galleries established throughout June and July, 1966, consistently produced newly mature beetles 35–40 days after the date of establishment. There was a tendency for shorter brood-rearing times in August and September, 1966. Brood-rearing times were much more variable in 1965. Galleries established from June through July, 1965, produced newly mature beetles after 22–37 days, whereas brood-rearing times of 50–71 days were observed later in the season. Brood-rearing times observed in the Jasper study area were thus comparable to those observed by Kabir and Giese (1966) in a laboratory study.

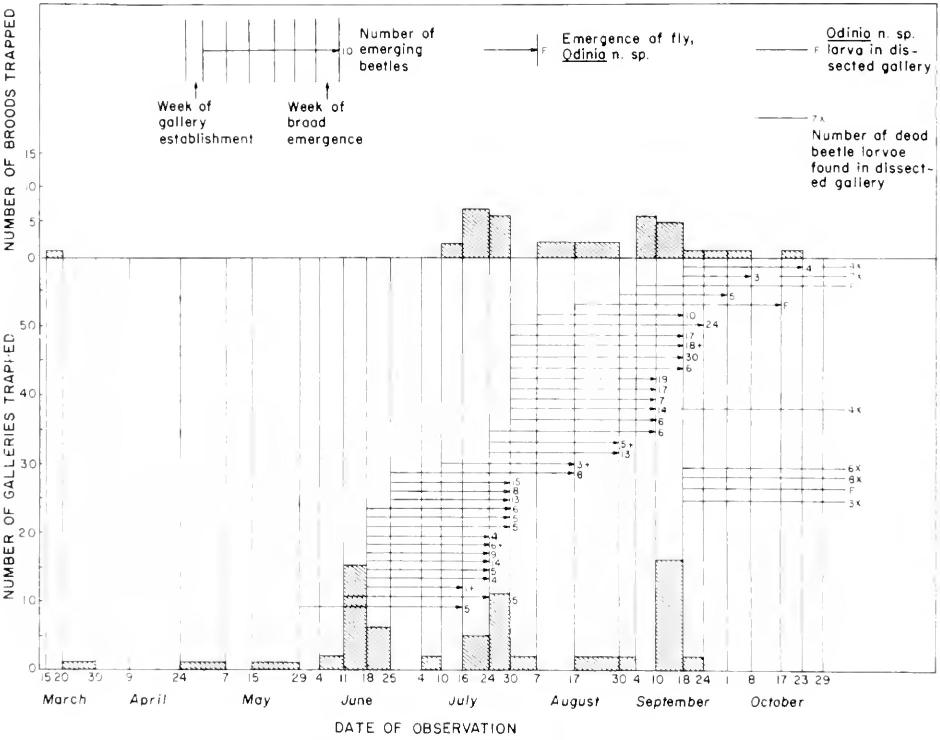

FIGURE 5. 1966 trapping results.

Dissections of galleries within which beetles were working revealed that the male beetle, closely followed by the female, begins excavation of the main tunnel of a gallery system. Once branching tunnels are established, the female assists with the excavation of these. A few egg cradles may be established and eggs deposited in them before excavation of the entire system is complete. One male, prevented from obtaining a mate by the presence of a trap over his gallery, excavated a system consisting of a main and two auxiliary tunnels, all wholly lacking in egg cradles, then abandoned it. Parent beetles usually died in the galleries before the emergence of their offspring.

Male/female ratios in 1965 and 1966 were 69/74 and 145/178 respectively. Galleries consisting of single tunnels with no egg cradles were frequently encountered. Such galleries were especially common in trees with unhealthy interiors, and were usually abandoned by the beetles which created them. Such galleries were never observed to produce offspring beetles.

Arthropod associates of C. columbianus.—Insects found associated with *C. columbianus* in the study area were the flies *Mycetobia divergens* (Walk.) (Anisopodidae), *Aulacigaster leucopeza* (Meigen) (Aulacigastridae), *Odinia meijerei* Collin (*Odiniidae*), and an undescribed species of *Odinia* (near *meijerei*) currently under study. *M. divergens* apparently completes the larval portion of its life cycle in galleries recently abandoned by *C. columbianus*, whereas *A. leucopeza* uses galleries which have been long abandoned. The habits of larvae and adults of the *Odinia* species suggest that the larvae of these flies prey upon the larvae of *C. columbianus* as well as those of *M. divergens* and *A. leucopeza*. Hopkins (1894a) illustrates and discusses a larva like that of the *Odinia* species taken from beetle galleries.

Immature mites of the genus *Leptus* were occasionally found clinging to dead and living adult timber beetles, and sucking their juices. Nematodes reported by Kabir and Giese (1966) were not observed in this study. Syrphid and ceratopogonid fly larvae mentioned by Kabir and Giese (1966) were not encountered.

Population dynamics.—Predation upon *C. columbianus* by organisms other than the *Odinia* and *Leptus* species was not observed. The latter organisms were not abundant and did not seem to influence the density of the beetle population. On two occasions (September 12, 1965, and August 17, 1966) mortality of timber beetles was observed following rainstorms. Beetles imbedded in short galleries or in inner bark were drowned and flushed from their burrows by an apparent increase in sap pressure in their host trees following these storms. Broods of offspring and adults in deeper galleries were not affected. Beetles in flooded reproductive galleries sometimes abandoned them.

The apparent predominance of climatic sources of mortality (rain, winter cold) over biotic sources in an area near the edge of an insect's range is a pattern anticipated by certain population theorists (Huffaker and Messenger, 1964). McManus and Giese (1968) provide evidence that climatic effects actually govern the density of the timber beetle's population in the study area.

Characteristics of the galleries.—When the galleries formed in 1966 were dissected, their features were compared in an effort to discover clues by which the generation of beetles responsible for each gallery could be distinguished. The following summarizes these comparisons.

Giese (1966) and Giese and McManus (1965) reported that early season galleries are normally accompanied by longer discolorations in the surrounding wood than are late season galleries. The present study confirmed this observation. This property was found to be too variable, however, to permit precise distinction of first, second and third generation galleries. Similarly, no consistent relationship was found between the lengths of tunnels, numbers of tunnels, or numbers of egg cradles in a gallery system and the generation period of the season in which the gallery was excavated. A striking tendency of second generation (July 11 to August 30, 1966) beetles to concentrate their attacks near the bases of their host trees, and of third generation (August 31 to October 8, 1966) adults to infest higher portions was noted, however (Fig. 6).

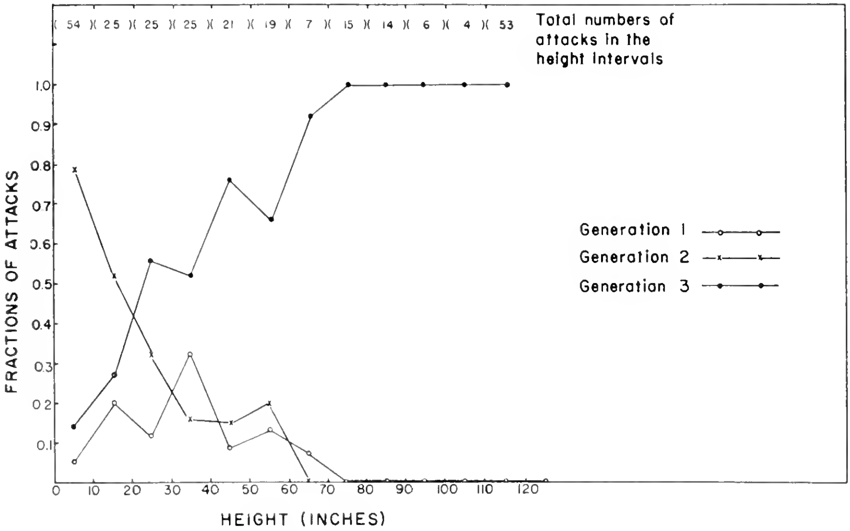

FIGURE 6. 1966 height distribution of three generations of attacks on trees 12 inches or greater in diameter.

The pattern shown in Figure 6 was observed both in lightly and in heavily infested trees. It was somewhat less marked in trees less than 12″ in diameter, although still unmistakable in them.

Certain properties of galleries examined during dissection may, when better understood, provide clues to the dates of gallery establishment within a given year. Figure 3 shows a deformation in the ring structure about a gallery entrance which was observed in about 3% of the galleries dissected. Such galleries terminate in the wood between two annual growth rings, the outer one of which is "indented" back to the rim of the gallery entrance, which it contacts. The growth ring from the following year sometimes shows a shallow indentation, as well. A prominent false "growth ring," which fades into obscurity within inches of the gallery, is usually present, and darkened necrotic wood is sometimes found immediately exterior to the gallery entrance in the growth ring from the following year. This deformation may identify galleries excavated before spring growth of the host tree is complete. Of the trapped and tagged galleries dissected in this study, only one, excavated the week ending June 18, 1966, was of this type. Others, including galleries excavated earlier, were more normal in their appearance.

False "growth rings," which resemble genuine annual growth rings, were found to accompany many of the dissected galleries. Two common types of false rings are shown in Figure 7. One of these simply covers the gallery entrance; the other is indented about the gallery entrance, and contacts it. Such rings almost invariably taper back toward the true annual ring representing the year of gallery establishment, and fuse with it (Fig. 7). Hopkins (1894a) describes the occurrence of such growths over galleries established in white oak.

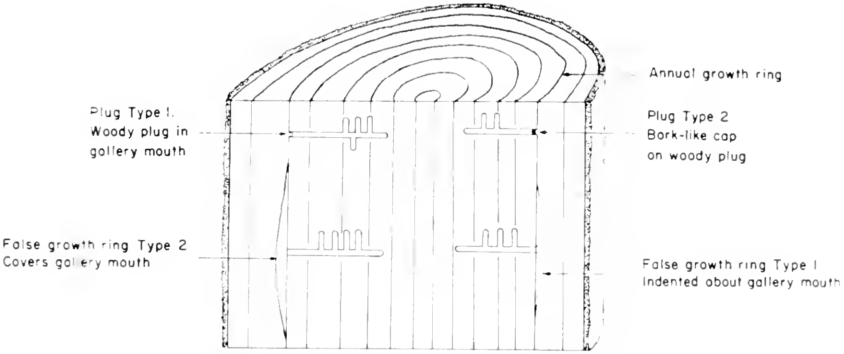

FIGURE 7. False growth rings and plugs associated with certain galleries of *C. columbianus.*

Woody plugs were often found blocking the entrances of certain galleries (Fig. 7). Such plugs, where present, consist either of intrusions of clean white wood produced in the year after gallery establishment, or of such intrusions capped by a distinct layer of bark-like brown wood.

Barklike plugs, evidently formed by proliferation of cambial tissues near the gallery entrances, were found in the mouths of some of the galleries excavated in 1966. At the time of dissection (January, 1967), growth of the 1967 annual ring over these galleries had not begun.

No correlation between the presence of plugs and that of false rings was evident. Certain trees consistently formed more and longer plugs than did others. Since the 1966 galleries were dissected before formation of the 1967 growth ring, full development of plug and false ring structures about the 1966 galleries was not observed. Whether or not these structures can be used to identify galleries excavated by different generations of beetles is therefore unknown.

Studies by McManus and Giese (1967), Hopkins (1894a), and the present authors indicate that different responses of tree tissues to attack by *C. columbianus* are characteristic of different tree species. Detailed studies of these responses may show them to accurately indicate the time period within which each attack was inflicted within a given year. If gallery generations can be thus distinguished, detailed analysis of the population dynamics of *C. columbianus* can be easily carried out (Milne and Giese, 1969).

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(Morgan—Habitat Selection of Tribolium, continued from p. 224)

In this study no investigation was undertaken to determine survival of life cycle stages at any given combination of temperature or humidity as this study was designed solely to explore temperature preferences of the four life cycle stages of five mutants & a wild type of *T. confusum* and *T. castaneum.* However, for wild types Howe (19) found that the shortest period of egg duration was 35° C for *T. confusum* and 37° C for *T. castaneum.*

Concerning effect of humidity on survival of egg and pupae, Holdaway (18) observed that both eggs and pupae of *T. confusum* have less chance of survival at high humidities.

But, in close association with work reported here that eggs of mutants may be deposited over a wide range of temperature despite definite preferences zones, Mikulski (24) has also stated that eggs may be deposited in a long range of temperatures but that they will not all survive.

Larval and Adult Temperature Preferences: In investigating the mobile forms in the life cycle of the mutant beetles, temperature preferences are not hard to recognize. In a temperature gradient where the beetles are normally healthy and living in a food medium and environment to their liking, they would naturally take up residence in areas best suited to their comfort. There is nothing to prevent them from doing so. The larval forms first concern is food, but where there is only a humidity gradient, as there was in this investigation, they will choose a comfortable environment.

The larvae on occasion exhibit cannibalistic tendencies. What initiates it is not fully understood, except that it may be a reaction resulting from coexistence. (Cannibalism is said to be a species specific and inherited characteristic.) In any case, the larvae, upon hatching, will choose an egg as its first nourishment. Yet the flour in which the insect lives is its primary source of food because it is most available. However, in this investigation the egg and larvae constituted the greatest number of forms in the population. In relation, however, there was no over-crowding in the food trays and all forms were able to find a suitable environment in which to establish themselves. A comparison of the mean-temperature ranges preferred by the larvae and adults of the mutant beetles of both species of *Tribolium* are given in Table 2.

TABLE 2. Mean temperature ranges of larvae and adults of *T. castaneum* and *T. confusum*

Mutants	Developmental Stage	
	Adults	Larvae
T. castaneum		
Jet	28.07 – 3.96	30.07 – 2.62
Sooty	25.48 – 3.61	28.49 – 2.66
Pearl	28.84 – 5.81	31.19 – 3.40
T. confusum		
Black	31.51 – 2.82	29.53 – 3.54
New York	32.34 – 2.96	28.35 – 5.04
Ebony	30.53 – 3.38	30.03 – 3.12

Investigation of the migration of both male and female adult beetles is constantly being studied. Although a preferred temperature for the adult wild-type beetle has been estimated and established by a few workers, the instability of these forms calls for further examination into both male and female activity.

Several workers (Bodenheimer, Schenkin and Deal) have published preferred temperature ranges for *T. confusum* beetles based on their previous acclimatizations, whether they were higher or lower temperature ranges. From the observations determined it would seem that temperature preferences for both larvae and adults of both *T. castaneum* and *T. confusum* are very close (Table 2) and that the insects will seek out their preferred temperature habitat readily. These observations agree with Graham's (12) observations that the temperature preference for the adult beetles of *Tribolium* is strictly a transistory matter.

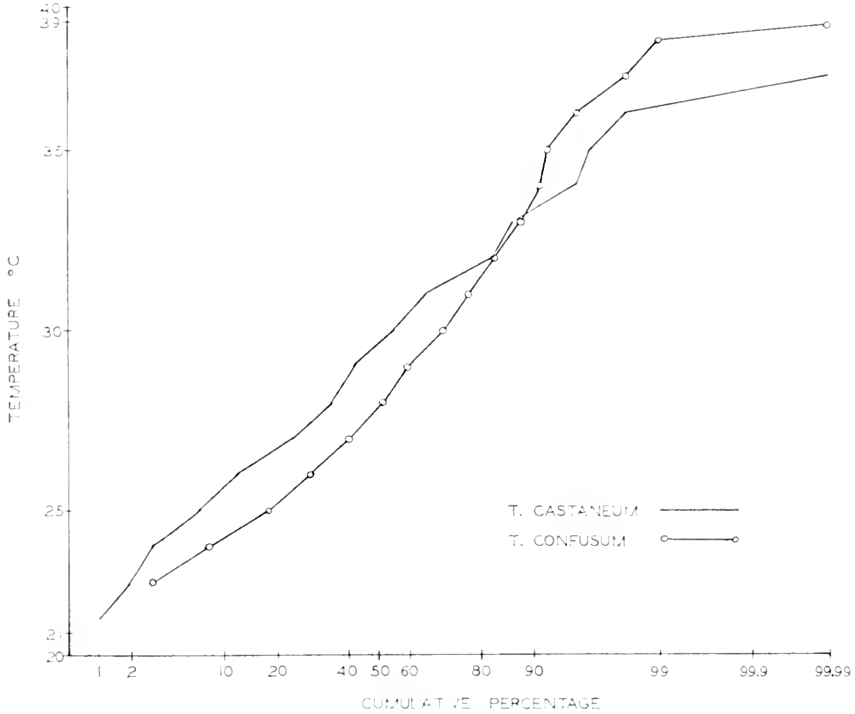

FIG. 9. Comparison of cumulative percentage deposition of larvae of *Tribolium castaneum* and *Tribolium confusum* over the given range of temperatures.

Effect of Light: Light has been found to stimulate movement in forms of *Tribolium* spp. This experiment demonstrated that after about a month, beetles browsed from one end of the trough to the other. They were never seen in dense clusters but were distributed loosely. This distribution occurred during the light period of twelve hours. Physiological needs may be a compelling factor in migration for both the male and the female. Dick (9) stated that egg-laying is stimulated by the female when she travels from a warmer to a cooler environment. Graham (12) established that the area where adult females laid their eggs in greatest numbers is at a temperature of 25° C. This distinguishes *T. castaneum* from *T. confusum* since the former prefers the warmer temperature.

In these experiments moisture condensed at the cold end of the troughs after a period of time. This condensation caused the flour to harden in an area in which the temperature ranged from 14° to 18° C. On examination, adult beetles were found boring into the hard dough. However, no examination was made to determine the sex of these burrowing beetles. The reasons for burrowing and for the other activities of both wild-types and mutants for an extended period of *Tribolium* spp. need clarification.

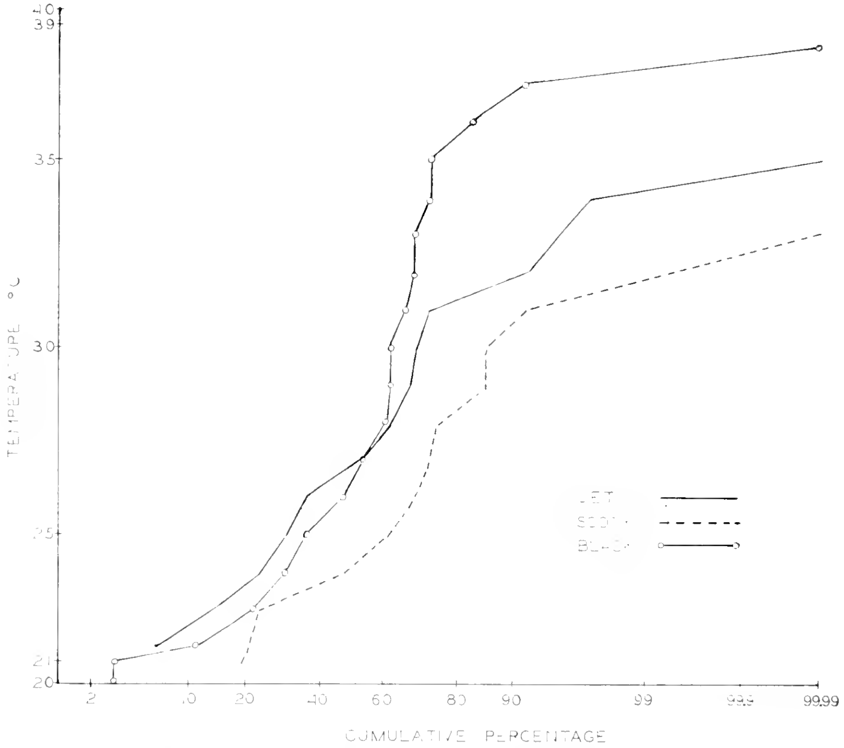

FIG. 10. Results indicate that the adults of the *Tribolium castaneum* mutants used in these experiments prefer more widely divergent temperatures than the *Tribolium confusum* mutants tested.

From observations made in this study the use of large numbers of beetles to determine temperature preferences is apt to clutter the data when beetles are studied in a limited space. A limited number of beetles given ample space on a temperature gradient and under controlled conditions of humidity, will choose quite readily the preferred temperature for all their developmental stages. Results can be readily obtained after the first generation of beetles exposed to conditions conducive to most rapid development of each metamorphic cycle is formed. The mobile forms, namely, the larvae and adults, should have ample time to choose a suitable temperature; that is for the adult female to deposit eggs, and for the larvae to migrate to a preferred temperature for termination of this stage of development as well as to moult for the last and final time to give rise to the pupal form.

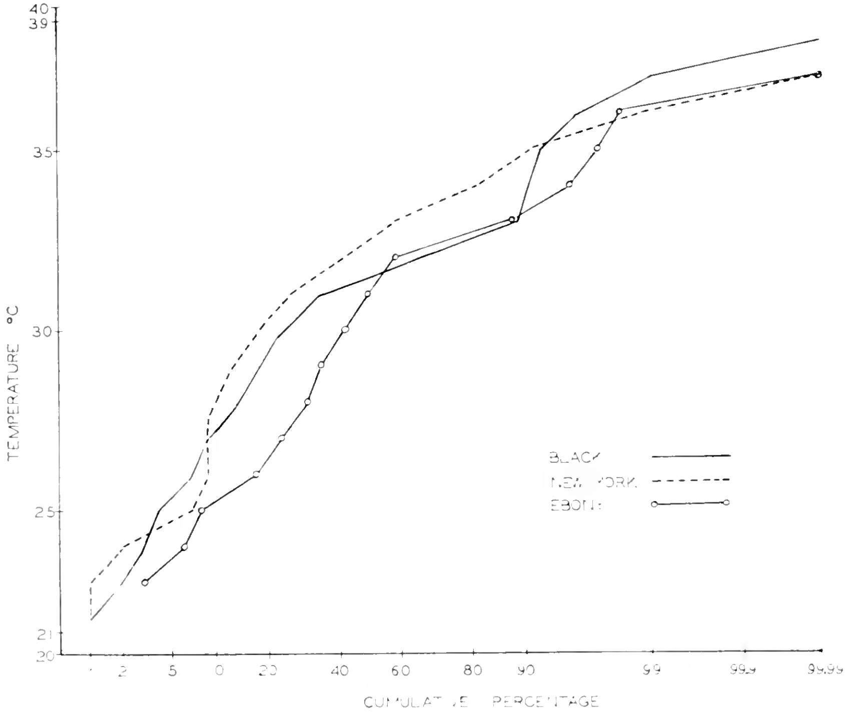

Fig. 11. Deposition of adults of *Tribolium confusum* at various temperatures.

Cumulative percentage numbers for all life cycle stages of the five mutants and one wild strain have been plotted against temperature ranges (Figs. 1–12). Egg deposition for all six mutants occurred over a wide range of temperature (Figs. 1–12) with "Sooty" (*T. castaneum*) reaching a maximum cumulative per cent deposition at the lowest temperature (33° C) as compared with 40° for "Pearl" and 38° for "Black" (*T. confusum*). Beetles of *T. confusum* had greatest cumulative number of eggs deposited (Fig. 2) in all temperature ranges.

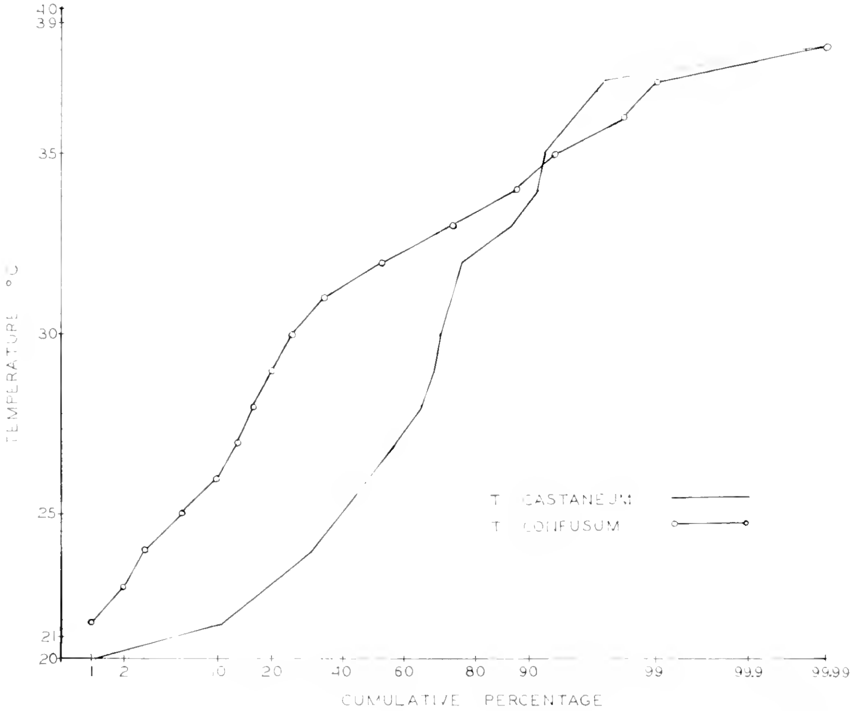

FIG. 12. Comparative of cumulative percentage deposition of adults of *Tribolium castaneum* and *Tribolium confusum* over a range of temperatures.

The pupae of all five mutants and the wild type were found at higher temperatures than were the eggs and in a narrower range of temperatures (Figs. 7–8). The pupae of "Sooty" (*T. castaneum*) again reached maximum cumulative per cent deposition at the lowest temperature (33° C) as compared with 38° for "Pearl" (*T. castaneum*) and the same temperature for "New York" (*T. confusum*). Beetles of *T. confusum* had slightly greater cumulative number of pupae to develop. However, there was very little difference in number pupae formed among all five mutants and the wild type at the temperatures studied (Fig. 9).

In the larval and adult stages the mutant "Sooty" showed the widest deviation of temperature selection of all mutants studied. "Sooty" reached maximum cumulative per cent deposition at 33–34° for both the larval and adult stages (Figs. 4–10). Highest cumulative number of larvae formed occurred for the *T. confusum* wild type "New York" (Fig. 7) but, as with the pupal stage, again there was very little deviation among all forms of mutants of the two species in cumulative per cent development of larvae (Fig. 6).

The greatest cumulative number of adults occurred for the wild type "New York" (*T. confusum*) (Fig. 11). "Sooty" mutant of *T. castaneum* again reached maximum cumulative per cent formation at 33° C (Fig. 10). Adults of *T. castaneum* mutants, although formed in lesser numbers, reached maximum cumulative per cent formation faster over a wider temperature range and particularly at lower temperature (Fig. 12).

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A New Nearctic Leafhopper of the Genus Flexamia (Hemiptera: Cicadellidae)[1]

HERBERT H. ROSS[2] and TIM A. COOLEY[3]

When studying the comparative geographic ranges of species of *Flexamia*, we discovered a morphological segregate close to but different from *F. sandersi* DeLong. This segregate we are considering a distinctive species described below.

Flexamia delongi new species

Length of male 3.4–4.1 mm, of female 3.5–4.2 mm. Head with proportions variable, but median length of crown usually about one-fourth to one-half greater than interocular width and six-tenths to seven-tenths transocular width. Hind wing exceeding claval apex, but not attaining apex of forewing. Face varying from dark above and shading to paler apically to brown or black throughout, in former case with dark area fading gradually along lower margin, not appearing as definite interocular band.

Male genitalia as in Figs. 1–4. Pygofer with posterior lobe produced posteriorly and truncate or slightly concave on dorsal portion of posterior margin. Connective in lateral aspect with keels flared dorsally. Aedeagus asymmetrical; shaft elongate, not cylindrical, gradually tapered; gonopore at base of apical third of length of shaft on dorsolateral surface at base of retrorse process, which extends basad to midlength of shaft; pair of lateral apical retrorse processes extending more than one-third, but less than one-half length of shaft, each with a distinct coarsely serrate margin and with very acute apex; apex of aedeagus broadly rounded.

Female seventh sternum with broad, convex, median posterior projection slightly notched at middle.

HOLOTYPE ♂, ALLOTYPE ♀.—Zion, Ill., Aug. 7, 1935, DeLong and Ross. Paratypes.—ILLINOIS: Elgin, Aug. 7, 1955, GL 537, H. H. Ross, 2 ♂, 1 ♀; Zion, July 25, 1934 to July 27, 1966, 32 ♂, 42 ♀. INDIANA: Tremont, Aug. 26, 1959, 4 ♂. WISCONSIN: nw of Eagle (Waukesha Co.), July 15, 1963, Stannard and Smith, 3 ♂; nw of Arena (Iowa Co.), July 17, 1963, Stannard and Smith, 1 ♂. Types in the collection of the Illinois Natural History Survey.

Comparisons.—In the Young and Bierne (1958) revision of the genus, males of *F. delongi* will key to *F. sandersi*, to which it is indeed most closely related and of which it has previously been considered a variant. The two may be separated by the following couplet.

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[1] This project was supported by a research grant from the National Science Foundation. Accepted for publication July 5, 1969.

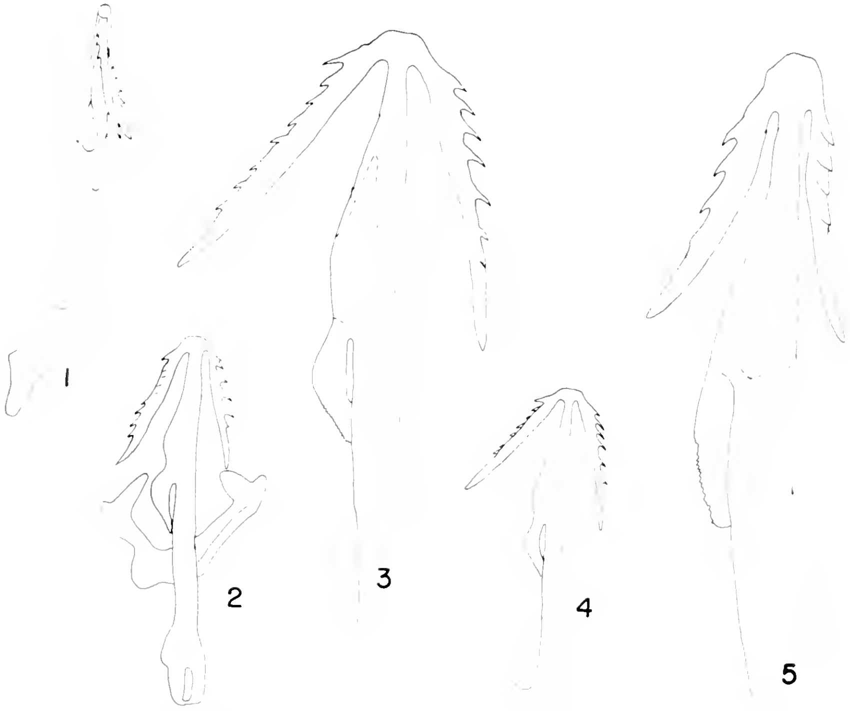
[2] Present address: Department of Entomology, University of Georgia, Athens, Georgia 30601.

[3] Present address: Illinois Natural History Survey, Urbana, Ill. 61801.

Apical processes of aedeagus more divergent, each with 6–9 teeth; when viewed in a position with the apical processes horizontal, a space is visible between the base of the gonopore extension and the shaft (Figs. 1–4) ..... **delongi**

Apical processes of aedeagus less divergent, each with 3–5 teeth; when viewed as above, no space is visible between the base of the gonopore extension and the shaft (Fig. 5) .... **sandersi**

To date no differences have been found that separate females of *F. delongi* from *F. sandersi*.



FIGS. 1–5. Aedeagus of species of *Flexamia*. 1–3, holotype of *F. delongi*; 4, paratype of same species; 5, holotype of *F. bidentata*. 1, aspect showing full view of gonopore (stippled); 2–5, aspect showing greatest divergence of lateral process. 3 and 5 about twice magnification of 1, 2, and 4.

Distribution. We have personally examined specimens of *F. delongi* and *sandersi* from Alabama, Illinois, Indiana, Louisiana, Massachusetts, Missouri, Virginia, and Wisconsin. On the basis of these records it appears that *F. sandersi* extends from the Gulf coast northward to central Illinois in the west and to Massachusetts in the east. In the Midwest *F. delongi* replaces *sandersi* in the *Andropogon* prairies of northern Indiana, northern Illinois and Wisconsin. Western records of *F. sandersi* from the Dakotas, Nebraska and Kansas have not been re-examined by us and their identity needs reconfirming. The type of *F. sandersi* is from Chain Bridge, Va., and the type of its synonym *F. bidentata* DeLong is from Wellesley, Mass.

REFERENCE CITED

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FLASH COMMUNICATION IN ASPISOMA SP. (COLEOPTERA: LAMPYRIDAE)[1, 2]

Edward G. Farnworth[3]

Studies of sexual communication in New World fireflies have been limited almost entirely to Nearctic species, although the flashing behavior of males of several Jamaican species has been reported (McDermott and Buck, 1959; Lloyd, 1969). I have made several observations on the behavior of a firefly in the genus *Aspisoma* on Isla de San Andrés (125 miles east of Nicaragua). This paper presents the first extensive account of flashing behavior during pair formation and courtship in a tropical species, the first report of behavior of any firefly species found on the small Caribbean islands, and the first report of flashing behavior of a species of *Aspisoma*.

Isla de San Andrés, the western-most island of the West Indies, is a 2 × 8 miles limestone island with a maximum elevation of 340 feet. It is covered almost entirely with coconut palms and scrubby second growth vegetation, with mangroves along the west and southwest coasts. The rainy season begins in July with heavy rains from August through October, and the dry season begins in December. My observations were made 23 to 29 July 1967.

The study area, 200 × 100 yards, was from the Big Pond west to a road. The vegetation consisted of coconut palms 50 to 60 feet high and dispersed secondary vegetation up to 6 feet on either side of a path bisecting the study area.

Flashing activity began on the ground and in low vegetation about 15 minutes after sunset and gradually more and more individuals took flight. Most individuals flew 6 to 10 feet above the ground, although some flew as high as 30 feet. The level of flashing activity fluctuated throughout the flashing period. Although light rain did not diminish activity, during heavy rain flying and flashing decreased and then ceased. Activity resumed

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[1] This study was conducted while the author attended a course sponsored by the Organization for Tropical Studies. The aid of this organization is gratefully acknowledged. Accepted for publication August 1, 1969.

[2] I thank Dr. James E. Lloyd for criticisms during the preparation of the manuscript, and Dr. Thomas C. Emmel and Mr. Michael J. Corn for help in the field.

[3] Department of Entomology and Nematology, University of Florida, Gainesville, Florida 32601.

when the rain stopped. Flashing decreased gradually toward the end of the activity period and intermittent flashes could be seen in the undergrowth 15 minutes after cessation of in-flight flashing. All activity ended 75 to 85 minutes after it began (90 to 100 minutes after sundown).

Flying males emitted a single, rippling flash, 0.3 to 0.4 second[4] in duration every 1.3 second[4] (range 1.0 to 1.5 second; n = 28; 82° F). Females were not observed to fly, but remained on the ground or up to 3 feet high on vegetation. They answered male flashes with single rippling 0.4–0.5 second flashes, 0.7–0.8 second[4] after the beginning of the male flash (n = 20; 82° F). After 2 to 5 flash exchanges, males landed within 1 foot of females and walked to them. Flash exchanges occurred during the walking phase of the male's approach, however, male flash interval and female response delay were shorter than during male in-flight exchanges. Males mounted females immediately on contact, oriented in the same direction, and engaged genitalia (copulation position ♂ ♀: Wojcik, 1969). During the ten copulations I observed, both sexes intermittently emitted glows or rippling flashes.

Females placed on the ground in individual vials answered flying males with the same flash as free females and often directed their light organ toward flashing males. Males flew on a direct line to caged females and landed within 2 feet of the vials after one to four flash exchanges. They then walked to, and climbed upon the vials, exchanging flashes with the females during the entire approach. I tried to attract males by simulating female flashes with a pen-light, and to elicit flashes from caged and free females with artificial male flashes, but was unsuccessful. Presumably I was unable to duplicate the flickering found in the fireflies' flashes and this may explain my inability to artificially induce responses. This suggests that the flickering is important in sexual recognition.

Free and caged females sometimes flashed spontaneously, that is, without apparent stimulation by a male. These spontaneous flashes were emitted in a rhythmic sequence in which flash intervals averaged 1.4 second (range 1.0 to 1.7 second; n = 9; 82° F), and the length of the flash was 0.4 to 0.5 second. Kaufmann (1965), described similar behavior in females of the West African firefly *Luciola discicollis*.

This firefly was the only one I saw on San Andrés. I have been unable to identify this species, but morphologically it is similar to *Aspisoma ignitum* L. (Leng and Mutchler, 1922). My specimens are similar to specimens collected on San Andrés by J. Zetek, April of 1931, which were tentatively identified as *A. ignitum* by Barber in 1931. Behavior voucher

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[4] Intervals timed with a stopwatch.

specimens will be deposited at the United States National Museum; Cornell University; and Florida Collection of Arthropods, Gainesville, Fla.

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The Entomologist's Record

[illegible]

A Note on Bioluminescence in Pleotomus (Coleoptera: Lampyridae).—In the course of field studies at Joshua Tree National Monument *Pleotomus nigripennis* LeConte (Figs. 2 and 3) was taken at the blacklight sheets on numerous occasions from 1961 to the present. In July 1969 it was noted that a male, attracted to a blacklight sheet, when disturbed, emitted a pale green glow from the underside. Subsequent examination of this and other specimens revealed that males were bioluminescent at two sites each (Fig. 1) on abdominal sternites three and four. The glow was suddenly bright at the moment the beetle was disturbed, then would diminish slowly over a period of approximately three minutes. When the beetle was again disturbed, again the light was emitted.

The capacity of the beetle to produce light is apparently limited. All specimens in which light production was noted were freshly emerged. In all specimens studied in the laboratory the ability seemed to diminish slowly and entirely disappear in approximately one week. After this time, however, the beetles seemed to be as vigorous and active as when the light was produced.

It has been determined that the material from Joshua Tree National Monument represents the first record for this beetle from California. It has been previously taken in Arizona. Its distribution within the Monument is apparently limited to areas demonstrating a strong Colorado Desert (Creosote Bush Scrub plant community)

(Continued on p. 272)

Taxonomic Notes on North American Anobiidae (Coleoptera)[1]

RICHARD E. WHITE[2]

Work done in preparation of an illustrated key to the North American genera of Anobiidae (to be submitted to *Annals Entomological Society of America*) has shown the necessity for changes in the generic placement of certain species; these changes and other notes are presented. The removal of *Ernobius trapezoideus* Fall and *E. champlaini* Fisher from *Ernobius* and assignment to *Episernus* provides the first North American record of the genus *Episernus*.

EPISERNUS Thomson, 1863, p. 151.

Fall (1905, p. 132) regarded the genus *Episernus* as doubtfully distinct from *Ernobius*. However, I find the following characters to be an adequate basis for distinguishing *Episernus* from *Ernobius*. In *Episernus* the pronotum bears a distinct lateral margin only basally; the prosternum before the coxae is equal to ½ to ¾ of the coxal diameter; the antennae are 10-segmented, and the first tarsal segment of the posterior legs is as long as the following 3 segments combined. In *Ernobius* the pronotum bears a sharp lateral margin throughout; the prosternum before the coxae is equal to ¼ to ½ of the coxal diameter; the antennae are 11-segmented (except 10-segmented in *gentilis* Fall), and the first tarsal segment of the posterior legs is no longer than the 2 following segments combined.

In the key to genera by Fall (1905, p. 132) the genus *Episernus* will key to *Ernobius*. *Episernus* can be distinguished in that the lateral margin of the pronotum is distinct only basally, and is absent or indistinct anteriorly; in *Ernobius* the lateral margin of the pronotum is distinct throughout.

During this work I have examined a specimen of the type-species of *Episernus* (*E. angulicollis* Thoms., by monotypy) determined by F. Espanol.

Episernus belongs in the subfamily Dryophilinae and in a phylogenetic sequence should be placed after the genus *Ernobius*. For the benefit of American workers a description of the genus *Episernus* (as derived from the two North American species) follows:

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[1] Accepted for publication August 28, 1969.

[2] Mail address: c/o U. S. National Museum, Washington, D. C. 20560.

General.—Body elongate, rather narrow, averaging about 2.5 times as long as wide; pubescence short, very [illegible] dense, yellowish, appressed, unicolorous, [illegible] uniform in direction; body surface [illegible] granulate-punctate.

Head.—Front nearly evenly convex, clypeal suture impressed, clypeus and labrum much wider than long. Eyes moderate in size; bulging from head, larger, more bulging in male; eyes of female separated by 2.0 to 2.6 times vertical diameter of an eye, those of male separated by 1.7 to 2.0 times vertical diameter of an eye. Antennae 10-segmented, last three segments lengthened and widened, those of female about 1.5 times as long as all preceding united, those of male about 2.5 times as long as all preceding united; first antennal segment broad, arcuate, longest of segments 1 to 7; segments 2, 3, and 4 similar in length, 2nd broadest; segments 5, 6, and 7 similar in form, 7th shortest. Last segment of maxillary and labial palpi similar, elongate, rather narrow, broadest basally, bluntly pointed apically, about 2 times as long as wide.

Dorsal surface.—Pronotal surface undulate; pronotum at base about eight-tenths as wide as elytra at base; pronotum at side with a sharp, distinct margin only at base, margin at middle of side blunt to obsolete, margin absent anteriorly. Scutellum small, tab-shaped, distinctly wider than long. Elytra with distinct humeri; surface granulate-punctate as rest of body, at extreme sides with faint indication of rows of large punctures.

Ventral surface.—Prosternum short, broad, length before coxae equal to [illegible] coxal diameter; front coxae touching, conical, rather prominent; mesosternum short, broad, posterior margin broadly V-shaped; middle coxae touching, conical, prominent; metasternum broadly bulging posteriorly, declivous anteriorly; metepisternum elongate, narrow, broadest anteriorly, more narrow posteriorly, nearly parallel-sided medially; metacoxae very narrow and elongate, widest medially, narrowly separated at center. Abdomen with 5 segments (sometimes a sixth visible), all sutures distinct, straight, 5 segments very similar in length, 2nd somewhat longer than others. Legs long and thin, tarsus of each leg nearly as long as to as long as its tibia, first tarsal segment of hind legs nearly as long as remaining segments combined, 3rd and 4th tarsal segments of all legs lobed beneath, 4th more distinctly so, tarsal claws with a narrow, elongate tooth basally.

Length.—3.0 to 4.7 mm.

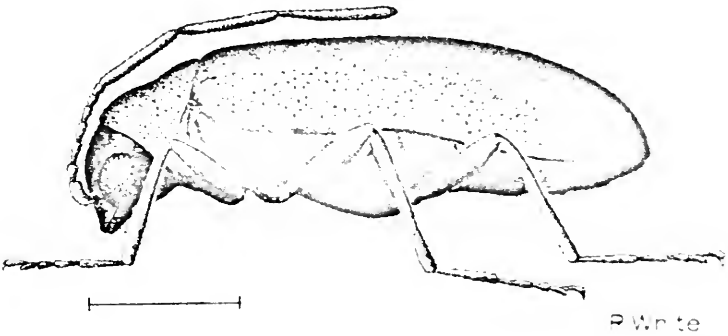

FIG. 1. Adult male of *Episernus trapezoideus* (Fall). Line equals 1 mm.

Episernus trapezoideus (Fall), 1905, p. 151, NEW COMBINATION, Fig. 1.

Episernus champlaini (Fisher), 1919, p. 298; NEW COMBINATION.

These two species have until now been placed in *Ernobius*, but are correctly assigned to the largely European genus *Episernus* Thomson (1863, p. 151).

XYLETINUS Latreille, 1809, p. 376.

Xyletinus brevis (White), 1960, p. 235; NEW COMBINATION.

I originally described the above species in the genus *Euvrilletta* on the basis of the elongate last 3 antennal segments. A detailed comparison of the morphology of *Euvrilletta xyletinoides* Fall (type-species of *Euvrilletta* by monotypy) and *E. texana* Van Dyke, 1946, p. 85, with *Xyletinus brevis* (White), *X. ater* (Cruetzer) (in Panzer, 1796, p. 9), *X. bucephalus* (Illiger), 1807, p. 10, and *X. peltatus* (Harris), 1836, p. 75, shows the above change to be desirable. The only significant difference that I find in the external anatomy of *Euvrilletta* from that of the above four species of *Xyletinus* is that the 3 terminal antennal segments of *Euvrilletta* are nearly, or fully as long as all preceding united; in *Xyletinus* the 3 terminal antennal segments are equal in length to only the 4 to 6 preceding segments combined. The genitalia of *Euvrilletta texana*, *Xyletinus brevis*, *X. ater*, and *X. peltatus* show no basic differences; that is, all are symmetrical, with the median lobe elongate and broadest basally, and the lateral lobes about as long as the median lobe. Each lateral lobe is rather leg-like and has a subapical palp-like process that is broadest apically. In addition, the median lobe of each bears internal spine and hook-like processes.

Xyletinus SPECIES GROUPS

Three natural groups of species can be recognized within the genus *Xyletinus*. In the first group (including *brevis*, *distans*, *sequoiae*, and *grossus*) the terminal 3 antennal segments are as long as the 5 to 6 preceding united, and the eyes are large. They are separated by 1 to 3 times the width of an eye as seen from the front. Some years ago type specimens of *Xyletinus grossus* and *X. sequoiae* were made available to me for examination. My sketches and notes on these show that they are very similar in antennal formation to *X. brevis*. These 4 species can properly be placed in *Xyletinus*, despite the antennal differences, because of very close agreement in other details of morphology, including the form of the male genitalia

In the second and third species groups the terminal 3 antennal segments are equal in length to the 4 to 5 preceding segments combined. In the second, or large-eyed, group (including *peltatus, harrisi, [illegible], and mucoreus*) the eyes are separated by 1 to 3 times the width of an eye as seen from the front. In the third, or small-eyed, group (consisting of *gracilipes, fasciatus, pubescens, lugubris,* and *fucatus*) the eyes are separated by 4 to 7 times the width of an eye as seen from the front.

It must be noted that the species *gracilipes* Fall is very aberrant for the genus. I have seen only Fall's type (USNM number 64850). It differs from all other members of the genus in that the tarsi are slender and nearly as long as or equal in length to the tibiae. The tarsi of the other species of *Xyletinus* are stout and ½ to ⅔ as long as the tibiae. Also the ventral surface of the head in *gracilipes* bears distinct depressions which receive the antennae in repose; the ventral surface of the head in most species is feebly to slightly depressed. Two described species (*fasciatus* and *pubescens*) have the head depressed beneath, the former to as great an extent, and the latter to a lesser extent than does *gracilipes*. In addition, the palpi of *gracilipes* are elongate and narrow. Though there is variation in the form of the palpi in the genus, the elongation is more developed in *gracilipes* than in any other species.

It is possible that *gracilipes* deserves being given separate generic rank (this was also noted by Fall, 1905, p. 203). However, the rank to be accorded *fasciatus* and *pubescens* would complicate such a move. Also, within the small-eyed series, there appears to be a number of undescribed species, and there are puzzling variations in series of named specimens. A thorough study of the genus with more material than now at hand will be necessary for an understanding of these problems and changes in the genus or additions to it at this time are not justified.

Examination of the European *Xyletinus ater* (Creutzer) has shown this species to be very similar to our third (small-eyed) species group. It also bears slight depressions on the ventral surface of the head between the eyes. In an application that has been submitted to the Commission on Zoological Nomenclature I have asked the Commission to exercise its plenary powers to designate *X. ater* as the type-species of *Xyletinus*.

XESTOBIUM Motschulsky, 1845, p. 35.
Xestobium marginicollis (Leconte), 1859, p. 87;
NEW COMBINATION

Ruckes (1958, p. 146) placed *Ernobius marginicollis* Leconte in *Hyperisus*. I have compared *Hyperisus plumbeum* (Illiger), 1801, p. 87

(type-species of *Hyperisus* by monotypy) with *marginicollis* and am in agreement that the two species are congeneric and different from *Ernobius*. In the most recent European treatment including *Hyperisus* (Espanol, 1964), the latter genus is treated as a subgenus of *Nestobium*.

A detailed comparison of *Nestobium rufovillosum* (DeG.) (the type-species of *Nestobium* by monotypy and original designation), *N. abietis* Fisher, and *N. affine* Leconte with *Hyperisus plumbeum* and *H. marginicollis* shows only the following differences. In the two species of *Hyperisus* the pubescence of the dorsal surface is unicolorous yellowish, uniform in density, and has intermixed, distinctly bristling hairs. Also the median elytral suture at the apical ½ is depressed, and there is a degree of asymmetry in the median lobe of the male genitalia. In the above species of *Nestobium* the pubescence of the dorsal surface is appressed and bicolored with irregular patches of generally dense, golden pubescence contrasting with the much sparser dark pubescence. Also, the median elytral suture at the apical ½ is not depressed, and the male genitalia are symmetrical. I regard the above differences as too feeble a basis for separation of *Hyperisus* from *Nestobium*, and regard the names as synonyms.

CAENOCARA Thomson, 1859, p. 907.
Caenocara californica LeConte.

Caenocara californica Leconte, 1878, p. 412.
Caenocara occidens Casey, 1885, p. 330.

Fall (1905, p. 274) synonymized Casey's *C. occidens* with *californica*. Casey (1924, p. 207) claimed that his *occidens* was not even closely related to *californica*, "having only about half the weight and being of a pale piceous color, uniformly throughout my series of three specimens, besides differing in many other ways."

I have compared Casey's type and two paratypes of *occidens* (USNM number 49236) with two specimens determined by Fall as *californica*. The three specimens of *occidens* are all about 1.4 mm in length, are reddish brown to dark reddish brown above, and reddish brown to nearly black below. The two specimens of *californica* are 1.5 and nearly 2.0 mm in length; the smaller is a little darker than any of the three specimens of *occidens*, and the larger is distinctly darker than any *occidens* specimens. I find no differences between these two series (in regard to external morphology, antennae, and palpi) other than size and color and conclude that the two names cover a single species.

PTILINUS Müller, 1764, p. xii.

Ptilinus acuminatus Casey, 1898, p. 63.

Hopping (1928, p. 8) synonymized *P. acuminatus* Casey and *P. basalis* Leconte. I have compared Casey's three female types (type and two paratypes with USNM number 48848) with *basalis* and find *acuminatus* to be a valid species. The characters presented by Fall (1905, p. 279) for distinguishing the two species are workable.

Ptilinus flavipennis Casey, 1898, p. 64.

Fall (1905, p. 281) synonymized *P. flavipennis* with *P. basalis*, Leconte however, comparison of Casey's male type and only specimen of *Ptilinus flavipennis* with a lengthy series of *P. basalis* Lec. has shown *flavipennis* to be a valid species distinct from *basalis*, as was stated by Casey (1924, p. 207). The type of *flavipennis* is 2.7 mm in length; the ramus of the third antennal segment is a little shorter than the segment itself, and the base of the ramus extends past the middle of the segment. The ramus of the fourth segment is 2 times as long as the segment, and the ramus of the fifth segment is 4 times as long as the segment. Males of *basilis* vary from 3.0 to 4.6 mm in length; the ramus of the third antennal segment is a little longer than the segment and its base extends to the middle of the segment. The ramus of the fourth segment is about 4 times as long as the segment, and the ramus of the fifth segment is about 6 times as long as the segment.

OLIGOMERUS Redtenbacher, 1849, p. 347.

Oligomerus oregonensis Hatch, 1961, p. 316.

Melville Hatch in his Beetles of the Pacific Northwest described and illustrated the above species. However, his illustration is clearly of a beetle belonging to the genus *Xyletinus*, and the drawing does not agree with his description of the antennae and elytral striae. In the description antennal segments 9 to 11 are termed "greatly enlarged," and the elytral striae as composed of "series of elongate punctures." The drawing shows the last three antennal segments to be but slightly enlarged, and the elytral striae to consist of fine lines. I am not able to recognize the species from the description, and regard the status of *O. oregonensis* Hatch as uncertain.

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New Exotic Crane-Flies (Tipulidae: Diptera). Part XVIII[1]

CHARLES P. ALEXANDER[2]

The preceding part under this general title was published in ENTOMOLOGICAL NEWS, Vol. 80 (5): 125–130. At this time I am describing three species of the genus *Hexatoma* Latreille from India, taken in Assam by Dr. Fernand Schmid and in South India by Mr. P. Susai Nathan, as well as a single species of the genus *Nephrotoma* Meigen, collected in Papua by Dr. John Wallace Boyes. The types of the novelties are preserved in my personal collection except where indicated otherwise.

Nephrotoma boyesi, NEW SPECIES

Head orange, region of the occipital brand with a large quadrate brown area, its anterior angles farther produced to attain the eyes; mesonotal praescutum light yellow with three conspicuous stripes, the central one broader, intensely polished black, its margins and the lateral stripes opaque black; scutum yellow, each lobe with two confluent opaque black areas; posterior sclerites of notum and the pleura yellow patterned with darker; wings weakly infuscated, restrictedly patterned with darker, cell *Sc* brown; abdominal tergites bicolored, yellow, the posterior borders blackened; male hypopygium with posterior margin of tergite produced into two approximated compressed-flattened blades that are provided with numerous blackened spinoid setae, the lateral armature of the plate including two or three strong blackened points; inner dististyle with posterior crest extended backward into a flattened glabrous blade; eighth sternite with posterior border broadly emarginate, lateral lobes obtuse, provided with abundant setae.

Male.—Length about 14.5 mm; wing 12.5 mm; antenna about 4 mm.
Female.—Length about 15 mm; wing 13 mm.

Frontal prolongation of head narrowly orange above, yellow on sides; nasus elongate, with conspicuous black setae; palpi obscure yellow, outer half of terminal segment blackened. Antennae with scape obscure yellow, pedicel dark brown, flagellum

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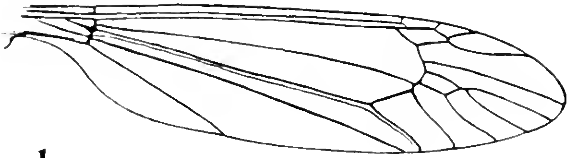
black; flagellar segments of male with conspicuous basal enlargements. Head orange, region of the occipital brand with a large quadrate dark brown area, the anterior angles farther produced laterad to attain the eyes where the color is more blackened; sides of posterior vertex and occiput with conspicuous black setae.



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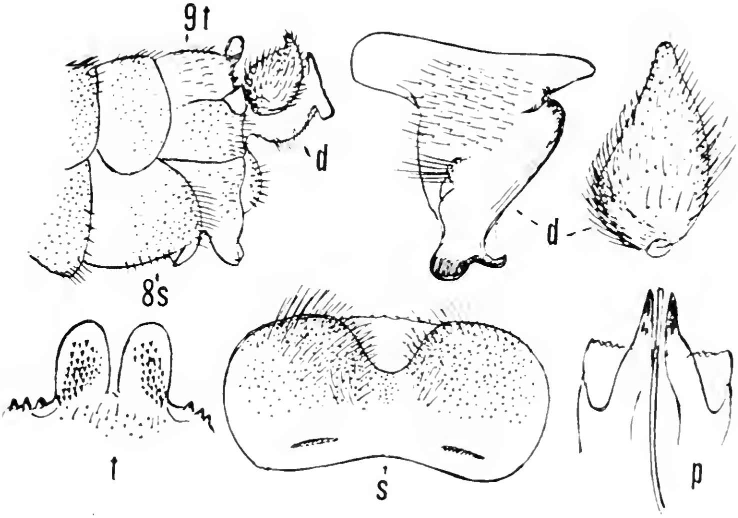

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FIG. 1. *Nephrotoma boyesi*, new species; venation. FIG. 2. The same; details of male hypopygium. (Symbols: *d*, dististyles; *p*, phallosome; *s*, 8th sternite; *t*, 9th tergite.)

Pronotal scutum light yellow, sides and the scutellum blackened. Mesonotal praescutum with ground light yellow, with three conspicuous stripes, central area broader, intensely polished black, the borders opaque black, very narrowly behind, broader on anterior half, gradually widened anteriorly and becoming confluent; lateral stripes opaque black, at anterior end with a paler brown spot that does not attain the margin; central point of suture with a blackened V-shaped mark; scutum light yellow, each lobe with two confluent dull black areas; scutellum dull black, parascutella pale except along the elevated posterior border; mediotergite yellow, posterior third with two contiguous polished black areas that are bordered by opaque black, pleurotergite orange dorsally, katapleurotergite light yellow, blackened beneath adjoining the halteres; mediotergite with conspicuous erect black setae. Pleura yellow, anepisternum and ventral sternopleurite with light brown markings, the former larger; a narrow transverse more blackened band between the mesepisternum and pteropleurite. Halteres light brown, base of knob slightly more darkened, apex slightly whitened. Legs with coxae and trochanters orange; fore femora black, bases very narrowly brightened, middle and hind femora paler brown; tibiae light brown, tips narrowly blackened; tarsi brownish black to black, claws of male toothed, microscopically hairy. Wings (Fig. 1) weakly infuscated, prearcular and costal fields more yellowed, including cell *C* and the narrow anterior borders of cells *R* and R_1, cell *Sc* darkened; stigma dark brown, basal section of R_{1+2} with a very narrow brown cloud; veins brown. Stigma with about eight strong trichia. Venation: Sc_1 ending shortly beyond origin of the short oblique *Rs*; cell M_1 short-petiolate, the stem longer in the holotype, nearly equal to *m*; *m-cu* on M_4.

Basal abdominal tergites bicolored, yellow, posterior borders blackened, narrow and intense on first segment, more extensive and slightly polished on outer segments, gradually increasing in amount, on outer four segments forming a solidly blackened ring, terminal segment more brightened in both sexes; sternites more obscure yellow. Ovipositor horn-yellow, including the dorsal shield, ventral shield black. Male hypopygium (Fig. 2) with posterior border of tergite, *t*, produced into two approximated erect compressed-flattened blades that are provided with numerous blackened spinoid setae, lateral armature of tergal plate with two or three small strong blackened points. Outer dististyle, *d*, broad, the greatest width more than one-half the length, apex extended into a relatively short point; inner style with posterior crest produced behind into a flattened glabrous blade, the apex obtusely rounded. Phallosome, *p*, with gonapophyses appearing as flattened yellow blades subtending the slightly longer blackened aedeagus, their apical borders microscopically roughened. Eighth sternite, *8s*, with posterior border broadly emarginate, the incisure filled with pale membrane, lateral lobes broadly obtuse, with abundant moderately long setae.

Habitat.—NEW GUINEA. *Holotype:* ♂, Wau, Papua, altitude 3,600 feet, June 7, 1968 (J. W. Boyes). *Allotopotype:* ♀, with the type. Holotype in Canadian National Collection, Ottawa; allotype in Alexander Collection. Submitted for identification by Dr. Herbert J. Teskey, of Ottawa.

The species is dedicated to Dr. John Wallace Boyes, distinguished student of cytology and genetics, who collected the material in 1968 while on a cytological expedition to many countries in the Old World Tropics. The species is distinguished from all other regional members of *Nephrotoma* by the body coloration, especially of the head, and in all details of the male hypopygium. The structure of the ninth tergite in the male is much as in two species of the genus in South India, *Nephrotoma fletcheriana* Alexander, and *N. kodaikanalensis* Alexander, which have the other hypopygial characters and the body coloration quite different from the present fly.

Hexatoma (Eriocera) glabricornis, NEW SPECIES

Size medium (wing of male less than 10 mm); general coloration of head and thorax brownish black, pruinose; antennae of male very long, exceeding two and one-half times the wing, black, flagellar segments virtually without vestiture; femora brownish yellow, tips narrowly darkened; wings faintly tinged with brown, veins behind costa virtually glabrous.

Male.—Length about 8 mm; wing 9.3 mm; antenna about 25 mm.

Rostrum much reduced, brown; palpi very small, brown. Antennae of male very long, exceeding two and one-half times the wing; scape light brown, darker above, pedicel very small, yellow; first flagellar segment brownish yellow on about the proximal third, remainder of antenna black; flagellar segments very long-cylindrical, virtually glabrous, with very few small scattered stout setae, other vestiture virtually lacking, not long and erect as in *prolixa*. Head brownish gray, clearer gray behind, with sparse long pale setae; vertical tubercle very large, subglobular, with a capillary darkened central vitta, orbital region on either side submembranous, buffy.

Pronotum and cervical region concealed. Mesonotum blackened, gray pruinose; praescutum with three brown stripes, the broad central one with a capillary blackened vitta, lateral and humeral borders with very long pale setae; posterior sclerites pruinose, centers of scutal lobes and posterior half of mediotergite with the pruinosity very sparse to appear blackened. Pleura brownish gray, more darkened above, metapleural region clearer gray. Halteres with stem yellow, knob dark brown. Legs with coxae brownish gray, without conspicuous setae; trochanters pale brown; femora, tibiae and basitarsi brownish yellow, tips narrowly darkened, remainder of tarsi brownish black. Wings faintly tinged with brown, prearcular and costal fields more brownish yellow; stigma elongate, slightly darker than the ground; veins pale brown, cord and vein R_{4+5} darker brown. Veins behind costa virtually glabrous, including *R*, distal section of R_5 with a few scattered trichia. Venation: R_{2+3+4} straight, less than twice R_{2+3}; elements of the cord behind vein R_5 in virtual transverse alignment; outer end of cell *R* about one-half broader than cell *M*; cell *1st* M_2 subequal to distal section of M_3; *m-cu* just beyond fork of *M*, subequal in length to distal section of Cu_1.

Abdomen dark brown, sparsely pruinose.

Habitat.—ASSAM. *Holotype:* ♂, Bomdi La, Kameng, North East Frontier Agency, 8,800 feet, June 16, 1961 (Schmid).

Hexatoma (*Eriocera*) *glabricornis* is most similar to species such as *H.* (*E.*) *prolixa* Alexander, differing in details of coloration, the virtually glabrous antennae, and in the lack of trichia of the wing veins.

Hexatoma (Eriocera) perelongata, NEW SPECIES

Belongs to the *albipunctata* group; size very large (length of male 32 mm; abdomen alone about 25 mm); mesonotal praescutum dull black, disk with four brownish gray stripes, posterior sclerites of notum blackened; antennae with proximal two flagellar segments yellow, remainder black;

wings dark brown, apex whitened; abdomen unusually long, chiefly dark brown, segments two to four vaguely paler.

Male.—Length about 32 mm; wing 19.5 mm; antenna about 5 mm, abdomen alone about 25 mm.

Rostrum brownish gray; palpi black. Antennae of male 8-segmented; scape and pedicel black, the former slightly pruinose; segments three and four yellow, remainder black; first flagellar segment about one-half longer than the second, outer two segments subequal. Head black, pruinose; vertical tubercle complex, including three small anterior lobules and a single rounded central protuberance behind.

Pronotum gray. Mesonotal praescutum with the ground dull black, disk with four obscure gray stripes, median darkening narrowed behind, obsolete before suture, humeral and lateral regions narrowly light gray; posterior sclerites of notum blackened, pleurotergite vaguely more pruinose. Pleura black, more pruinose ventrally. Halteres with stem brown, knob black. Legs with coxae and trochanters black, pruinose; femora, tibiae and basitarsi brownish black, their tips darker, remainder of tarsi black. Wings almost uniformly dark brown, base of cell *1st A* and posterior margin of *2nd A* slightly paler; extreme wing tip whitened, including parts of cells R_3, R_4 and R_5; veins darker brown, yellow in the whitened apex. Longitudinal veins beyond cord chiefly with sparse trichia, these lacking on veins comprising cell *1st* M_2, more numerous on R_5. Venation: R_{1+2} about one-half longer than R_{2+3+4} or R_{2+3}; *m-cu* shortly before fork of M_{3+4}, longer than distal section of Cu_1.

Abdomen unusually long, as shown by the measurements; chiefly dark brown, segments two to four vaguely paler brown, base of segment six slightly paler.

Habitat.—SOUTH INDIA. *Holotype:* ♂, Cinchona, Anamalai Hills, 3,500 feet, May 1967 (Susai Nathan).

Hexatoma (Eriocera) perelongata is most nearly allied to species such as *H. (E.) elongatissima* (Brunetti) and *H. (E.) tenuis* (Brunetti), differing in the coloration of the legs, thorax and abdomen. Brunetti describes the male antennae of *elongatissima* as being 7-segmented, possibly in error.

Hexatoma (Eriocera) uniflava, NEW SPECIES

General coloration of body blackened, praescutum dark gray with more blackened stripes; legs brownish black, tips of femora and tibiae still darker; wings dark brown, apex in outer radial cells whitened; abdomen dull black, including the genital shield of ovipositor; segment four conspicuously light yellow on proximal half of both the tergite and sternite, interrupted at midline.

Female.—Length about 15 mm; wing 14 mm; antenna about 3.8 mm.

Rostrum black, gray pruinose; palpi black. Antennae of female 10-segmented; scape and pedicel brownish black, flagellum pale brown; flagellar segments progressively shorter outwardly, terminal slightly longer than the subequal eighth and ninth segments. Head blackened, sparsely pruinose; vertical tubercle double, anteriorly with a more blackened transverse elevation, behind with a smaller cone.

Pronotum brownish gray. Mesonotal praescutum dark gray with more blackened stripes, the lateral pair solidly darkened, the broad intermediate areas more grayish on centers of anterior ends, the central line darkened, a more blackened marginal spot behind the humeri; posterior sclerites of notum blackened. Plura black, with restricted gray areas, especially on sternopleurite, anepsternum with a more blackened spot immediately below the darkened dorsopleural region. Halteres with stem light brown, knob dark brown. Legs with coxae black, sparsely pruinose; trochanters black; femora brownish black, outer ends still darker; tibiae brown, tips darker; tarsi brownish black. Wings strongly dark brown, cell *C* slightly more yellowed; a pale streak behind base of vein *1st A;* wing tip whitened, including outer end of cell R_1 and parts of cells R_3 and R_5. Venation: R_{2+3+4} slightly longer than R_{2+3}, subequal to R_{1+2}; cell *1st* M_2 subequal to distal section of vein M_{1+2}.

Abdomen dull black, including the genital shield of ovipositor; segment four with slightly more than the proximal half of both tergite and sternite light yellow, narrowly interrupted by the brownish black border of tergite and paler areas on sides of sternite. Ovipositor with cerci very long and slender, horn colored.

Habitat.—SOUTH INDIA. *Holotype:* Cinchona, Anamalai Hills, 3,500 feet, September 1967 (Susai Nathan).

In the coloration of the mesonotal praescutum the present fly is generally similar to *Hexatoma* (*Eriocera*) *pulchrithorax* (Brunetti) which differs in the larger size and in the coloration of the thorax, abdomen and legs. The pattern of the abdomen of the present species appears to be distinctive.

Two New Species of Sub-Arctic American Orthoptera

V. R. Vickery[2]

Recently I published a report on the Orthoptera of Alaska, Yukon and the Mackenzie District of the Northwest Territories (Vickery, 1967). Since that time I have received specimens which were not previously recorded. These belong to new species so it is necessary to describe them in order to bring our knowledge of the Orthoptera of this area up to date. Superficially, both new species described in this paper resemble known species and it was not until a detailed examination was made that they were discovered to be undescribed.

The first species resembles *Bruneria brunnea* (Thomas). It might have been recorded as a northern record for that species but for the fact that the locality in which it was found is 750 to 1,000 miles north of the previous records for *B. brunnea*. Comparison of the specimens at hand with specimens of *B. brunnea* from Chilcotin, British Columbia, and from 10 miles east of Fort MacLeod, Alberta, has revealed the resemblance to be superficial. Genitalic differences (Figs. 5 to 8) are so great that the new species should possibly be placed in a new genus, although at present it is tentatively assigned to *Bruneria*.

Bruneria yukonensis NEW SPECIES

(Figs. 1–5, 7)

Holotype.—Male, "Canada: Yukon, Lake Laberge shore, 62° N.; 135° W., 23–VIII–1961, D. Marsh." A second label on the specimen bears the additional data: "W. shore of lake; deep creek, no trees, grassy slope burned out by sun." [Specimen in the Lyman Entomological Museum.]

Very similar in appearance to *B. brunnea* (Thomas), (Figs. 1 and 2), differing in the following external characters: head smaller in proportion to the body; frontal fastigium narrower near the vertex and sulcate below the median ocellus, gradually becoming obsolete (not terminating abruptly immediately below the ocellus as in *brunnea*); lateral foveolae of vertex narrower and decreasing in width at apices (not regularly rectangular as in *brunnea*); median carina of pronotum faintly cristate on prozona, elevated but not arcuate on metazona (not uniformly elevated on both as in *brunnea*); tegmina reaching nearly to the tip of the abdomen, 12.3 mm long (not slightly exceeding the tip of the abdomen as in *brunnea*, in which mean length of teg-

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[1] Accepted for publication July 7, 1969.

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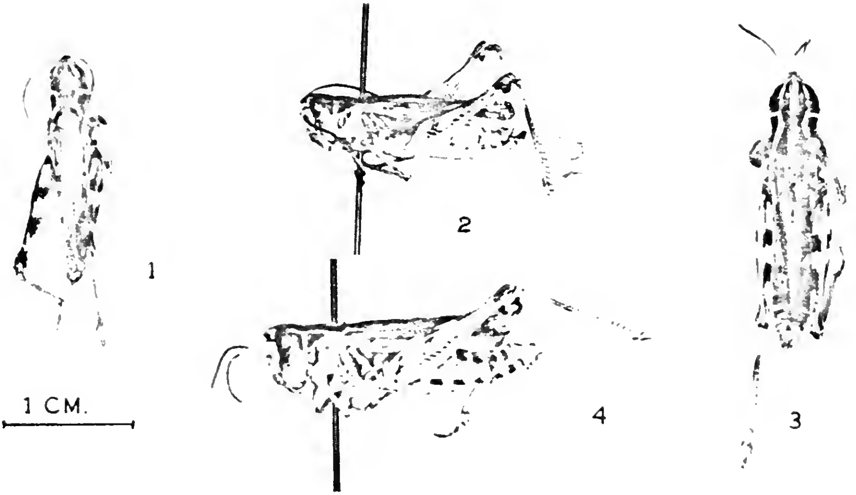
mina of five specimens from Fort MacLeod, Alberta, is 14.8 mm). Measurements also differ slightly as follows (those for a mean of five specimens of *brunnea* from the above locality are given in parentheses for comparison, all measurements in mm): width of vertex between the eyes, 1.1 (1.3); pronotal length, 3.2 (3.5); length of hind femur, 11.6 (11.1); length of hind tibia, 9.2 (8.9).



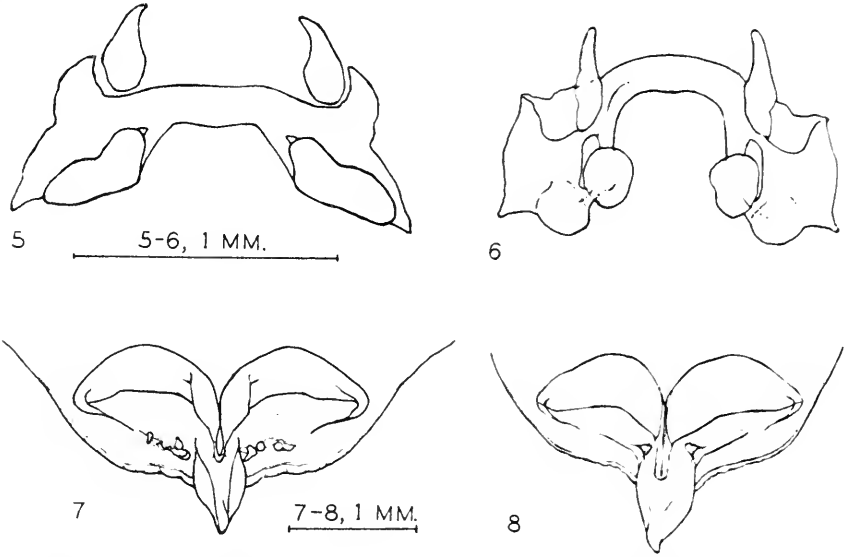
FIGS. 1–4. *Bruneria yukonensis.* FIG. 1. Holotype, male, dorsal view; FIG. 2. Holotype, male, lateral view; FIG. 3. Allotype, female, dorsal view; FIG. 4. Allotype, female, lateral view.

The color and color-pattern are as in *B. brunnea,* but tend in the holotype (as well as the others in the type series) to be somewhat accentuated, the paler areas having become bleached due to alcohol immersion.

The internal genitalia differ from those of *B. brunnea* (Fig. 6) mainly in the epiphallus (Fig. 5) being broader, the bridge flatter and the ancorae and lophi much heavier. These differences are clearly shown by comparison with several specimens of *brunnea* from the northern part of its range, both east and west of the continental divide, in Saskatchewan, Alberta and British Columbia, all of which conform to the type shown in Fig. 6. No significant differences were found between the aedeagal valves of the two species.

Allotype: Female, same data as the holotype.

Differs from the holotype in sexual characters and in size, the small size of the head in proportion to the body (Figs. 3 and 4), as compared with *B. brunnea,* is even more noticeable; median carina of pronotum uniformly elevated throughout; differing slightly from *B. brunnea* in the following measurements (those for a mean of five specimens from Fort MacLeod, Alberta, are given in parentheses for comparison, all measurement's are in mm), width of vertex between eyes, 1.4 (1.6); pronotal length, 3.7 (3.8); length of hind femur, 11.6 (11.1); length of hind tibea, 9.2 (8.9); length of tegmina, 12.3 (14.8).



Figs. 5–8. Fig. 5. Male epiphallus of *Bruneria yukonensis*, dorsal aspect; Fig. 6. Male epiphallus of *Bruneria brunnea* (Thomas), dorsal aspect; Fig. 7. Female subgenital plate of *Bruneria yukonensis*, dorsal aspect (removed and cleared); Fig. 8. Female subgenital plate of *Bruneria brunnea* (Thomas), dorsal aspect (removed and cleared).

The color and color pattern are very similar to those of *B. brunnea*.

The dorsal surface of the subgenital plate (Fig. 7—drawn from the paratype) differs from that of *B. brunnea* (Fig. 8) in being slightly broader, and in having the floor pouches somewhat narrower, but mainly in the degree of development of the "columellae" (*sensu* Randell, 1963), which in *yukonensis* are strongly developed, multiple, and occur over much of the length of the contact area, whereas in *brunnea*, they are single and located at the inner margins of the contact areas.

Paratype: One female, same data as the holotype.

Very similar to the allotype, differing only in the following measurements: pronotal length, 3.9; tegminal length, 15.1, hind femur, 12.1, hind tibia, 9.9 mm.

Key to species of Bruneria

1. Head small in proportion to body; tegmina reaching nearly to tip of abdomen; distribution northern...........**B. yukonensis** Vickery

Head large in proportion to body; tegmina slightly exceeding tip of abdomen; distribution more southern (known only as far north as Jasper and Edmonton, Alberta, and Prince Albert and Lloydminster, Saskatchewan)................**B. brunnea** (Thomas)

Note: No other species of this genus is found as far north as Canada but are confined to the southwestern United States.

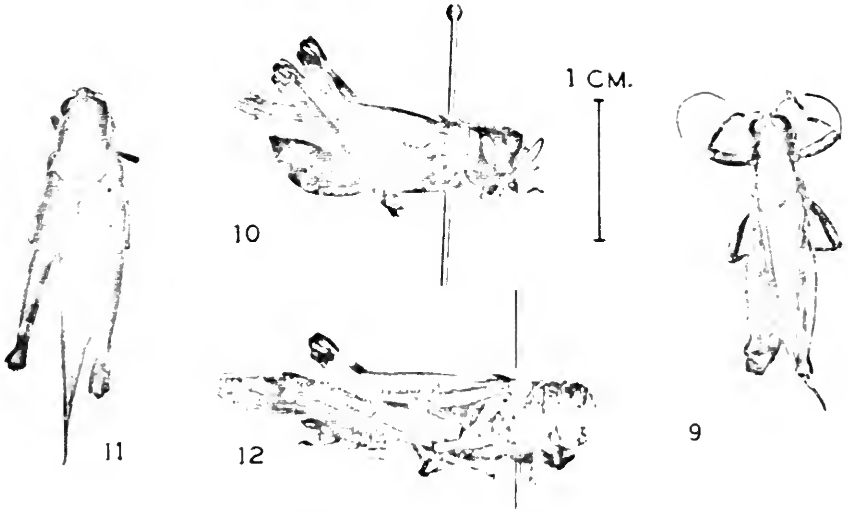
During the summer of 1968, several specimens of *Melanoplus* were collected near Fairbanks, Alaska, by Mrs. R. Gordon. Examination of these revealed that they are not conspecific with any of the known North American *Melanoplus*. They are here described as a new species and are named for Vivian Gordon, in appreciation of her interest and efforts in providing the specimens.

Melanoplus gordonae NEW SPECIES

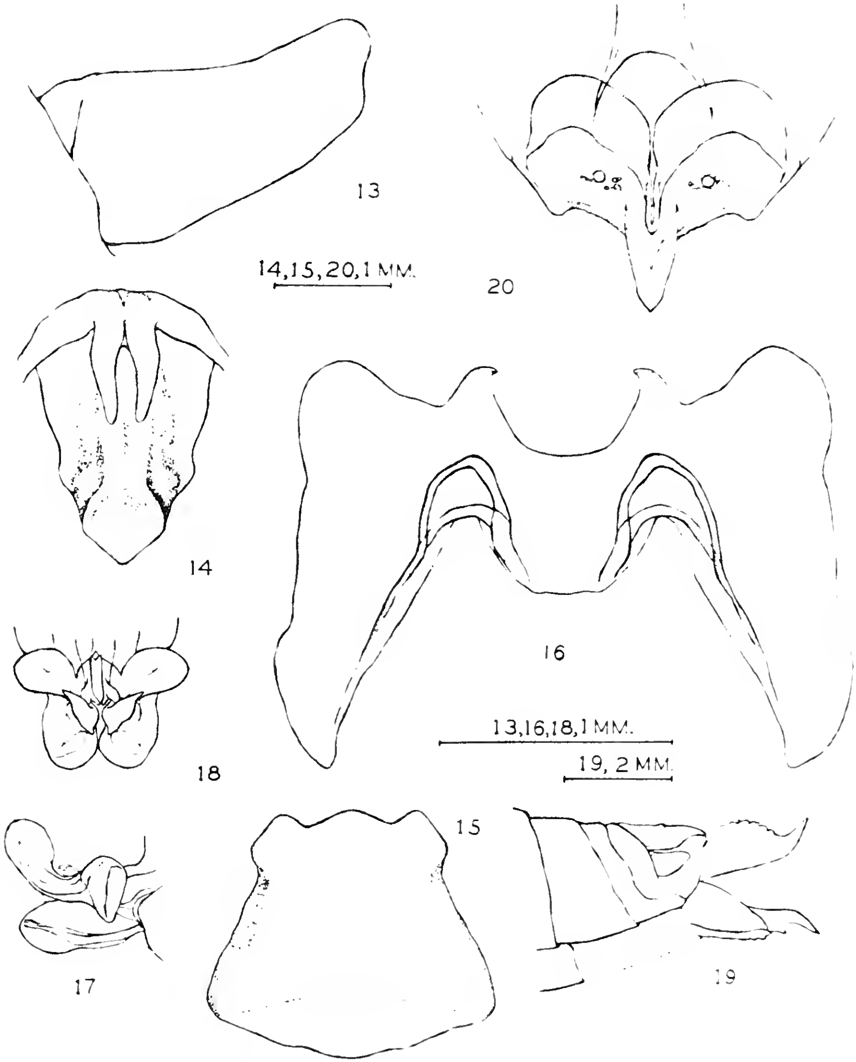
(Figs. 9–20)

Holotype.—Male, "U. S. A.: Alaska, nr. Fairbanks, 2 mi. along Gilmore Trail, 13-VIII-1968, V. Gordon." [Specimen in the Lyman Entomological Museum.]

Size similar to *Melanoplus femurrubrum femurrubrum* (De Geer), which it superficially resembles (Figs. 9 and 10), differing in the following respects: frontal costa broader and of generally uniform breadth (the slight enlargement at the level of the median ocellus more pronounced and abrupt), in profile projecting more in advance of the eyes, and with sulcation less pronounced than in *femurrubrum;* median carina of pronotum more elevated on metazona; subgenital plate distinctly trilobate at apex (Fig. 15), not entirely rounded as in *femurrubrum;* furculae more convergent (Fig. 14) but otherwise similar to *femurrubrum;* cerci much broader throughout, not distinctly narrowed at apex, and with apex distinctly emarginate (Fig. 13); comparative measurements of the holotype with the mean of a sample of five males of *femurrubrum* (in parentheses) from Salmon Arm, British Columbia, are as follows (all in mm): width of vertex between the eyes, 0.60 (0.43); pronotal length, 4.65 (4.10); fore femur length, 3.5 (3.3); hind femur length, 11.3 (11.0); length of hind tibia, 9.9 (8.6); tegminal length, 15.5 (14.7).



Figs. 9–12. *Melanoplus gordonae*. Fig. 9. Holotype, male, dorsal view; Fig. 10. Holotype, male, lateral view; Fig. 11. Allotype, female, dorsal view; Fig. 12. Allotype, female, lateral view.



FIGS. 13-20. *Melanoplus gordonae.* FIG. 13. Left cercus of male, lateral aspect; FIG. 14. Furculae of male, dorsal aspect; FIG. 15. Subgenital plate of male, posterior aspect; FIG. 16. Epiphallus of male; FIG. 17. Aedeagal valves, male, dorsal aspect; FIG. 18. Aedeagal valves, male, dorsal aspect; FIG. 19. Terminal abdominal segments of female, showing cerci and ovipositor valves; FIG. 20. Female subgenital plate dorsal aspect (removed and cleared).

The coloration is very similar to *femurrubrum*, both being without dark bars on the external face of the hind femur.

The internal genitalia differ from those of any other northern species of *Melanoplus*, the epiphallus is larger and much more heavily sclerotized with the bridge and lophi broader and heavier (Fig. 16); the aedeagal valves resemble those of *femurrubrum*, but are narrower apically in dorsal aspect (Fig. 18) and are more obtusely rounded in lateral aspect (Fig. 17).

Allotype: Female, same data as holotype (Figs. 11 and 12).

Differs from the holotype in sexual characters and in larger size, and in the fact that the hind femur shows indistinct barring dorsally which extends to the outer face over the upper chevrons. The dorsal area of the prozona appears reddish, but this may be due in part to alcohol immersion.

The female cerci are triangular but with both upper and lower edges strongly convex (not concave as in *M. femurrubrum* and are longer than those of *M. sanguinipes;* the dorsal ovipositor valves are broader (Fig. 19), with the "shoulder" angle of 130°, as compared with angles of 133° in *femurrubrum* and 117° in *sanguinipes* (Brooks, 1958); the tip of the ventral ovipositor valve appears longer. Comparative measurements of the allotype with the means of a sample of five females of *femurrubrum* from Salmon Arm, British Columbia (in parentheses) as follows (all in mm): width of vertex between the eyes, 0.65 (0.65); pronotal length, 5.2 (4.9); fore femur length, 3.5 (3.3); hind femur length, 13.3 (12.5); length of hind tibia, 11.4 (10.2); tegminal length, 22.0 (17.3).

The dorsal view of the female subgenital plate (Fig. 20) shows the edges with very strong posterolateral projections, much more accentuated than in other northern species of *Melanoplus;* the columellae are strongly sclerotized and more specialized.

Three additional specimens, probably belonging to this species, have the same locality data, but were collected earlier during the same season. They are all juvenile so that determination is not considered positive.

It is hoped that additional material will soon be collected at the type locality in order to increase our knowledge of this hitherto overlooked species.

KEY TO SPECIES OF **Melanoplus** FOUND IN ALASKA, YUKON AND MACKENZIE DISTRICT

(Most of the salient features are illustrated by Brooks, 1958 or Vickery, 1967).

1\. Males...2
Females...9
2\. Tegmina shorter than abdomen...3
Tegmina exceeding the abdomen...5

3. Hind femur banded on outer face.................................4
Hind femur not banded on outer face, pale yellowish-brown..........
....**M. b. borealis** (Fieber)

4. Cercus broad at base and narrowing to blunt apex..................
....**M. frigidus** (Boheman)
Cercus long, sides subparallel, somewhat incurved and broadly
rounded at apex........................**M. fasciatus** (F. Walker)

5. Cercus broad, not strongly tapered on apical half...................6
Cercus strongly tapered on apical half; subgenital plate with
apex concave; confined to extreme southern part of Mackenzie
District..........................**M. f. femurrubrum** (DeGeer)

6. Cercus large, rectangular, with rounded apex bent dorsally;
furculae small; apex of subgenital plate truncate or rounded
acute.................................**M. k. kennicotti** Scudder
Cercus smaller, flat or nearly so; apex of subgenital plate
notched or trilobate...7

7. Apex of subgenital plate trilobate, the lobes of equal height,
outer lobes projecting laterally and obliquely truncate (Fig. 15)....
....**M. gordonae** Vickery
Apex of subgenital plate notched......................................8

8. Subgenital plate broader than deep; furculae medium-sized and
distinctly divergent................**M. s. sanguinipes** (Fabricius)
Subgenital plate long, produced upward behind; furculae large,
long and nearly parallel........................**M. bruneri** Scudder

9. Tegmina not reaching the tip of the abdomen........................10
Tegmina exceeding the abdomen...12

10. Hind femur banded on outer face.....................................11
Hind femur not banded......................**M. b. borealis** (Fieber)

11. Tegmina short, extending only to the fourth abdominal segment;
hind femur mainly pale with dark bands....**M. frigidus** (Boheman)
Tegmina longer, extending beyond the sixth abdominal segment;
hind femur mainly dark with pale bands..**M. fasciatus** (F. Walker)

12. Dorsal surface of tegmina spotted; tegmina just reaching apices
of hind femora........................**M. k. kennicotti** Scudder
Dorsal surface of tegmina not spotted, tegmina exceeding apices
of hind femora...13

13. Antennal crescent not divided; hind femur without bands...........
..................................**M. f. femurrubrum** (DeGeer)
Antennal crescent divided; hind femur banded.........................14

14. Lower flange of hind femur with pink to reddish stripe on outer
surface; dorsal angle of upper ovipositor valve 117°..............
..................................**M. s. sanguinipes** (Fabricius)
Lower flange of hind femur entirely yellow; dorsal angle of
upper ovipositor valve greater than 125°...........................15

15. Upper edge of cercus straight; dorsal angle of upper ovipositor
valve 145°...................................**M. bruneri** Scudder
Both edges of cercus convex; dorsal angle of upper ovipositor
valve 130°...................................**M. gordonae** Vickery

ACKNOWLEDGMENTS

The author wishes to extend thanks to Mrs. R. Gordon, Fairbanks Alaska, for her interest and efforts; Miss Diane E. Johnstone, who prepared the photographs and illustrations; and to Miss Nora Brown for the typescript.

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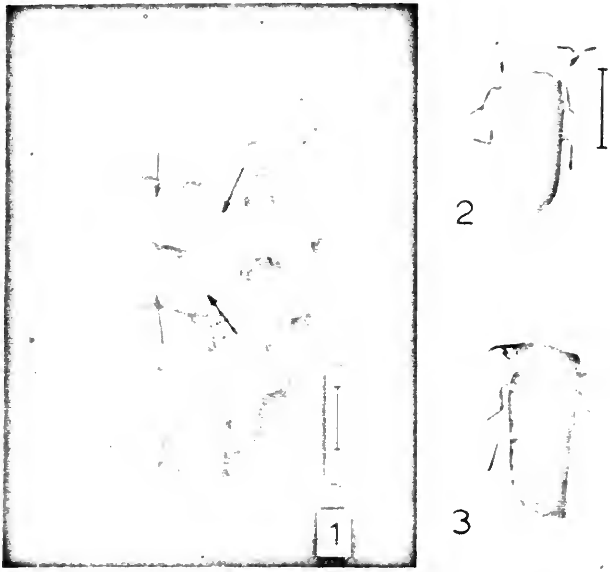
(Continued from p. 251)



FIGURES 1-3. FIG. 1. Photomicrograph of the abdominal sternites of *Pleotomus nigripennis* LeConte; FIG. 2 Dorsal view of *Pleotomus nigripennis* LeConte; FIG. 3. Ventral view of same. (Line figure 1 equals 1 mm, FIGS. 2 and 3 equals 5 mm.)

influence. This is the first evidence of light production in the genus *Pleotomus*. The active period of the adult male beetles within the Monument is limited to the period from the last week of May to the end of July.

The author is indebted to the late J. W. Green for determining material and distributional data and to Robert and Soori Bell, students at this Institution, for their observations of this phenomenon. ELBERT L. SLEEPER, *Entomology, California State College, Long Beach, California* 90801.

Trishormomya crataegifolia[1] (Felt), a Redescription of Adult and Immature Stages[2]

Donald W. Webb[3] and James E. Appleby[4]

Trishormomya crataegifolia was originally described by Felt (1907) as *Hormomyia crataegifolia*, who later transferred it to the genus *Trishormomya* in 1920. This species of cecidomyid forms the thorn cockscomb gall on *Crataegus* (Winterringer, 1961). The immature stages were collected on *Crataegus mollis* (Torrey & Gray) Scheele, from Mahomet, Champaign County, Illinois. An adequate key to the adults is given in Felt (1920). No key to the immature stages is presented here, since the immature stages are not known for any of the other species of *Trishormomya*, except for a very limited description of a larva of *T. verruca* by Felt (1920).

Felt's original description of this species was very limited; thus the authors feel a redescription of the adults, in addition to a description of the immature stages, is desirable as a precursor to a future paper on the life history and bionomics of this species.

Trishormomya crataegifolia (Felt)

1907 Felt, E. P., Bull. New York St. Mus. 110: 160 (*Hormomyia*)
1908 ——, Bull. New York St. Mus. 124: 388 (*Hormomyia*)
1908 Jarvis, T. D., Ent. Soc. Ontario, 38th Rep't.: 86 (*Hormomyia*)
1909 Felt, E. P., Ent. Soc. Ontario, 39th Rep't.: 45 (*Hormomyia*)
1909 Jarvis, T. D., Ent. Soc. Ontario, 39th Rep't.: 83 (*Hormomyia*)
1915 Felt, E. P., Bull. New York St. Mus. 175: pl. 3, Fig. 8 (*Hormomyia*)
1918 ——, Bull. New York St. Mus. 200: 136 (*Hormomyia*)
1920 ——, Bull. New York St. Mus. 231–232: 224–226 (*Trishormomya*)
1922 Wellhouse, W. H., Mem. Cornell Univ. Agr. Exp. Sta. 56: 1082 (*Hormomyia*)
1958 Pritchard, A. E., and E. P. Felt, Bull. Connecticut Geol. Nat. Hist. Surv., 6th fascicle 87: 205 (*Trishormomya*)
1961 Winterringer, G. S., Illinois St. Mus., Story of Ill. Ser. 12: 29 (*Trishormomya*)

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[1] Cecidomyiidae: Diptera.

[2] Accepted for publication September 3, 1969.

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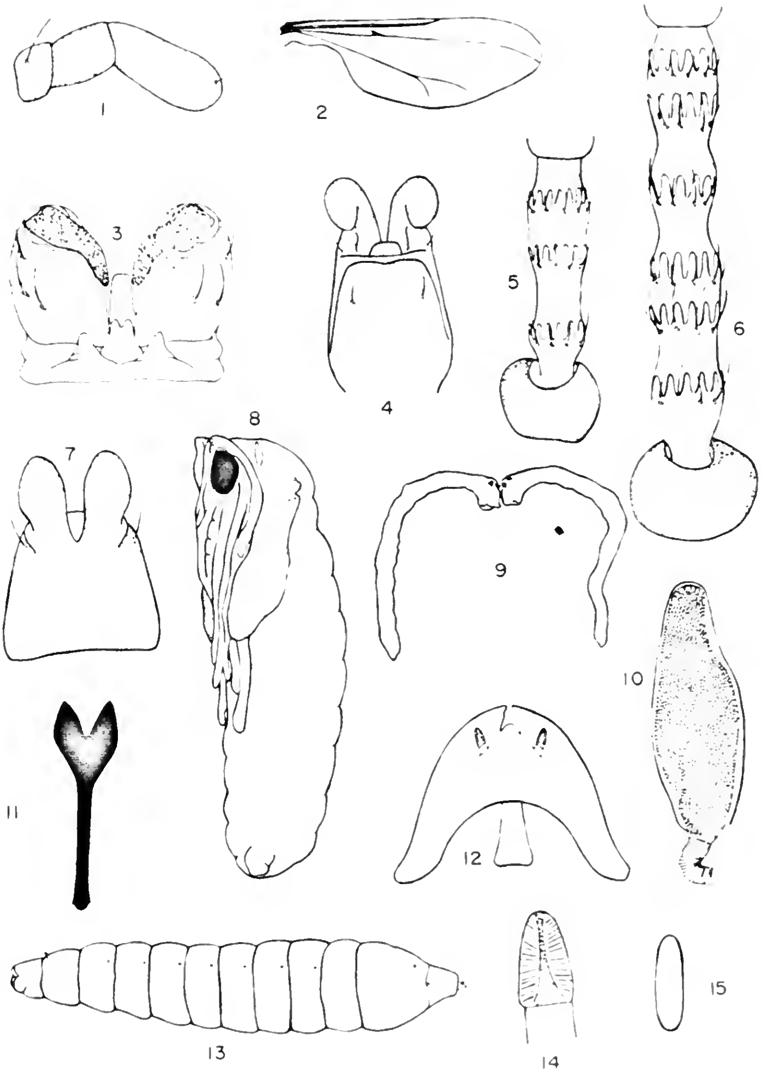
[4] Section of Economic Entomology, Illinois Natural History Survey, Urbana, Illinois 61801.



Figs. 1–15. *Trishormomyia crataegifolia* (Felt). Fig. 1. Maxillary palp of male; Fig. 2. Wing venation of male; Fig. 3. Male terminalia, dorsal view; Fig. 4. Female terminalia, dorsal view; Fig. 5. Male antenna, second basal segment and first flagellar segment; Fig. 6. Female antenna, second basal segment and fused first and second flagellar segments; Fig. 7. Female terminalia, ventral view; Fig. 8. Pupa, lateral view; Fig. 9. Antennal sheath of pupa, ventral view; Fig. 10. Respiratory apparatus of pupa, lateral view; Fig. 11. Spatula of larva, ventral view; Fig. 12. Head of larva, dorsal view; Fig. 13. Larva, lateral view; Fig. 14. Antenna of larva, dorsal view; Fig. 15. Egg, dorsal view.

ADULTS

Male.—Length (exclusive of antennae) 2.8 ± 0.017 mm. Head dark brown to black, oval; eyes black, bare, holoptic over length of three facets posterior to base of antennae, facets of equal size; ocelli absent; antennae pale brown, two basal segments, 12 flagellar segments; basal segment (scape) subrectangular, 1.5 times longer than wide; second segment (pedicel) spherical (Fig. 5) dark brown; flagellar segments binodal (Fig. 5) 3.3 times longer than wide; basal node globular (length 0.006 ± [illegible] mm) with single whorl of setae and circumfilum; apical node subrectangular (length 0.087 ± 0.0001 mm) with two whorls of setae and circumfila; apex of apical segment acute; maxillary palpus (Fig. 1) (5:7:10) pale yellowish brown; apical segment subrectangular, rounded apically, 1.5 times longer than wide; frontoclypeus dark brown, glossy, setae absent; occipital setae in biseriate row extending from base of eyes to apex of head.

Pronotum dark brown, truncate medially, expanded laterally; mesonotum and scutellum pale to dark brown, postalar area pale yellow; vittae indistinct; acrostichal setae in biseriate row extending three-fourth length of mesonotum; prealar setae (10–12) in biseriate row; postalar setae (2–4) in uniseriate row; scutellar setae in biseriate row across dorsum of scutellum; metanotum dark brown; halteres pale yellow, covered with short, erect, brown setae.

Wing (Fig. 2) length 3.3 ± 0.004 mm, 2.8 times longer than wide; membrane hyaline, veins pale yellowish brown; alula greatly reduced; squama small, narrow, with fringe of elongate setae; anal angle rounded; humeral crossvein absent; C circumambient, broader along anterior margin; Sc lies alongside R_1, ending in R before reaching C; R_1 ends distal to fork of Cu_{1-2} and tip of Cu; R_5 ends beyond apex of wing; apex of wing rounded; Cu_{1+2} forks proximal to tip of R_1; pedicel length[5] 1.1 times length of R_1; Cu_1 and Cu_2 end before reaching wing margin.

Legs yellowish to dark brown, elongate; basitarsus very short, equal to or shorter than fifth tarsal segment; tibial spurs and puvilli absent; empodium pulvilliform; tarsal claws simple.

Abdomen brown to dark brown, shagreen; terminalia (Fig. 3) pale brown; ninth tergite reduced, posterior margin with two pairs of short, paramedial tubercles; basistyle broad, 1.7 times longer than width at base; dististyle dark brown, curved apically, apex black with numerous, short, fine, black setae; ventral plate elongate, tapered apically, 2.0 times longer than width at base, apex rounded.

Leg proportions	Fe	Ti	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5
I	97	108	12	67	30	18	12
II	93	95	11	54	28	17	12
III	116	111	11	74	39	22	13

Female.—Length (exclusive of antenna) 3.8 ± 0.111 mm. Head and lower part of face dark brown; eyes black, bare, holoptic over length of three facets posterior to base of antennae; antennae dark brown, two basal segments, 11 flagellar segments, two basal segments as in male, first and second flagellar segments fused (Fig. 6), remaining flagellar segments 3.0 times longer than wide; basal node globose (length 0.09 ± 0.0001 mm) with single whorl of circumfilum and setae; apical node subrectangular (length 0.06 ± 0.0001 mm) with two whorls of setae and circumfila; maxil

---

[5] Pedicel length: the length of Cu from its origin to origin of Cu.

lary palpus pale yellowish brown (8:10:11), apical segment subglobose; ocelli and occipital setae as in male.

Pronotum, mesonotum and scutellum dark brown; vittae indistinct; acrostichial, prealar, postalar and scutellar setae as in male; halteres pale yellow, clavate.

Wing length 3.8 ± 0.085 mm, 2.9 times longer than wide; membranes hyaline, veins brown; pedicel of Cu$_{1+2}$ 1.2 times length of R$_1$; other characters as in male.

Legs pale brown.

Abdomen and terminalia (Figs. 4, 7) pale yellowish brown, shagreen, tapered posteriorly; ninth tergite reduced, subrectangular; apical margin truncate; tenth tergite small, rectangular, apex truncate; cerci large, rounded apically, curved ventrally.

Leg proportions	Fe	Ti	Ta$_1$	Ta$_2$	Ta$_3$	Ta$_4$	Ta$_5$
I	98	95	13	60	27	17	13
II	88	92	11	50	26	16	13
III	117	112	13	72	36	23	14

PUPA

Length 3.2 ± 0.031 mm, width 1.0 ± 0.005 mm, 3.2 times longer than wide; (Fig. 8) pale yellowish brown, wing pads and eyes black; respiratory apparatus flask shaped (Fig. 10) length 0.12 ± 0.0001 mm, width 0.04 ± 0.0001 mm, 2.4 times longer than wide; apex rounded, with several large apical vesicles; antennal sheath (Fig. 9) unsegmented, extends to base of first abdominal segment; two lateral tubercles present near base, length 0.012 mm, width 0.014 mm, 1.2 times wider than long; wing pads end at middle of third abdominal segment; abdominal tergites shagreen; posterior rounded with pair of rounded evagination for genital structures.

LARVA

Length (Fig. 13) 4.5 ± 0.182 mm, width 1.1 ± 0.041 mm, 4.1 times longer than wide; head (Fig. 12) retracted partially into thorax, length 0.134 ± 0.0044 mm, width 0.163 ± 0.0001 mm, 1.2 times wider than long; antennae (Fig. 14) short, length 0.020 ± 0.0008 mm, width 0.008 ± 0.0006 mm, 2.0 times longer than wide; basal segment rectangular, length 0.008 ± 0.0006 mm, 1.25 times wider than long; apical segment conical, apex rounded, length 0.012 ± 0.0016 mm, 1.2 times longer than wide; style broad, elongate, apex rounded, length 0.092 ± 0.0055 mm, width 0.046 ± 0.0064 mm, 2.0 times longer than wide; spatula (Fig. 11) dark brown, forked apically, apices acute 0.267 ± 0.0035 mm, width 0.069 ± 0.0025 mm, 3.3 times longer than wide; spiracles present on mesothoracic segment and abdominal segments one through eight; pseudopods absent, spinnules present laterally on abdominal sternites; posterior bilobed.

EGGS

(N = 30) Length (Fig. 15) 0.376 ± 0.002 mm, width 0.111 ± 0.002 mm, 3.4 times longer than wide; bright reddish orange, ellipitical, glossy, surface smooth.

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Bibliography of New Guinea Entomology (Gressitt and Szent-Ivany). Ann tated, 6,140 references, through 1967; all fields of entomology New Guinea, Bi marcks, Solomons; all subjects indexed. Pacific Insects Monogr 18, 674 pp., ma 1968. $12.50 bound; $11.50 wrappers Bishop Museum Press, Box 6037, Honolu Hawaii 96818.

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CYANIDE TOLERANCE IN MILLIPEDES: COMPARISON OF RESPIRATION IN MILLIPEDES AND INSECTS[1]

F. R. Hall,[2] R. M. Hollingworth[3] and D. L. Shankland

Several years ago, specimens of the millipede *Pleuroloma flavipes butleri* (McNeill) were brought to the Department of Entomology at Purdue. Upon confinement in cyanide killing jars, the millipedes remained alive and active. When handled they produced a volatile compound with the almond-like smell of cyanide. After placing a millipede in a small closed test-tube with several german cockroaches (*Blattella germanica* (L.)), the insects died within a short time while the millipede remained unharmed. Further investigation showed that *P. f. butleri* was considerably more tolerant than *B. germanica* to injected potassium cyanide (Hall, 1967). These observations suggested that like some other millipedes (Eisner and Meinwald, 1966) *P. f. butleri* produced hydrogen cyanide as a defensive compound and raised the intriguing question of how these animals survive their own toxic secretions.

The degree of resistance to cyanide in an organism has frequently been correlated with its level of respiration. Thus Bodine and Boell (1938) report that sensitivity of diapausing *Melanoplus* eggs to cyanide increases with their rate of respiration and very low respiratory activity has been reported for cyanide-insensitive diapausing lepidopterous pupae (Schneiderman and Williams, 1954). A biochemical basis for the dependence of cyanide sensitivity on rate of oxygen consumption is provided by the excess terminal oxidase hypothesis (Kurland and Schneiderman, 1959). On the other hand Yust and Sheldon (1952) report that in scale insects which were highly tolerant to cyanide, the male pupae had a high respiration rate which did not differ from that of susceptible pupae. There is little data on millipede respiration but reports suggest that they too may have low rates. This paper is therefore concerned with investigation of the nature of the toxic defensive secretion of *P. f. butleri* and a second, cyanide-producing millipede *Euryurus leachii* (Gray) and with assessing the respira-

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[1] Journal Paper No. 3867 of the Purdue University Agricultural Experiment Station.

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tion rates of these millipedes in contrast to two cockroaches, *B. germanica* and *Blaberus discoidalis* (Serville).

A more detailed report of the biochemical basis for the tolerance mechanism will be published elsewhere.

EXPERIMENTAL ANIMALS

Specimens of *E. leachii* were collected from rotting logs in summer and fall of 1965 and the spring of 1966 at McCormick's Creek State Park, Spencer, Indiana. Specimens of *P. f. butleri* were obtained from large migratory populations in the summer and fall of 1965 in Lakeville and Martinsville, Indiana. Females outnumbered males by about 10 to 1. A third migratory population, largely of last instar larvae, was sampled in Columbus, Indiana in summer, 1966.

Both species were reared in covered clear plastic boxes containing 2 to 3 inches of decaying wood and leaf litter which was kept moist by periodical addition of water. *E. leachii* prospered and a year round colony was maintained but it was not possible to maintain the colony of *P. f. butleri* for more than a few months under these conditions.

B. germanica and *B. discoidalis* were laboratory strains reared on Gaines dog food and water. Both the insects and millipedes were maintained at 65–75° F with a 12 hour light-dark cycle.

IDENTIFICATION OF HYDROGEN CYANIDE AS A SECRETORY PRODUCT OF THE MILLIPEDES

Adults and immatures of both *P. f. butleri* and *E. leachii* when disturbed emit a colorless liquid with a pungent almond-like odor from small openings on the dorsal surface near the tips of some of the notal projections. Such secretory ducts are located in both species on segments 5, 7, 9, 10, 12, 13, 15, 16, 17, 18 and 19 of adult males and females. A series of semimicro qualitative spot tests for hydrogen cyanide (Feigl, 1958) were carried out on these secretions. The tests were replicated and appropriate blanks and standard solutions were included.

Picric Acid Test.—The defensive secretion was collected directly on small pieces of filter paper treated with a saturated solution of picric acid and sodium carbonate solution. A red color developed which indicated the presence of cyanide.

Starch-Iodine Test.—The test is based on the combination of cyanide and iodine to form colorless cyanogen iodide. Ten adults of each species were placed in stoppered 50 ml flasks. After shaking the flasks vigorously for a few seconds, a blue potassium iodide-starch paper treated with 0.1 N iodine was inserted. Rapid discharge of the color again indicated cyanide in the atmosphere of the flask.

Palladium-Dimethylglyoxime Test.—A drop of the secretion was mixed with alkaline palladium dimethylglyoxime and nickel ammonium chloride. The formation of a red complex indicated the presence of cyanide.

This combination of positive tests strongly indicates the presence of cyanide in the defensive secretions of both *P. f. butleri* and *E. leachii*. It has been suggested that species of *Pleuroloma* release HCN under natural conditions (Young (1958)) but the presence of cyanide in the secretions of *E. leachii* has not been previously reported. Probably the repugnatorial gland secretions also contained compounds other than HCN (Eisner and Meinwald, 1966) but these were not examined.

RESPIRATION RATES

Respiration was determined in terms of oxygen consumption by Warburg respirometry, using standard manometric techniques (Umbreit, 1964). Individuals of *P. f. butleri, E. leachii* or *B. germanica* were placed in 20 ml Warburg flasks with a center-well containing a filter paper wick dipping in 0.2 ml of 20 per cent KOH. *B. discoidalis* were placed in special Warburg flasks with a final volume of 100 ml and containing 0.5 ml 20 per cent KOH. In each case, correction was made for the volume of the animals in the flask. Both male and female *E. leachii* were found to produce an unknown volatile compound, not absorbed by the KOH trap, which led to erroneous results. The release of this material was prevented by waxing over the secretory ducts with a mixture of 1 part beeswax and 1 part petroleum jelly. The millipedes were left about 30 minutes after this treatment before respiration measurements were made.

In all cases a 15 minute equilibration period was allowed before readings of oxygen consumption were made at 15-minute intervals for 1 to 2 hours. During this period, oxygen consumption was approximately linear and the individual readings were averaged.

The effect of temperature on respiration rates of *P. f. butleri* (female) and *E. leachii* (both sexes) is shown in Fig. 1. In both species, the respiration rate of the males was slightly higher than that of the females although there were too few males of *P. f. butleri* for a statistically valid comparison to be made. For *P. f. butleri* females a mortality of about 40 per cent was noted at 35° C. *E. leachii* was not harmed by this temperature. If the data from 10° to 35° C are averaged, mean Q_{10} values were

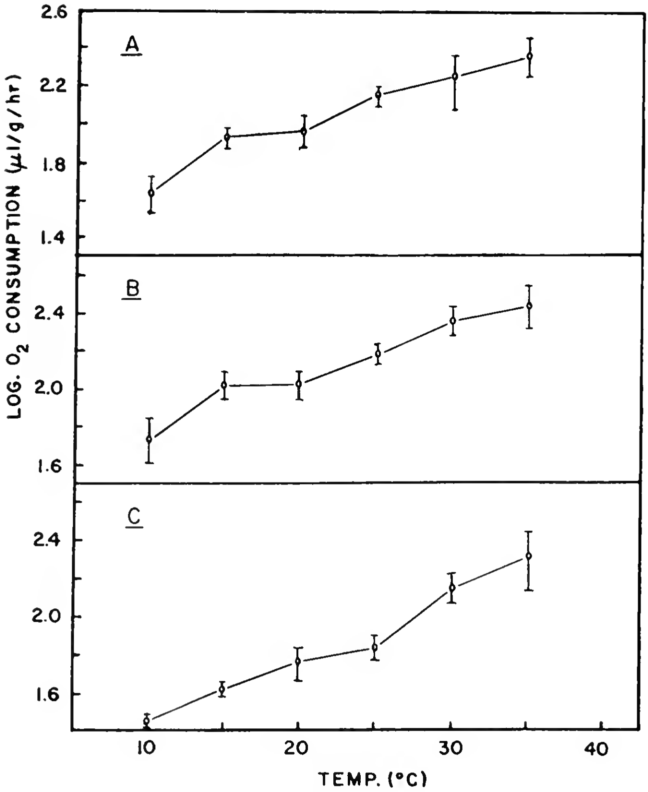

FIG. 1. Relationship of oxygen consumption to temperature in two species of millipedes. Bars represent 95% confidence levels. A. *E. leachii* (♀); B. *E. leachii* (♂); C. *P. f. butleri* (♀).

2.32 for *P. f. butleri* (female), 2.02 for *E. leachii* (male) and 1.97 for *E. leachii* (female). These values are in good agreement with the Van't Hoff relationship ($Q_{10} = 2$). However, it is clear from Fig. 1 that the rise in oxygen consumption with temperature is not constant for either species. A distinct plateau occurs between 20° and 25° with *P. f. butleri* and between 15° and 20° for both sexes of *E. leachii.*

Such plateaus, often around 15°, have been found for various insects (Keister and Buck, 1964) and may sometimes be related to rearing temperature. Cloudsley-Thompson (1968) noted that several species of millipedes are observed to have a kinetic "preference" for temperatures around 15° C. However, the physiological basis and importance of such plateaus is too complex to be inferred from this brief study.

TABLE 1. Respiration rates at 25° C

	No. of Animals	Mean Wt (g)	Oxygen Consumed[1]
P. f. butleri (♀)	20	0.494	74 ± 9
P. f. butleri (♂)	—	—	102
E. leachii (♀)	18	0.188	148 ± 17
E. leachii (♂)	17	0.169	155 ± 18
B. germanica (♂)	20	0.056	702 ± 52
B. discoidalis (♂)	13	2.250	269 ± 15

[1] μl O_2 consumed/hr/g body wt ± 95% confidence limits.

Comparative respiration rates of the four species at 25° C are presented in Table 1. The rates for both species of resistant millipedes are clearly well below those of the two susceptible insects, although it is worth noting that the data for *P. f. butleri* were taken when they had been maintained in the laboratory for about two months. Specimens freshly collected had respiration rates 50 to 100 per cent higher than those given here. The relatively low oxygen consumption of the millipedes may indicate that their resistance to cyanide is a further example of the excess terminal oxidase mechanism.

The oxygen consumption values for the cockroaches fall within the range quoted by Keister and Buck (1964) for non-flying insects at or around 25° C. Despite the relatively low respiration rates obtained with the millipedes, their oxygen consumption is still considerably greater than that reported for some other millipedes, e.g., 3 to 5 μl O_2 per hour per g body weight for both *Arthrosphera dalyi* (Paulpandian, 1966) and *Spirostreptus asthenes* (Dwarakanath and Job, 1965). The millipede rates are also much larger than oxygen consumption values reported for cyanide-resistant forms such as diapausing lepidopterous pupae, e.g., *Platysamia cecropia*, 16 and *Antherea pernyi*, 14 μl O_2 per hour per g body weight (Keister and Buck, 1964), but much lower than that for resistant pupal male scale insects (1,800 μl O_2 per hour per g body weight; Yust and Sheldon, 1952). Thus it may be concluded that although there is frequently a qualitative relationship between the level of respiration and ability to tolerate cyanide in invertebrates, the present work suggests that this relationship is by no means absolute. Probably this fact is an indication that different mechanisms of resistance are operating in different organisms, each having its own basal respiration rate.

ACKNOWLEDGMENT

We wish to thank Dr. Nell B. Causey, U. Arkansas, for her identification of the millipedes.

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Notes on the Taxonomic Status of Cerceris tepaneca Saussure and C. sextoides Banks[1] (Hymenoptera: Sphecidae)

HERMAN A. SCULLEN[2]

Through the kindness of Dr. Max Fischer of the Naturhistorisches Museum of Wien, Austria, the writer has been able to restudy the lectotype of *Cerceris tepaneca* Saussure and to compare it with type material of *Cerceris sextoides* Banks and the various subspecies of *C. clypeata* Dahlbom as recognized by the writer (Scullen, 1965, pp. 469 to 476). It is the present conclusion of the writer that *C. tepaneca* Saussure is a subspecies of *C. clypeata* Dahlbom with a distinctive color pattern on the abdomen which separates it from the nominate subspecies and other subspecies of the eastern United States. *C. clypeata tepaneca* Saussure is a color form not uncommon in south central Mexico. *C. sextoides* Banks was erroneously reduced as a synonym of *C. tepaneca* Saussure by the writer (Scullen, 1965, p. 509) and should be recognized as a valid species. *C. sextoides* Banks is a much larger species and has not been taken in south central Mexico. *C. eurymele* Banks is correctly placed as a synonym of *sextoides.*

Both sexes of *C. clypeata tepaneca* Saussure are distinguished from the other subspecies of *C. clypeata* Dahlbom by having the yellow bands of the more distal abdominal tergites greatly enlarged. The corresponding bands on other recognized subspecies are reduced to narrow lines or are eliminated entirely.

The corrected synonymy of *C. clypeata tepaneca* Saussure and *C. sextoides* Banks is as follows:

Cerceris clypeata tepaneca Saussure, NEW STATUS

Cerceris tepaneca Saussure, 1867, p. 90.—Schletterer, 1887, p. 504.—Cameron, 1890, p. 125, Tab. 8, figs. 6, 6a, 6b, 6c.—Dalla Torre, C. G., 1897, p. 478.—Ashmead, 1899, p. 296.—Scullen, 1961, p. 48, in part.

Cerceris sextoides Banks

Cerceris sextoides Banks, 1947, p. 10.—Scullen, 1951, p. 1010.

Cerceris eurymele Banks, 1947, pp. 11–12

Cerceris tepaneca Scullen, 1961, p. 48, in part; 1965, pp. 509–511, figs. 96, 176a, b, c.

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A Preliminary Study of the Idiocerinae of Chile (Homoptera: Cicadellidae)[1, 2]

Paul H. Freytag and William P. Morrison[3]

The Chilean fauna of leafhoppers is unique and seemingly, in most groups, quite separate from the leafhoppers in the remaining countries of South America. The Idiocerinae are of this unique type and are not now known from anywhere else. Their closest relatives are in the genus *Idioscopus* Baker which occurs mostly in the Oriental and African areas of the world. They cannot be properly placed in this genus, however, so are here being described in a new genus.

All Chilean specimens in this subfamily examined so far belong to this new genus. These were from the central area of Chile, from the province of Coquimbo to the province of Conceptión. The entire country has not been surveyed, so this initial picture will undoubtedly change.

Chileanoscopus new genus

Type–species: *Chileanoscopus hamulus* n. sp.

Crown short, broad, rounded to front. Ocelli on face, near or above ends of frontal sutures, nearly same distance between them as to each eye. Antennae long, male without disc. Lora rounded, somewhat overlapping clypeus on each side. Forewing with normal venation, appendix large. Hind femur with 2 apical setae and 1 subapical seta. Male plates thickened, paddle-shaped, fringed with long fine setae. Male aedeagus simple, tubular, without major processes, apodeme large.

This genus resembles *Idioscopus*, as redefined by Maldonado-Capriles (1964 and 1965), in wing venation and femoral setae. It differs in that the male plates are thickened and quite broad apically instead of long and narrow, and the aedeagus is simple instead of with 2–4 processes. This is the only known idiocerine genus in the new world with the subapical seta on the hind femur.

Because the females of the species are so closely related, no key is given for their separation.

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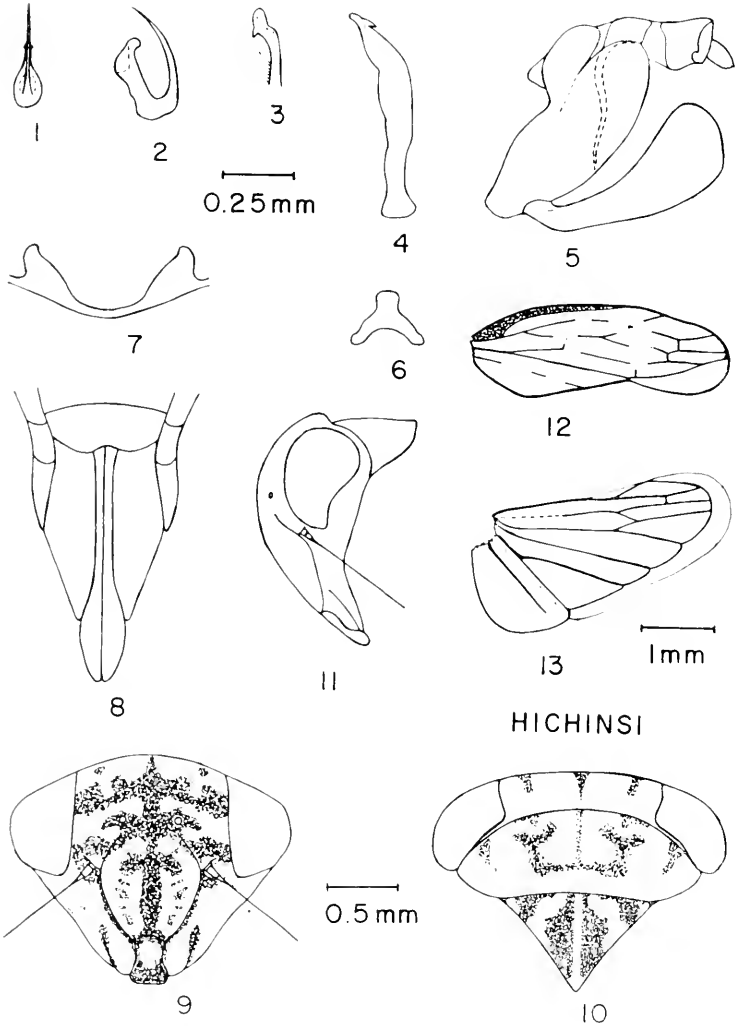


FIGS. 1–10. *Chilcanoscopus hichinsi* (Heller). FIG. 1, ventral view of aedeagus; FIG. 2, lateral view of aedeagus; FIG. 3, ventral tip of style; FIG. 4, lateroventral view of style; FIG. 5, lateral view of genital capsule; FIG. 6, dorsal view of connective; FIG. 7, dorsal view of male 2nd sternal apodemes, all male drawings to same scale; FIG. 8, ventral view of female genitalia; FIG. 9, face view of female head; FIG. 10, dorsal view of female head, pronotum and scutellum; FIG. 11, lateral view of female head and pronotum; all female drawings to same scale; FIG. 12, right forewing; FIG. 13, right hind wing, drawn to same scale.

KEY TO THE MALES

1. Tip of style hooked (Fig. 25); aedeagal shaft curved and extending slightly beyond aedeagal apodeme (Fig. 24) 2
1′. Tip of style straight (Fig. 3); aedeagal shaft not extending beyond aedeagal apodeme (Fig. 2) 3
2(1). Tip of aedeagal shaft flattened dorsoventrally into a diamond shaped plate (Fig. 32) .... **repandus** n. sp.
2′. Tip of aedeagal shaft only slightly expanded (Fig. 23) .... **hamulus** n. sp.
3(1′). Aedeagal shaft evenly curved (Fig. 15) .... **ancorus** n. sp.
3′. Aedeagal shaft nearly straight (Fig. 2) .... **hichinsi** Heller

Chileanoscopus hichinsi (Heller) NEW COMBINATION
(FIGS. 1–13)

Idiocerus hichinsi Heller, 1969, p. 155

Length of males 4.9–5.3 mm and of females 5–5.3 mm.

Structure.—Head wider than pronotum, margin slightly but evenly rounded. Head, pronotum, and scutellum smooth. Forewings smooth with small pits along main veins; appendix large. Male second sternal apodeme (Fig. 7) stout, slanting with small apex.

Coloration.—Highly patterned over-all with spots and blotches of reddish brown to black on a tan to yellow background, males darker than females. Head, pronotum and scutellum (Figs. 9 and 10) yellow, patterned with reddish brown or black. Forewings (Fig. 12) generally smoky tan or yellow with veins darker, interrupted with light yellow areas.

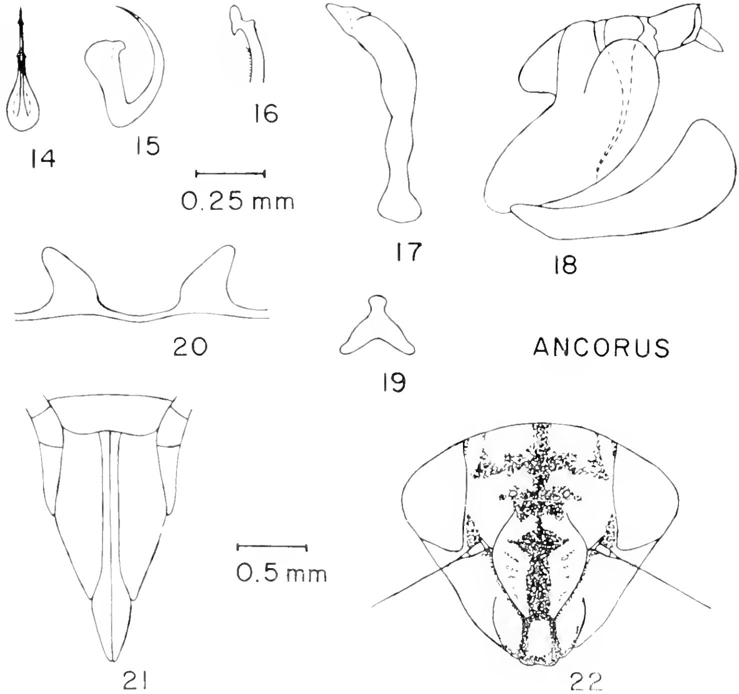
Male genitalia.—Plate thick at base, then gradually laterally flattened toward a paddlelike apex. Pygofer narrow, with apex rounded and produced on each side. Tenth segment extending basally on each side as a fine process, within pygofer, to a point near base of styles. Styles with a patch of setae on lateral margin of narrowed middle, apical end scooped out medially with apex thin, straight, margin rounded, subapical hooklike process on lateral side. Connective thick and V-shaped. Aedeagus simple with shaft nearly straight except near apex where it bends slightly dorsad; apodeme well developed, narrowing in ventral view to apex, expanded near apex in lateral view, and apex in line with base and apex of shaft.

Female genitalia.—Ovipositor extending beyond pygofer slightly more than its own width. Pygofer narrow, long, with rounded margins. Posterior margin of 7th sternum broadly rounded with a large median emargination.

Type.—Holotype male from Tabon Tinceja, Talca, Chile, October 10, 1964, O. Hichins, in the collection of the Institute de Biología, Universidad de Chile, Valparaiso, Chile.

Notes.—This appears to be the most common species found in Chile. There seems to be much minor variation in morphological structures and this could be a complex of species. At the present time, however, the specimens of this species can be separated from the other species by the nearly straight aedeagal shaft.

Specimens examined.—2 males, 2 females, Los Pollines, Prov. de Nuble, Chile, March 4, 1952, L. E. Pena; 1 male, 4 females, El Clarillo, Chile, February 19, 1953, 800–1,500 m, L. E. Pena; 1 male, 1 female, Santiago, Chile, January 19, 1954, 600–1,100 m. L. E. Pena; 1 male, 4 females, Curanipe, Chile, December 4, 1953, L. E. Pena; 1 male, 1 female, Cobquecura, Chile, December 14, 1953, L. E. Pena; 2 males, 2 females, El Canelo, Chile, December, 1952, L. E. Pena; 4 males, 11 females, Trequalemo, Chile, December 6, 1953, L. E. Pena; 2 males, 24 females, Penalolen, Santiago, Chile, October 10, 1953, L. E. Pena, all in the North Carolina State University Collection; 14 males, 19 females, Conceptión, Chile, December 16–21, 1967, D. M. DeLong Collection; 2 males, 6 females, Renca, Santiago, Chile, November 1950, N. N. Coll., in the Ohio State University Collection.



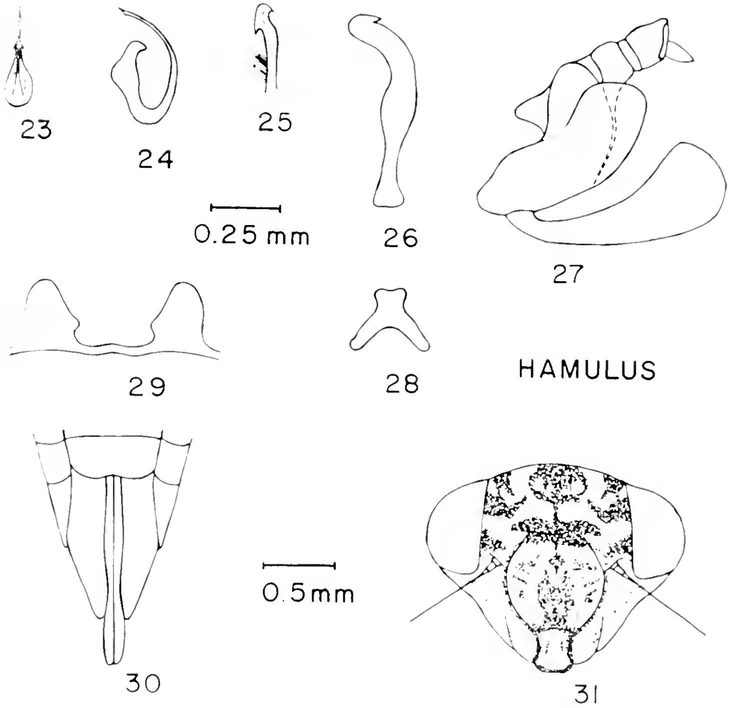
FIGS. 14–22. *Chileanoscopus ancorus* n. sp. FIG. 14, ventral view of aedeagus; FIG. 15, lateral view of aedeagus; FIG. 16, ventral tip of style; FIG. 17, lateroventral view of style; FIG. 18, lateral view of genital capsule; FIG. 19, dorsal view of connective; FIG. 20, dorsal view of 2nd sternal apodemes, all male drawings to same scale; FIG. 21, ventral view of female genitalia; FIG. 22, face view of female head, female drawings to same scale.

Chileanoscopus ancorus NEW SPECIES
(FIGS. 14–22)

Length of males 4.7–5.1 mm and of females 4.9–5.2 mm.

Structure.—Similar to *hichinsi.* Male second sternal apodeme (Fig. 20) long, stout, slanting with a truncate apex.

Coloration.—Similar to *hichinsi.* Face (Fig. 22) mostly patterned with reddish brown or black.



FIGS. 23–31. *Chileanoscopus hamulus* n. sp. FIG. 23, ventral view of aedeagus; FIG. 24, lateral view of aedeagus; FIG. 25, ventral tip of style; FIG. 26, lateroventral view of style; FIG. 27, lateral view of genital capsule; FIG. 28, dorsal view of connective; FIG. 29, dorsal view of male 2nd sternal apodemes, all male drawings to same scale; FIG. 30, ventral view of female genitalia; FIG. 31, face view of female head, female drawings to same scale.

Male genitalia.—Plates thick at base, then gradually laterally flattened toward a paddlelike apex. Pygofer narrow, with apex rounded and produced on each side. Tenth segment extending basally on each side in a fine process within pygofer to a point near base of styles. Styles with a patch of setae on lateral margin of narrowed middle, apical end scooped out medially with apex thin, straight, with rounded margin, subapical hooklike process on lateral side. Connective thick and V-shaped

Aedeagus simple with arched shaft narrowing to a pointed apex, a pair of very small thornlike bumps on lateral margin subapically; apodeme well developed, narrowing in ventral view to apex, expanded in lateral view near apex, and apex in line with base and apex of shaft.

Female genitalia.—Ovipositor extending beyond pygofer slightly more than its own width. Pygofer narrow, long, with rounded margins. Posteiror margin of 7th sternum broadly rounded with a large median emargination.

Type.—Holotype male, Llay-Llay, Valp., Chile, February 4, 1951, Ross and Michelbacher. Allotype female, same data as holotype. Paratypes, 3 males, 6 females, and 1 nymph, same data as holotype. Holotype, allotype, and 8 paratypes in the California Academy of Science Collection; and 2 paratypes in the University of Kentucky Collection.

Notes.—Besides the type series two other series of specimens in the California Academy of Science Collection were examined. These series were: 7 males, 18 females Zapallar, Acon., Chile, December 15, 1950, Ross and Michelbacher; and 1 male, 4 females, 10 km east of Zapudo, Acon., Chile, November 28, 1950, Ross and Michelbacher.

Chileanoscopus hamulus NEW SPECIES

(Figs. 23–31)

Length of males 4.1–4.5 mm and of females 4.0–4.5 mm.

Structure.—Short stubby species with head wider than pronotum, margin slightly rounded. Male second sternal apodeme (Fig. 29) short, truncate with a small median projection near base.

Coloration.—Similar to *hichinsi.* Face (Fig. 31) mostly patterned with reddish brown or black.

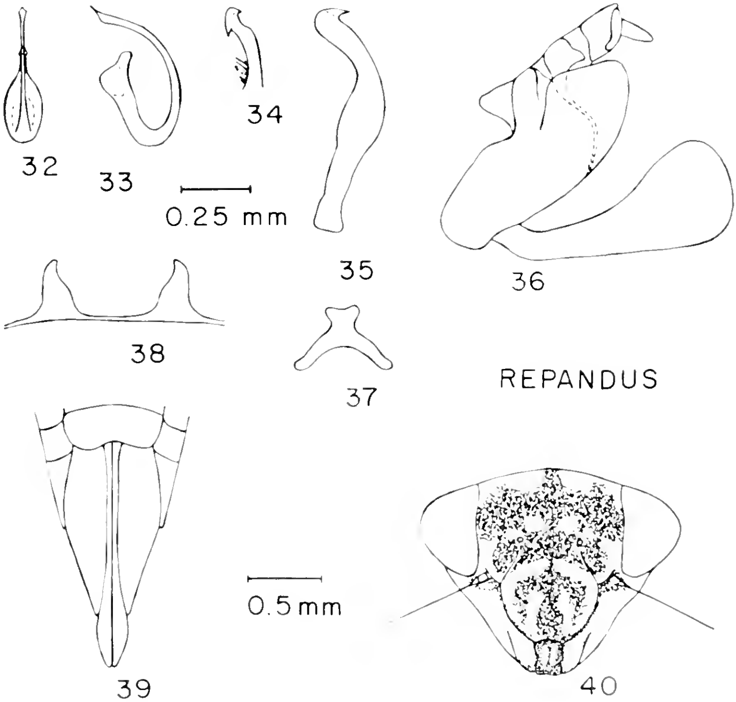
Male genitalia.—Plate thickened at base, then gradually laterally flattened toward a broad paddlelike apex. Pygofer narrow, with apex rounded and produced on each side. Tenth segment extending basally on each side in a fine process within pygofer to a point near base of styles. Style with patch of setae on lateral margin of middle, apical end scooped out medially with apex thin, bent medially and hooked, subapical hooklike process on lateral side. Connective thick and V-shaped. Aedeagus simple with narrow arched shaft extending to a slightly enlarged apex; apodeme well developed, narrowing to a slightly expanded apex in ventral view, expanded area near apex in lateral view, and apex not in line with base and apex of shaft.

Female genitalia.—Ovipositor extending beyond pygofer slightly more than its own width. Pygofer narrow, stubby, with rounded margins. Posterior margin of 7th sternum broadly rounded with a large median emargination.

Types.—Holotype male, Rio Blanco, Chile, February 28, 1954, L. E. Pena. Allotype female, same data as holotype. Paratypes, 19 males, 14 females, same data as holotype. Holotype, allotype, and 19 paratypes in the North Carolina State University Collection, 10 paratypes in the University of Kentucky Collection, and 4 paratypes in the California Academy of Science Collection.

Notes.—In this species the female genitalia appear to be shorter than in other species. This is also reflected in the total length of both the male and the female as this seems to be the smallest of the known species.

Besides the type series 53 other specimens were examined. These were: 3 males, 7 females, El Manzano, Chile, June 10, 1954, L. E. Pena, in the North Carolina State University Collection; 4 males, 9 females, 35 miles south of Oralle, Chile, December 1, 1950, Ross and Michelbacher; 2 males, 7 females, 50 km south of La Serena, Chile, December 1, 1950, Ross and Michaelbacher; 7 males, 14 females, 5 miles north of Illapel, Chile, November 30, 1950, Ross and Michelbacher, all in the California Academy of Science Collection.



FIGS. 32–40. *Chileanoscopus repandus* n. sp. FIG. 32, ventral view of aedeagus; FIG. 33, lateral view of aedeagus; FIG. 34, ventral tip of style; FIG. 35, lateroventral view of style; FIG. 36, lateral view of genital capsule; FIG. 37, dorsal view of connective; FIG. 38, dorsal view of male 2nd sternal apodemes, all male drawings to same scale; FIG. 39, ventral view of female genitalia; FIG. 40, face view of female head, female drawings to same scale.

Chileanoscopus repandus NEW SPECIES
(FIGS. 32–40)

Length of males 4.5–4.8 mm, and of females 4.6–5 mm.

Structure.—Similar to *hichinsi.* Male second sternal apodeme (Fig. 38) short, norrowing to a rounded apex, with a small median projection near base.

Coloration.—Similar to *hichinsi.* Face (Fig. 40) mostly patterned with reddish brown or black.

Male genitalia.—Plate thickened at base, then gradually laterally flattened toward a broad paddlelike apex. Pygofer narrow, with apex truncate and produced on each side. Tenth segment extending basally on each side in a fine process within pygofer to a point near base of styles. Style with patch of setae on lateral margin of middle, apical end scooped out medially with apex thin, bent medially and hooked, subapical hooklike process on lateral side. Connective thick and V-shaped. Aedeagus simple with narrow arched shaft extending to a flattened diamond-shaped apex in ventral view; apodeme well developed, narrowing to a slightly expanded apex in ventral view, expanded area near apex in lateral view, and apex not in line with base and apex of shaft.

Female genitalia.—Ovipositor extending beyond pygofer slightly more than its own width. Pygofer narrow, long, with nearly straight margins. Posterior margin of 7th sternum broadly rounded with a large median emargination.

Types.—Holotype male, Las Cabras, Prov. de Huble, Chile, March 8–10, 1952, L. E. Pena. Allotype female, same data as holotype. Paratypes, 2 males, 1 female, same data as holotype. Holotype, allotype and 1 paratype in the North Carolina State University Collection; and 2 paratypes in the University of Kentucky Collection.

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A New Species of Anombrocheir Buckett and Gardner from the Inner Coast Ranges of Northern California [1]

MICHAEL R. GARDNER [2] and JOHN S. BUCKETT [2]

In a recent paper (Buckett and Gardner, 1969) we described *Anombrocheir,* a new genus of xystodesmid milliped. Since the submission of that manuscript, an additional new species has been collected and is assignable to this genus.

Differences in the new species make it necessary to redefine the genus *Anombrocheir.* As can be seen by the illustrations of the gonopods (Figs. 2 and 3), the telopodite of the new species is bifurcate (thus the derivation of the specific name), unlike the massive entire telopodite of *A. spinosa* Buckett and Gardner.

The distribution map (Fig. 1) indicates that *Anombrocheir* is known to occur only in the inner coast ranges of northern California. The habitat of the new species is the same as that of *A. spinosa,* and a discussion of this habitat was presented previously (*ibid.,* p. 72).

The key to California genera of Xystodesmidae presented by us (*ibid.,* pp. 67 and 69) will require emendations due to information presented in Causey and Tiemann (1969) and in this paper. These changes will be incorporated with new information in a future paper.

Anombrocheir Buckett and Gardner

Anombrocheir Buckett and Gardner, 1969. Ent. News, 80(3): 69–70.

Diagnosis: Body 23–33 mm in length and 4.8–6.5 mm in width; color a light yellowish-gray dorsally, with orange on tips of paranota and epiproct.

Description.—Head smooth and shining, with prominent coronal suture; antennae reaching back to the fifth segment along paranotal margins.

Tergites smooth, paranota well developed, extending ventrolaterad from mid-body height, with anterior lateral margin rounded and posterior corners acute, though not produced much caudad; collum narrow, about one-third as long as broad, with anterior margin curving evenly back, posterior corners equal to posterior margin of collum. Sterna low mesally, distinctly produced laterally, a transverse groove present between legpairs of each segment. Legs long, with femur extending beyond lateral margin of segment; leg segments unmodified except for moderate prefemoral spine; second and

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[1] Diplopoda: Polydesmida: Xystodesmidae. Accepted for publication September 16, 1969.

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third legs of male each with a pair of cylindrical ventral processes; second legs of female with a prominent pair of elongate coxal projections.

Gonopod socket large, sub-oval in shape, with posterior rim raised heighth of one coxal width; gonopods large, with coxae broad and joined together with a distinct sclerotized sternal connective which is surrounded by connective tissue and situated just distad of coxal muscles; telopodite joined to coxa distally by movable joint at oblique angle; telopodite massive, longer than coxa and lacking long processes; apex with curved flange or short processes; seminal canal coursing almost directly up mesal surface, ending in a small solenomerite.

Type species: *A. spinosa* Buckett and Gardner, by original designation.

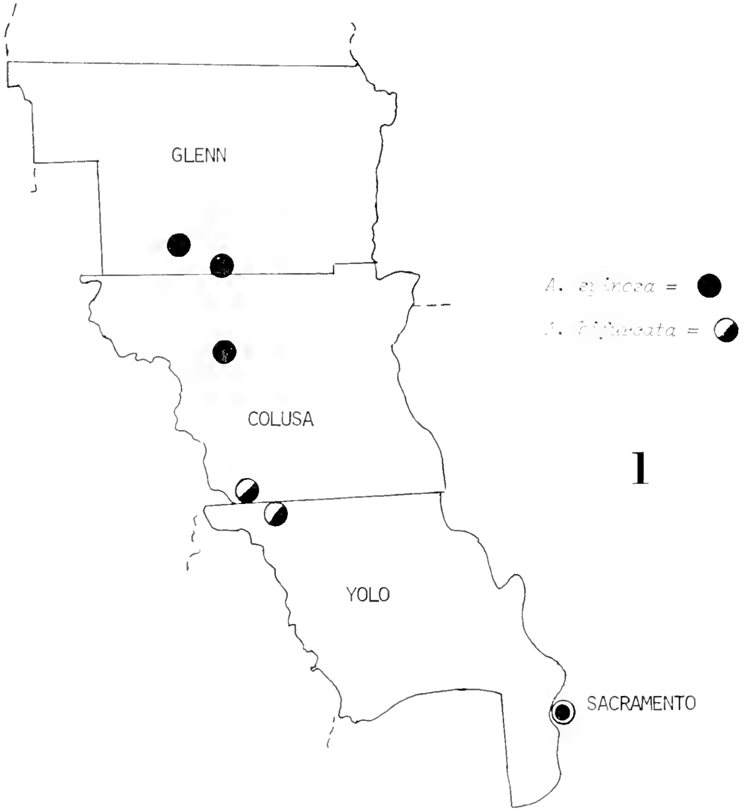


FIG. 1. Distribution map of *Anombrocheir spinosa* and *A. bifurcata* in the inner coast ranges of northern California.

Anombrocheir spinosa Buckett and Gardner

Anombrocheir spinosa Buckett and Gardner, 1969. Ent. News, 80(3): 70-71.

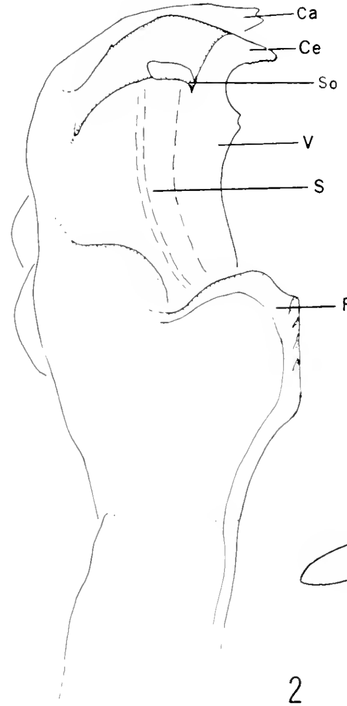
Additional record: 3 males, 10 females, 1 immature, 7.7 miles northeast Stonyford, *in* Colusa County, California, 23 March 1968 (J. S. Buckett and M. R. Gardner).

Anombrocheir bifurcata Gardner and Buckett, NEW SPECIES

Diagnosis: Differs from *A. spinosa* mainly in the gonopods, in which the telopodite possesses a lobelike femoral process; gonopod apex distinctly bifurcate, both short processes acute and curved mesad.

Description.—Holotype male, 28 mm in length; 6.0 mm in width. Coronal suture prominent, ending abruptly above antennal sockets, two prominent setae located on each side; vertex smooth and shining, but etched with many minute transverse impressed striae; frons with a pair of setae dorsally between antennal sockets, a pair just below antennal sockets and separated by a distance equal to two-thirds the intersocket distance, and a row of six setae on each side near ventral margin of frons; clypeus with a transverse row of 25 setae; labrum with a transverse row of 22 setae; gula with a broad, shallow groove parallel to lateral margin of facial shield; a distinct supra-antennal groove present; antennae moderate in length, reaching caudad to fifth segment along lateral margins of paranota and separated by a distance equal to second antennal segment; first antennal segment cylindrical, not longer than width of socket, with two dorsal and two ventral subapical setae exceeding width of segment; second segment three times length of first, proximal part half width of first, but apical part equal to it in width, with numerous short setae along dorsal and ventral margins and four long apical setae; segments three to five setose, subequal in shape, narrower proximally; segment three subequal in length to two, segments four and five slightly shorter; segment six the longest, cylindrical, about half as wide at base as apex and covered with fine setae; seventh segment subhemispherical, with four sense cones inset at apex.

Tergites smooth dorsally, except for many minute longitudinal impressed striae; lateral extensions of paranota with subcuticular reticulations, paranota projecting slightly ventrolaterad from midbody height and each exceeding width of body cylinder by about 30% of the cylinder; paranota slanted, with posterior margin higher than anterior margin; collum with anterior margin broadly rounded covering back of head; posterior corners of collum rounded, not projecting beyond posterior margin of segment; collum short, about one-third as long as broad; following seven segments with anterolateral corners increasingly rounded, posterior corners produced; segments 8 to 19 with anterolateral margins of paranota broadly rounded, with the posterior corners acutely rounded and produced distinctly caudad of segment; repugnatorial pores opening on dorsal side of lateral margins of paranota near caudal corner; segments 7 to 20 progressively reduced, with segment 19 greatly reduced, tergite narrower than distance between posterior corners of segmnt 18; epiproct subtriangular, its apex truncate and exceeding anal valves; epiproctal setae with two pairs of paramedial dorsal setae close to mesal line (one about midlength of segment, the other near apex), three setae along each lateral margin of tergite and two pairs of apical setae; anal valves roughened, anal lips produced and lined by two pairs of setae; hypoproct sublenticular, longer than half its width.



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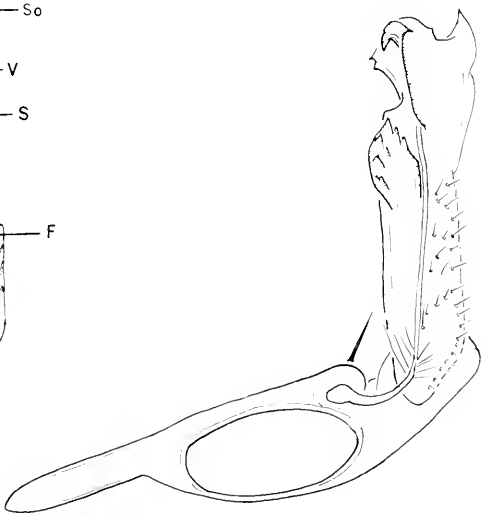

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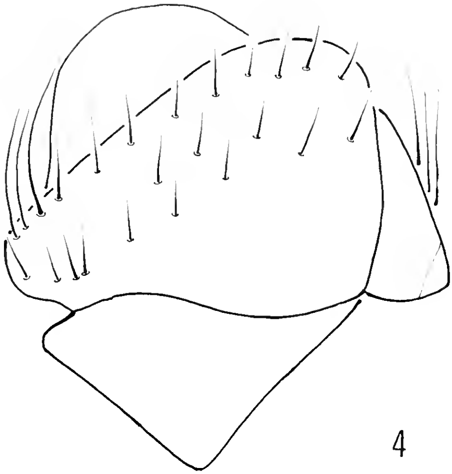

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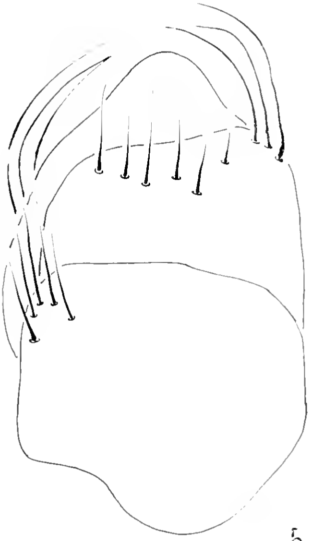

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FIGS. 2-5.

Sternum of first legs not exposed between closely adjacent coxae; second through seventh segments with intercoxal area of sternum becoming gradually wider; following segments with sterna finely wrinkled, low mesally, raised out from body cylinder in lateral regions by one-third coxal width, a distinct transverse groove present between legpairs of each segment; pleural area smooth; anterior stigma of each segment elongate-oval, the posterior one subcircular and smaller.

Legs long and robust, femur exceeding lateral margin of paranota, coxae separated by slightly more than two coxal lengths; second coxa with small, rounded caudal process; third coxa with rounded, anteroventral lobe; succeeding legs with coxa short, slightly flattened, densely setose; prefemur about 1.3 times length of coxa and slightly broader, with a distinct ventral apical spine; femur very narrow basally, widening to three times basal width at apex, about 1.2 times length of prefemur; postfemur shorter and narrower than coxa, and tibia of same proportions, but shorter and narrower yet; tarsus subcylindrical, more densely setose than previous segments, shorter than prefemur, with a large, slightly curved claw equal to almost half the length of tibia; femur and tarsus becoming exaggerated in length near posterior end of body, tarsus subequal to previous two segments in length and femur almost twice length of tarsus.

Gonopod socket suboval in shape, with a low anterior rim and raised posterior rim, socket extending cephalad through two-thirds of prozonite and cauded to eighth sternum, its width slightly narrower than distance between lateral margins of eighth coxal sockets.

Gonopods very large, telopodites produced cephalad to anterior margin of sixth segment; coxae erect, longer along lateral margin than along mesal margin; anteriorly, coxae joined at apex of mesal margins by distinct oval sternal remnant and a translucent band of connective tissue beneath sternum; coxae connected posteriorly by abundant transverse muscle tissue; telopodite joined to coxa by movable hinge which flexes longitudinally, permitting a vertical- or anterior-facing position of the telopodite; telopodite massive, exceeding coxa in length, with segmentation obscured; from anterior aspect telopodite narrowing just beyond origin then gradually widening until wider than coxa; numerous long setae generally distributed on posterior surface and on mesal surface near origin; rounded lobe produced mesad from anterior surface beyond middle of telopodite, its mesal surface marked with prominent vertical striations; vertical flange produced on mesal surface of telopodite, extending from point caudad of mesal lobe to apex; apex of telopodite distinctly divided into two short processes; a caudal process ending in a prominent mesal spine and a cephalic process receiving the vertical flange, ending in acute mesocaudal spine, and bearing small subapical anterior solenomerite; solenite emerging from coxa anteriorly, entering seminal canal on mesal surface of telopodite, proceeding caudad of mesal lobe and cephalad of vertical flange to solenomerite.

Specimens examined.—CALIFORNIA: holotype male, 8.5 miles northwest Rumsey, *in* Colusa County, 19 January 1969 (M. R. and R. C.

FIGS. 2–5. FIG. 2. Holotype male, *Anombrocheir bifurcata*. Anterior aspect of apical half of telopodite of left gonopod. Ca = Caudal process; Ce = Cephalic process; F = Femoral lobe; S = Seminal canal; So = Solenomerite; V = Vertical flange. FIG. 3. Holotype male, *A. bifurcata*. Left gonopod, mesal aspect. FIG. 4. Paratype female, *A. bifurcata*. Left cyphopod, anterior aspect. FIG. 5. Paratype female, *A. bifurcata*. Left cyphopod, mesal aspect.

Gardner). Paratypes: 6 males, 3 females, same data as holotype; 15 males, 12 females, 8.6 miles northwest Rumsey, *in* Colusa County, 12 February 1969 (J. S. Buckett and M. R. Gardner); 1 male, 5 females, 3.3 miles northwest Rumsey, Yolo County, 19 January 1969 (M. R. and R. C. Gardner); 1 male, 3 females, 3.5 miles northwest Rumsey, Yolo County, 12 February 1969 (J. S. Buckett and M. R. Gardner).

DISCUSSION

The holotype will be placed in the Arthropod Type Collection, Department of Entomology, University of California; Davis; paratypes will be deposited in the United States National Museum, Washington, D. C., and in the authors' private collection.

Although there are strong differences between *spinosa* and *bifurcata* in the details of the gonopods, the basic structure is quite similar. In *spinosa* the femoral region is greatly thickened, and in *bifurcata* this thickened region is produced as a lobe. The vertical flange of *bifurcata* is produced almost identically in *spinosa*. The gonopod apex of *spinosa* is much larger than in *bifurcata* and the solenomerite is developed as a broad flange rather than a small acute spine. The prominent caudal process of *bifurcata,* however, possesses no apparent equivalent in *spinosa.*

In the female of *bifurcata*, the cyphopods closely resemble those of *spinosa* from caudal aspect. From mesal aspect, however, one sees that the caudal surface of the valve curves mesad, covering most of the surface. Unfortunately, the large proximal sclerite shown in Fig. 5 was removed from the cyphopod of *spinosa* as illustrated in our previous paper (Buckett and Gardner, *op. cit.,* Fig. 3), making comparison difficult. The cyphopods in this genus exhibit pronounced variability, and are not satisfactory in themselves for species identification.

All collections of *A. bifurcata* were made in Cache Creek Canyon. Ecologically, it was interesting to note the high density of the Western Banded Glowworm, *Zarhipis integripennis* (Le Conte), which preys upon *A. bifurcata*. At the locality 8.5 miles northwest of Rumsey, in Colusa County, where the milliped population was heavy, the authors observed that approximately one-third of the population suffered predation by the Western Banded Glowworm.

In several instances, the larvae of *Z. integripennis* were observed to be either alongside or inside the millipeds. The position of the larvae and mode of entrance into the millipeds agrees with the information given by Tiemann (1967, p. 257). The large female larvae possibly feed on millipeds other than *Anombrocheir*, as their size is greater in length and width than specimens of either species of *Anombrocheir*.

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Tiemann, D. L. 1967. Observations on the natural history of the Western Banded Glowworm *Zarhipis integripennis* (Le Conte) (Coleoptera: Phengodidae). Proc. California Acad. Sci. 35(12): 235–264 + 4 pls.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

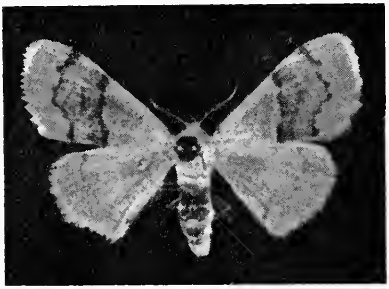
A Geometrid Moth Hitherto Unrecorded from the United States.—On April 15, 1966, I took two females of a moth unknown to me at light in the hardwood hammock on Key Largo, Florida. They seemed to belong to the subfamily Sterrhinae of the family Geometridae. The moths had a wingspan of about one-half inch, and had a striking forewing pattern of light olive green with a dull scarlet median band; the hindwing was concolorous whitish. Although I kept them alive for oviposition, no eggs were laid.

Later that year I received from Mr. Charles P. Kimball of Sarasota, Florida, a series of 35 males and 13 females of this species, all from Key Largo. He was unable to identify them, and had received them too late for mention in his *Lepidoptera of Florida* (1965).

In attempting to learn if this were an undescribed species, I sent specimens to Mr. D. S. Fletcher of the British Museum. He identified the species as *Acratodes oblinataria* Möschler, described from Puerto Rico. Furthermore, he found that the Florida material compared favorably with the subspecies *scintillans* Warren, described from British Guiana. A third name applied to the species is aberration *fasciata* Prout, of which Caracas, Venezuela, is the type locality. The three names seem to reflect slight differences in maculation, especially expression of the median band. Some variation in this band was seen in the series before me, indicating a possible source of confusion; however, none of the Florida specimens have the band almost wanting, as is the case with some neotropical specimens in the National Museum of Natural History. The species is widely distributed in South America and the Caribbean area, although its full range and life history are not recorded.

The specimens sent by Kimball were all but one taken by Mrs. Spencer Kemp in 1965 and 1966 in every month except March, May, and September; however, *oblinataria* can probably be found on Key Largo throughout the year. The other specimen is the earliest known from Florida, taken by H. V. Weems, Jr., July 20, 1962. These specimens are in the Kimball collection.

Acratodes oblinataria should be placed in the McDunnough *Check List* (1938) after *Xystrota davisi* Grossbeck (p. 143, No. 4137). Until revisionary studies clarify the correct generic placement of *oblinataria*, it should be left in *Acratodes* (as used by L. B. Prout in Part 61 of *Lepidopterorum Catalogus*, 1934). McDunnough listed in *Xystrota* the North American species ascribed by Prout to *Acratodes*, and probably would have included *oblinataria* in *Xystrota* as well.



Acratodes oblinataria Möschler, female; taken at Key Largo, Florida, April 15, 1966. Wingspan 16 mm.

It seems strange to me that this species was not discovered in Florida by earlier workers. Perhaps its colonization of Key Largo is very recent, and that it was brought in on the winds of a hurricane. More probably it was simply missed, possibly due to lack of collecting on Key Largo. It seems well entrenched now, although the subtropical hardwood hammock on northern Key Largo is doomed to clearance for development in a few years. Sad to say, this species may become extinct in Florida almost before its presence was discovered.

I wish to thank D. S. Fletcher and C. P. Kimball for their assistance.—Charles V. Covell, Jr., *University of Louisville, Kentucky 40208.*

(Entomologist's Record continued on p. 304)

Distinction between Phytomyza horticola Goureau and P. syngenesiae (Hardy) (Diptera, Agromyzidae)[1]

GEORGE C. STEYSKAL[2]

The widespread and very polyphagous leafminer formerly known as *Phytomyza atricornis* Meigen or *P. chrysanthemi* Kowarz, as well as by several less-used names, has been shown by Griffiths (1967) to consist of a complex of 5 species: *P. aragonensis* Griffiths (Spain; in leaves of *Lactuca tenerrima*), *P. lindbergi* Spencer (Canary Islands; host unknown), *P. farfarella* Hendel (Jugoslavia to Iceland; in leaves of *Taraxacum* and *Leontodon* species), *P. horticola* Goureau (widespread; polyphagous), and *P. syngenesiae* (Hardy) (widespread; polyphagous). Because type specimens of *P. atricornis* appear to be lost and inasmuch as numerous records in the literature under that name no longer can be referred to the correct species, Griffiths has decided that it is best to abandon the name and to consider *P. atricornis* a *species dubia*.

Only *P. syngenesiae* of this group has been found in the Americas (Canada and United States). The other widespread and economically important species, *P. horticola*, according to Griffiths, is distinguishable from *P. syngenesiae* virtually only by details of the male postabdomen. These differences may be summarized as follows:

Aedeagus with distiphallus strongly developed, divergent from base (sclerotic portion from apical view V-shaped); mesophallus little or not reflexed apically; blade of sperm pump strongly deflected to one side; acrostichal hairs usually completely absent .... **P. horticola** Goureau

Aedeagus with distiphallus more weakly developed, divergent only towards apex (sclerotic part Y-shaped from apical view); mesophallus strongly reflexed apically; blade of sperm pump fan-shaped, roughly symmetrical; 1–4 acrostichal hairs frequently present .... **P. syngenesiae** (Hardy)

In order to recognize *P. horticola* more easily in intercepted material, I examined specimens in the U. S. National Museum collection, including series determined by Griffiths, in a search for non-genitalic characters; however, I could do no more than confirm Griffith's conclusions. Griffith's

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[1] Accepted for publication August 15, 1969.

[2] Systematic Entomology Laboratory, U.S.D.A., c/o U. S. National Museum (Natural History), Washington, D. C. 20560.

figures 12–15 (*P. syngenesiae*) and 16–20 (*P. horticola*) show only the sperm pump and the aedeagus with only partial outlines of membranous structures, as well as the surstylus of *P. horticola* only. Specimens macerated in NaOH solution, and even those freshly-killed, show a number of additional postabdominal characters. Such may be seen in figures 1 and 2, prepared from material macerated in NaOH solution and drawn while the postabdomen was supported in water. In *P. syngenesiae*, I would draw attention especially to the acutely projecting tip of the pro-

Details of *Phytomyza* species. Fig. 1. *P. horticola* Goureau, New Delhi, India, reared from peas. Fig. 2. *P. syngenesiae* (Hardy), Alameda County, California, reared from chrysanthemum. A, male inner copulatory apparatus (phallosome), profile; B, epandrium, profile, with oblique mediventral view of surstylus; C, hind end of puparium, dorsal view; dp, distiphallus; h, hypandium; mp, mesophallus; pep, proepiphallus; 10S, 10th sternum (not shown in Fig. 2).

epiphallus (*pep*), which is often visible in untreated killed specimens, and the bifurcate condition of the lateral arms of the hypandrium (*h*) at their point of junction with the epandrium. The surstylus of *P. syngenesiae* protrudes somewhat farther than that of *P. horticola* and bears longer hairs on its mesal face, none of which are visible in profile.

Inasmuch as these flies are known to pupate within their mines, puparia may often be found in intercepted plant material. I examined a few available puparia of *P. horticola* and several of *P. syngenesiae* and found them very similar to each other, but when seen from a directly dorsal view I noted a distinct difference in the general posterior outline and the relative extension of the posterior spiracles. In *P. horticola* (fig. 1C), the general outline is sinuate with a well-developed apical emargination and the posterior spiracles do not extend beyond the outline; in *P. syngenesiae* (fig. 2C), the outline is evenly coarctate and the spiracles project beyond the outline. No comparable larvae of both species were available.

REFERENCE CITED

GRIFFITHS, G. C. D. 1967. Revision of the *Phytomyza syngenesiae* group (Diptera, Agromyzidae), including species hitherto known as "*Phytomyza atricornia* Meigen." Stuttgart. Beitr. Naturk. 177: 1–28.

(Entomologist's Record continued from p. 300)

New Collection Records for Niveaspis ilicis (Hoke), (Homoptera: Diaspididae).—*Niveaspis ilicis* (Hoke) was described as *Lepidosaphes ilicis* by Hoke (1927, p. 352) from 2 adult females, 2 second stage females, and 1 male collected on leaves of *Ilex opaca* Ait. near Como, Mississippi, X–29–21. Ferris (1938a, p. 150) transferred *L. ilicis* to a new genus, *Lyraspis* Ferris and stated that it was known only from the original record. Later, he (Ferris, 1941d, p. 302) transferred *ilicis* to the genus *Niveaspis* MacGillivray.

The following collections should be recorded because there has been no additional host or distribution report since the species was described.

Cumberland Island, Camden Co., Georgia on *Ilex cassine* L. III–16–68, IV–27–68; on *Ilex opaca* Ait. IV–27–68; on *Ilex* sp. IX–2–68. Headlight Community, Clinch Co., Georgia on *Ilex* sp. XII–29–68. Camp Cornelia, Charlton Co., Georgia on *Ilex cassine* L. VI–15–68. Needmore Community, Echols Co., Georgia on *Ilex vomitoria* Ait. VIII–3–69.

All of the above collections were from the bark of the host plants and the scales were extremely obscure. None was found on the leaves as reported by the describer.

Niveaspis ilicis (Hoke) is represented in our collection by 16 adult females on slides and some dry material. Voucher specimens are in the Florida D.P.I. collection, Gainesville, Fla., the V.P.I. collection, Blacksburg, Va., and the USNM, Washington, D. C.

References are cited in Morrison and Renk, A selected bibliography of the Coccoidea, USDA, Misc. Pub. 734.—H. H. Tippins and Ramona J. Beshear, *Georgia Experiment Station, Experiment, Ga. 30212.*

Taxonomic and Distributional Note on Monoeceus texanus Champion (Coleoptera, Alleculidae).—*Monoeceus texanus* was described by Champion (1888, *Biologia Centrali-Americana*, 4 (pt. 1): 44) on the basis of a single specimen from Southern Texas. According to Miss Christine M. F. von Hayek of the British Museum (personal communication), there is a note in the Champion material stating that the type is in "Coll. Horn." I have not been able to locate the type at either the Philadelphia Academy of Natural Sciences or the Museum of Comparative Zoology.

This species is distinguishable from all other alleculids occurring in the United States in that the thorax is short, strongly transverse and greatly dilated, with the basal angles strongly produced posteriorly.

I have examined 10 male and 10 female specimens of this species and collecting data are as follows: *Texas:* Brownsville, no date, 2; Columbus, June–July, 3; Esperanza Ranch, Brownsville, May–August, 3; Falfurrias, June, 4; Sabinal, March–September, 2; San Diego, February, 2; Sealey, July, 2; Victoria Co., September, 4.—James D. Marshall, *Biology Department, The College of Idaho, Caldwell, Idaho 83605.*

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BIONOMICS OF THE BARK BEETLE PREDATOR, THANASIMUS DUBIUS FAB. (COLEOPTERA: CLERIDAE)[1]

Edward C. Mignot[2] and Roger F. Anderson[3]

Many species of checkered beetles are well known predators of bark beetles; consequently, the adults of these insects are commonly observed on the outside bark while the larvae are in the inner-bark of trees infested with bark beetles. Inasmuch as checkered and Ostomid beetles are usually the most abundant insect predators of bark beetles and because only a few intensive studies have been made on these insects it was thought desirable to evaluate the effectiveness of two species of these common predators, *Thanasimus dubius* Fab. and *Temnochila virescens* Mann. Therefore, a study on these relationships was undertaken in 1964 and conducted over the following two year period, 1964 to 1966.

Part of these studies entailed collecting a considerable amount of information on the life history and ecology of these predators and for one of these, the checkered beetle, *Thanasimus dubius*, the results are presented in this paper. A future paper will deal with the ostomid beetle, *Temnochila virescens*.

About the same time the present study was made Thatcher and Pickard (1966) also studied the predator, *Thanasimus dubius*, in which the host prey was the southern pine beetle, *Dendroctonus frontalis* Zimm. The results of their work concerning the life history were somewhat similar to those presented here, but for certain aspects we have more detailed data.

Other rather intensive studies of clerid beetles as predators of bark beetles were those of Person (1940) and Struble (1942). Person studied *Thanasimus lecontei* (Wolc.) whereas Struble was concerned with *Enoclerus sphegeus* Fab.

In a third paper, which is scheduled for future publication, the potential effectiveness of both *Thanasimus dubius* and *Temnochila virescens* in regulating bark beetle populations will be discussed.

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[1] This study was supported jointly by the Southern Forest Disease and Insect Research Council and Duke University. Accepted for publication November 3, 1969.

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METHODS OF STUDY

Both field and laboratory studies were used. Ten pines (*Pinus taeda* L.) were felled in each of twelve different areas of the Duke University Forest which is located near Durham, North Carolina. These trees were cut at four different times during the year—spring (April), early summer (June), late summer (August), and fall (September). This experimental design resulted in infestations by bark beetles at various times during the warmer seasons so that activities of the associated predators could be followed in the field. The prey bark beetles consisted mostly of the 5-spined pine engraver, *Ips grandicollis* (Eichh.) and to a lesser extent the small 4-spined *I. avulsus* Eichh. and the large 6-spined *I. calligraphus* Germ. The felled trees were observed periodically to determine the presence of infestations by the pine engravers and the associated predators. Starting three weeks after each group of trees had been cut, and continuing thereafter at weekly intervals for a period of twelve weeks, bolts two feet long were cut from the boles of the felled trees. The bark was removed from these samples so that the bark beetles and predators present in the innerbark could be identified, counted, and their developmental stage determined.

TABLE 1. Length of the developmental periods for the predator, *Thanasimus dubius* and its host, the pine engraver, *Ips* spp.

Insect Species	Time of Year			
	Spring Days	Early Summer Days	Late Summer Days	Fall Days
Ips spp	34–37	31–35	33–35	32–34
T. dubius	67–83	Absent[4]	Absent[4]	240–262[5]

[4] Only adults were observed on the outside bark, larvae and pupae were not found.

[5] The long developmental period was because the larvae passed the winter in this state.

In the laboratory the predators were reared in Petri dishes. The inside of the bottom plates were usually covered with moistened filter paper so as to produce moisture conditions similar to those in the innerbark where the immature stages of the predators normally live. The larval stages of the predators were fed with larvae and pupae of the pine engraver beetles (*Ips* spp.) whereas the adult predators were fed with adult engraver beetles. Various constant temperatures were used for the laboratory studies. For the oviposition studies a small piece of pine bark had to be enclosed with each pair of beetles. This provided a suitable place for egg deposition.

RESULTS

The data collected on the life cycle of the checkered beetle, *T. dubius*, in the field are summarized in Tables 1 and 2, whereas similar data collected in the laboratory are presented in Table 3. Mortality data for the developmental stages at the various temperatures are presented in Table 4.

TABLE 2. Development of *Thanasimus dubius* in the field

Time of Year	Instar					
	1	2	3	4	Pupal	Total
	Days	Days	Days	Days	Days	Days
Spring	4	21	7	4	17	53
Autumn	4	33	166[6]	6	19	228

[6] Extended length for this stadium was because the insects passed the winter in this instar.

TABLE 3. Development of *Thanasimus dubius* at various constant temperatures

Stage of Development	Temperature °C				
	20	25	30	35	37½
	Days	Days	Days	Days	Days
Egg	13 (1.2)[8]	11 (0.9)	8 (0.7)	10 (1.6)	16 (1.2)
Larval Instars					
1	9 (1.4)	7 (1.1)	12 (1.7)	15 (1.4)	16 (2.6)
2	24 (2.8)	20 (2.1)	31 (2.0)	34 (2.4)	38 (2.3)
3	11 (1.7)	8 (0.9)	14 (1.2)	16 (1.8)	21 (3.3)
4	10 (1.3)	9 (1.5)	15 (1.3)	18 (1.9)	23 (2.3)
Pupa	22 (1.6)	18 (1.0)	14 (1.0)	16 (1.4)	20 (21.)
Total	89	73	94	109	134

[8] Values in parentheses are standard errors. Five replicates were used for each temperature.

Longevity of the adults when kept separately in Petri dishes varied from 21 to 57 days. Longest survival occurred at 25° C ($\bar{x} = 51$ days) and the shortest at 37½° C ($\bar{x} = 28$ days). The averages and standard errors for the five replicates used for each of the five temperatures were as follows: 20° C, 44 ± 2.3 days; 25° C, 51 ± 2.6 days; 30° C, 45 ± 1.6 days; 35° C, 29 ± 1.8 days; 37½° C, 28 ± 2.3 days.

TABLE 4. Mortality suffered by *Thanasimus dubius* during the developmental period

Stage of Development	Temperature °C				
	20	25	30	35	37½
	Percent Mortality[9]				
Egg	31.0	28.0	34.0	59.0	83.0
Larval Instar					
1	33.0	26.6	27.0	22.0	11.5
2	2.2	5.0	5.1	4.4	1.8
3	2.0	3.6	4.1	2.3	0.7
4	1.2	2.6	2.4	1.1	0.4
Pupa	8.1	5.8	5.5	3.7	1.1
Total	77.5	71.6	78.1	92.5	98.5

[9] Mortality values for each stage are based on the total population at the beginning (e.g., number of eggs). The number of insects used for each stage at each temperature varied from 27 to 74 with the average being 48.2.

The average preoviposition period from the time of beetle emergence to when the first egg was laid varied from 3 days at 20° C to 7 days at 37½° C. At 25° C and 30° C the length was 4 days and for 35° C it was five days. Five replicates were used at each temperature studied with the range for each varying from 3 to 4 days at 20° C to 6 to 8 days at 37½° C. Subsequently, the oviposition period continued for an average of 21 days at 37½° C to 47 days at 25° C.

Total egg production for five pairs of these predators varied from an average of 11 to 112. The average number of eggs per female for the various temperatures were as follows: 20° C, 81 eggs; 25° C, 106 eggs; 30° C, 112 eggs; 35° C, 37 eggs; 37½° C, 11 eggs. These were produced at an average rate of 3.6 to 19.6 eggs per week.

Rather dry conditions were better than a moist environment for larval development. Mortality was 61.1 percent when the insects were reared on moist filter paper, but was only 41.3 percent when the paper was kept dry. A total of 80 larvae were used in this study.

Whenever two *T. dubius* larvae were enclosed together in a Petri dish, one commonly killed and ate the other. When other food (bark beetle larvae or pupae) was present, however, the rate of cannibalism was reduced to about 35 percent when two larvae were caged together for a period of two days. When the usual food consisting of bark beetle larvae or pupae was absent, however, one larva always soon destroyed the other. The adult beetles, on the other hand, were not cannibalistic even in the absence of other food.

In the field, the density of the *T. dubius* populations, on the outside of logs infested with pine engravers was higher, both during the spring (averaging 1 beetle per square foot of bark) and the fall (0.8 beetles per square foot) than it was during the three hot summer months from June through August. During the latter period the average was 0.5 beetles per square foot. Larval populations of the earlier instars of this predator also averaged about 1 per square foot of inner-bark surface during both the spring and fall seasons. However, this density decreased as the larvae matured so that for the last (4th) larval instar and the following pupal stage there averaged only 0.5 insects per square foot of inner-bark. As can be seen from the data in Table 1, there were no immature stages of *T. dubius* present in the logs infested with *Isp* spp. during the three hot summer months of June, July, and August.

DISCUSSION

The data presented in Tables 1 to 4 show that the bark beetle predator, *T. dubius*, developed fastest and survived better at the cooler temperatures that occur during the spring and fall seasons. Throughout the hot summer months from June through August, the immature stages of this predator were absent in logs exposed in the field and infested with bark beetles even though the adults were present. During the hot summer season this ecological niche in the inner bark was consistently and completely occupied by another common predator, *Temnochila virescens*.

Other data presented here pertaining to eggs production, incubation period, and development from egg to adult of *T. dubius* in the field are somewhat similar to those reported by Thatcher and Pickard (1966).

As with most preliminary types of studies, this one suggests several relationships that should be investigated more thoroughly. One aspect that should be clarified is to determine why the immature stages are absent during the hot summer months. As stated previously, the inner-bark of logs infested with bark beetles during the summer was occupied by another predator, *Temnochila virescens*. If *T. dubius* did not produce a generation during the three hot summer months the beetles either had to survive as adults until autumn, at which time they reproduced, or they produced a summer generation with the larvae feeding on some prey other than bark beetles. In either case, the density of the immature stages of *T. dubius* was as large in the autumn as it was in the spring. It is suspected that during mid-summer the clerid larvae were destroyed by the other common predator, *Temnochila virescens*.

Another somewhat unexpected result was that the rate of development decreased considerably at a temperature of only 30° C. At 25° C the rate of development from time of oviposition to the imago was 23, 33, and 46 percent faster than it was at 30° C, 35° C, and $37\frac{1}{2}$° C, respectively. This adverse effect of higher temperatures agrees with the other results indicating that *T. dubius* succeeds better at cooler temperatures.

And, lastly, the interspecific relationship between the two predators, *Thanasimus dubius* and *Temnochila virescens*, should be investigated more thoroughly especially at cooler temperatures. This type of study may help to explain the fate of the ostomid larvae in the spring and fall and the clerid larvae in the summer.

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Plecoptera from High Altitudes and a New Species of Leuctra (Leuctridae)[1]

Stephen W. Hitchcock[2]

Abstract

Five species of stoneflies have been previously recorded from the alpine zone above timberline in the White Mountains of New Hampshire. Two of these were probably carried up by wind and do not survive in the area. Two additional species of *Nemoura* were found existing there. Eleven species were collected near or above timberline in Wyoming, two of these being new records for Wyoming. The alpine zone in the east has relict arctic populations with occasional incursions of temperate species. Alpine zones in the west have populations that are continuous north and south. *Leuctra laura* new sp. is described. A key to *Leuctra* males of the northeast is given.

High mountain areas are of considerable interest in the study of populations for they allow intrusions of northern species into more southern areas. The alpine zone of the White Mountains is a restricted area that has been under scrutiny of biologists since the late eighteenth century. The higher reaches of the western cordillera cover a vast expanse that have been only imperfectly examined. Recently I have collected stoneflies near and above timberline in both the Presidential range of New Hampshire and the Wind River range of Wyoming. Several stoneflies have been recorded from the former, apparently none from the latter.

Alexander (1940) has given a fine summary of the biology and geology of the Mt. Washington area of New Hampshire so no detailed descriptions will be given here. The following stoneflies have been previously recorded from the alpine zone of Mt. Washington: *Diura nanseni* (Kempny) (Perlodidae), *Leuctra variablis* Hanson, *Nemoura nigritta* Provancher (Nemouridae), *Leuctra tenuis* (Pictet) and *Arcynopteryx compacta* (MacLachlan) (Perlodidae). The first two species were found at the Lakes of the Clouds (el. 5,000 feet) or the outlet to it. An additional record from this spot is *Nenmoura trispinosa* Claassen collected by me on June 28th. These stoneflies were numerous and emerging as adults at noontime. As might be expected, they resembled specimens from the north in Quebec rather than western populations in Illinois. The adults were all macropterous but did not fly. If disturbed, they lifted their wings, the ever present wind

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[1] Accepted for publication September 13, 1969.

[2] Connecticut Agricultural Experiment Station, Box 1106, New Haven, Connecticut 06504.

carried them a few feet, whereupon they folded their wings, dropped to the ground and ran into rock cracks or other shelter.

Nemoura washingtoniana Claassen was originally collected from "Mt. Washington" but without specific data to enable it to be placed by life zone. It is of interest therefore that I captured one male and two females from a small brooklet coming off the snowfields over timberline above the headwall of Tuckerman Ravine at about 5,100 feet.

Slosson (1895, 1897) recorded two stoneflies from above timberline on Mt. Washington and probably from the summit as her collecting was apparently restricted to the vicinity of the hotel at the top of the mountain (el. 6,288 feet). *Nemoura nigritta* (= *N. delosa*) ranges from Florida to southern Quebec. It is perhaps the most common *Nemoura* in southern New England and it would therefore seem likely that *nigritta*, being a more southern species and common in streams, was a likely candidate to be carried by winds to the summit, rather than breeding in the little water available above timberline. *Leuctra tenuis* recorded by Mrs. Slosson in 1895 may also be a chance capture. Most *Leuctra* fly readily and I have taken them one-half mile from the nearest stream. I have found the closely related *L. tenella* in a stream on the wooded slope of Mt. Washington and, if flying near timberline, could be easily carried upwards by the wind currents. In the absence of contrary evidence, *L. tenuis* should also not be considered an inhabitant of the upper slopes.

Three different elements then make up the Plecoptera fauna of the alpine zone in the White Mountains: a) casual visitors—lowland species of more southern range taken by convection air currents and deposited in the area but which cannot survive (example—*Nemoura nigritta*); b) temperate species—species whose range is continuous latitudinally to the north and can survive in the alpine zone as equivalent to the northern edge of its range. If the local population is wiped out by an extra severe winter or other catastrophe, it can be replenished by immigrants from the same stream farther down the slope in the Hudsonian or Canadian zones (example—*Nemoura trispinosa*); c) northern species—species whose range is discontinuous to the north and the White Mountains represent an isolated southern remnant of an otherwise circumpolar distribution. If destroyed in the local area, there can be no immediate replacement (example—*Diura nanseni washingtoni*).

Tuckerman Ravine, a protected glacial cirque on the eastern slope of the range, has been extensively collected for stoneflies. *Arcynopteryx compacta*, a transcontinental arctic species, has been taken there as has a single female *Nemoura*, possibly *oregonensis*. Both of these represent isolated outposts of more northern or western species.

Tuckerman Ravine also contains the following new species:

Leuctra (Leuctra) laura NEW SPECIES

(Figs. 1, 3, 4)

Male: Light brown in color; prosternal sclerites and wing venation typical of subgenus; first six abdominal segments unexceptional, seventh tergite bears a broad sclerotized lobe that is barely raised above the surface and extends two-thirds the way across the tergite, a membranous area extends from the posterior margin of the tergite forward on each side of the lobe; the eighth tergite bears a trifurcate process reaching (in dorsal view) almost to the hind margin, the lateral teeth of this process sharply pointed and raised above the surface of the tergite, the center tooth smaller and appressed to the surface so that it turns slightly downward; the posterior membranous margin of the tergite drops sharply down from the trifurcate process, this membranous area extends anteriorly on each side of the process; the ninth tergite largely membranous except for a lightly sclerotized area medially; the vesicle (ventral lobe) of the ninth sternite setiferous and twice as long as wide, the center portion of the sternite flattened, somewhat membranous and slightly recessed medially, the terminal lobe sharply produced; paraprocts curved and of approximate equal width throughout; the titillators shorter than the paraprocts and only slightly curved. Length to tip of wings 8.5 mm.

The holotype male was taken by sweeping the foliage over Cutler's Brook at the base of Tuckerman Ravine (el. 3,300 feet), Mt. Washington, N. H., June 28, 1969. It will be placed in the United States National Museum, type number 70772.

Female: unknown. There were two distinctive *Leuctra* females collected with the holotype, either of which could be the female of this species. The most likely specimen, based on size and color, is illustrated in Fig. 2 and described as follows:

Light brown in color; prosternal sclerites, abdominal tergites and wing venation typical of subgenus; subgenital plate of the eighth sternite slightly produced into two broad, flattened lobes with a shallow narrow notch between them; a lighter colored area extends forward from this notch to the anterior margin of the sternite so forming an irregular longitudinal stripe; cerci setiferous with a small lobe distally at the tip. Length to tip of wings 10.7 mm. Captured at some time and place as the male of *Leuctra laura.*

There is no recent key to North American *Leuctra*. *L. laura* would fit in as follows to a key to male *Leuctra* s.s. of the northeast:

1. Raised processes on both tergites 7 and 8 or processes on neither................2
   Process on either tergite 7 or tergite 8 but not on both..........................4
2. No processes on either tergite 7 or 8; or a single, rounded, hardly raised process on each segment...**ferruginea**
   Processes on both tergites 7 and 8; process on 8 either bi- or trilobed............3
3. Process bilobed on each of tergites 7 and 8............................**duplicata**
   Process trilobed on tergite 8; single, rounded, hardly raised on 7...........**laura**

4. Process on tergite 7 only..5
   Process on tergite 8 only..9
5. Process on tergite 7 distinctly trilobed..6
   Process of tergite 7 not trilobed..7
6. No spines on apices of paraprocts, titillators slightly curved or straight...**variablis**
   Paraprocts finely spinulate apically, titillators well curved.................**triloba**
7. Process of tergite 7 reaching anterior margin of 8th tergite....................8
   Process of tergite 7 not reaching more than halfway across tergite 7.......**tenella**
8. Sclerotized process long, extending out over tergite 8; vesicle longer than wide..........**tenuis**
   Sclerotized process not extending over tergite 8; vesicle as wide as long.........**variablis**
9. Tergite 8 with a single process...10
   Tergite 8 with two processes or a single bifurcate or trifurcate one............11
10. Process truncate..**truncata**
    Process rounded and hardly raised..**ferruginea**
11. Tergite 8 with a trifurcate process...**laura**
    Tergite 8 with two processes or a single bifurcate one.......................12
12. Process of tergite 8 with 2 slender processes widely separate and several times as long as wide; paraprocts without trough......................**sibleyi**
    Process of tergite 8 with two lobes close together; trough in paraprocts.....**maria**

There are no specific lists of timberline insects of the Rocky Mountains. However, Knight and Gaufin (1966) and Gaufin (1964) give some measure of expected stoneflies. The following stoneflies were collected from July 16 to 20 at elevations of 10,000 to 10,500 feet in the Bridger Wilderness Area of Wyoming.

Nemoura haysi Ricker—a mating pair well above timberline on a cliffside several hundred yards from the nearest water (Bear Lake).

Nemoura columbiana Claassen—above timberline at the outlet to Pass Lake.

Paraleuctra purcellana (Neave)—female among scrub willows at outlet to Faler Lake. The venation of the hindwing was not typical of *Paraleuctra* but the genitalia and abdominal sclerotization of the abdomen are distinctive.

Perlomyia utahensis Needham and Claassen—above timberline at outlet to Pass Lake.

Capnia confusa Claassen—above timberline at Bear Lake.

Capnia gracilaria Claassen—two gravid females at outlet to Faler Lake.

Alloperla lamba Needham and Claassen—outlet to Faler Lake.

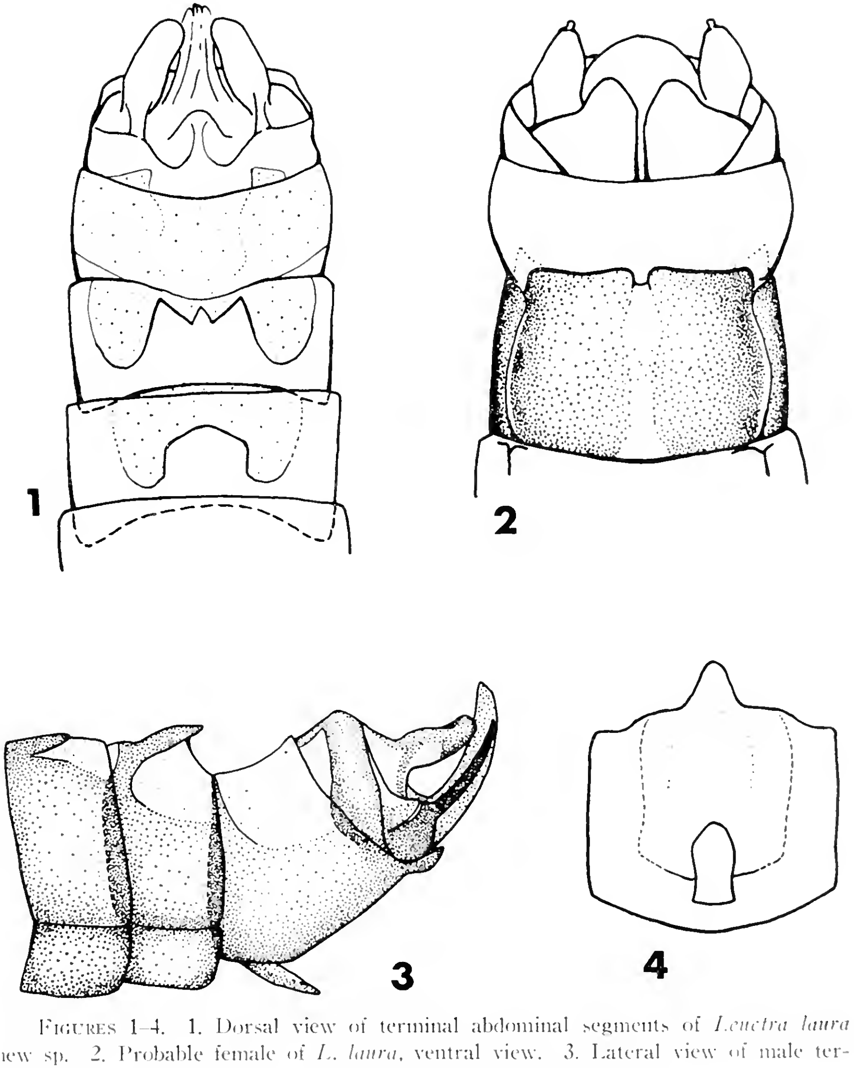
Alloperla fidelis Banks—numerous at both Faler Lake and its outlet. A female was captured ovipositing on the lake at 10 A.M.

Paraperla frontalis (Banks)—.

Arcynopteryx watertoni? Ricker—both of the above were collected in a grassy meadow with scattered trees in a pocket otherwise above timberline.

Isoperla ebria (Hagen)—Faler Lake.

The most notable thing in this list is the wide spread distribution of all these insects in the cordillera. There were no rare or restricted species. This is in strong contrast to the situation in the White Mountains. Although the Bridger area is twice the elevation of the White Mountains, the



FIGURES 1–4. 1. Dorsal view of terminal abdominal segments of *Leuctra laura* new sp. 2. Probable female of *L. laura*, ventral view. 3. Lateral view of male terminalia, *L. laura*. 4. Ventral view of male ninth sternite, *L. laura*.

weather is less rigorous and the higher life zones are continuous to the north and south. Nebeker and Gaufin (1967) present a map showing barriers and the zones of isolation in the mountainous areas of the west. These particular insects fall into the Wasatch zone with affinities to the Wasatch and Uinta Mountains and the mountains of south central Utah. However the Green River drainage has an altitudinal connection to the north through the Absaroka Mountains and two species (*P. purcellana* and

A. watertoni), not previously recorded from Wyoming (Gaufin, 1964) nor from the general Wasatch area but rather from Montana and north, were found at 10,300 feet altitude. These two species may be establishing themselves at the headwater of the Green River after having surmounted the mountain passes to the north and will eventually be found farther south. Because of the Snake River Plain barrier on the west and the desert areas of south central Wyoming on the east, the headwaters of the Green River may be the present main corridor for northern aquatic insects to make their way south into the Colorado River drainage.

At the higher, colder altitudes, stoneflies are less restricted to streams and will be commonly found in lakes as well. Many of these high country lakes contain no fish as the steep streams preclude natural movement of the fish into them. Others have been artificially stocked, usually with a single variety of trout. They thus provide a natural laboratory to examine the effects of fish on native arthropod populations. It should be possible to study undisturbed lakes as well as those subject to feeding pressure by different species of trout.

The alpine zone of the White Mountains represents an area available for colonization only since the retreat of the Wisconsin glaciation. It is an area of rigorous climate characterized by a relict plecopteran arctic fauna being occasionally invaded by more temperate species. These isolated populations of stoneflies have already shown evidence of differentiation (Brinck, 1954). The higher areas of the Rockies have been available for colonization for a longer period of time and the continuum of areas of high altitude is much greater. Consequently, stoneflies from northern areas are found extending far to the south and there is a greater population flux between zones of isolation.

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The Mature Larva and Pupa of Calobatina geometroides (Cresson) (Diptera: Micropezidae)[1]

J. B. Wallace[2]

Abstract

Larvae and puparia of *Calobatina geometroides* (Cresson) were collected in detritus in an old tree trunk at Warm Springs, Georgia. The mature larvae and puparium are described. Characters are given for separating *Calobatina* larvae from those of other known Micropezidae.

There are very few published descriptions of immature stages of micropezids in entomological literature. Hennig (1952) and Steyskal (1964) brought together information on the immature stages of this family. Steyskal included a key to the known third instar larvae of the Micropezidae. There are approximately 31 species of micropezids in 8 recognized genera north of Mexico in the Nearctic realm (Steyskal, 1965). However, there are only two or three descriptions of immature stages of the Nearctic fauna known and included in Steyskal's (1964) key.

Based on the known information of life histories, micropezid larvae appear to have saprophagous feeding habits. Sabrosky (1942) reared *Rainieria antennaepes* (Say) (as *R. brunneipes*) from puparia found in the crotch of an American elm. Berg (1947) reared *Mimegralla albimana* (Doleschall) from a variety of moist decaying plant material ranging from underneath the bark of trees to pulp surrounding palm seeds in the Solomon Islands. Steyskal (1964) reported additional rearings of *Mimegralla* spp. in ginger root from Asia. *Taeniaptera lasciva* (F.) has apparently been reared from underneath the bark of fig trees in Florida (Steyskal, 1964).

According to Steyskal (1964), there are three species in the genus *Calobatina* in the U. S. *Calobatina geometroides* is distributed from Missouri and Kentucky southward to Texas and Florida. Specimens included in this paper were collected from approximately 1 cubic foot of moist organic debris in a hollow stump of tulip poplar, *Liriodendron tulipfera*, within 100 yards of the famous spring at Warm Springs, Georgia. In addition to the micropezids, a number of Tabanidae larvae (Diptera), Collembola and isopods were feeding in the above media.

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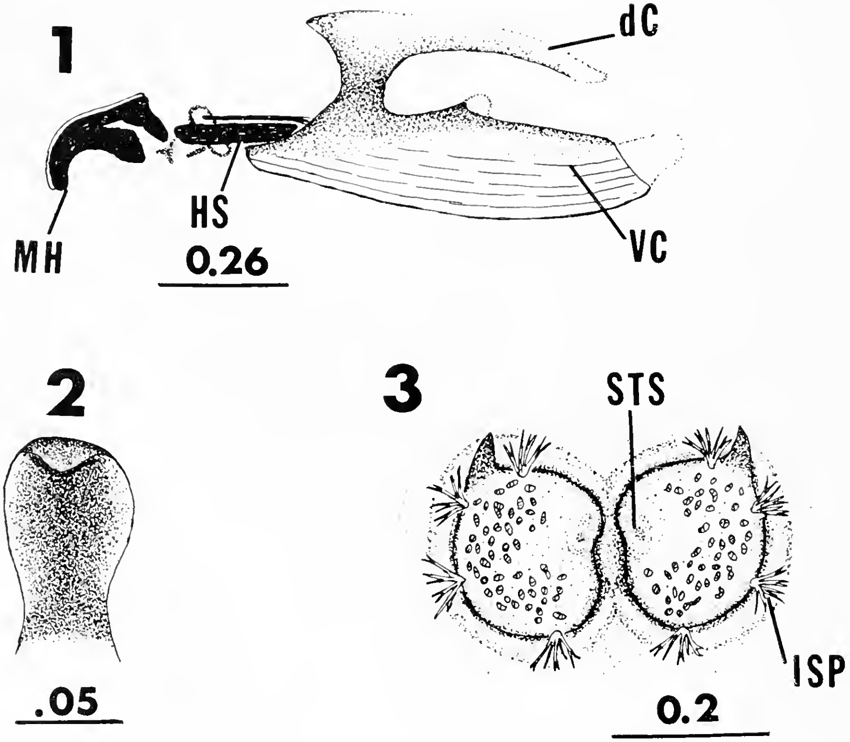
On April 26, 1969, 8 larvae and 7 puparia were collected from the above habitat. All of the larvae were apparently in the late 3rd-instar when collected. Five of the 7 puparia had evidently been parasitized when found. The dorsal cephalic caps of the latter puparia were still intact and 3 of them had small holes in their midportion where the parasites had apparently emerged. No parasites were successfully reared from the remaining puparia. The puparia were formed in the same habitat as that in which the larvae were living. Some of the larvae and puparia were found as deep as 6 inches below the surface of the debris. The rather "spoon-shaped" mouthhooks (Fig. 2) and the larval habitat suggests saprophagous feeding habits of *C. geometroides.*

One adult emerged on May 30, 1969, from the puparia collected on April 26, 1969. These puparia had been held in the laboratory in 1 × 2



FIGS. 1–3. Third stage larva of *Calobatina geometroides.* 1, cephalopharyngeal skeleton (dc, dorsal cornua; HS, hypostomal sclerite; MH, mouthhook; vc, ventral cornua). 2, ventral view of apex of left mouthhook; 3, posterior spiracular plates (isp, interspiracular processes; sts, stigmatic scar). (All measurements in mm.)

in. plastic snap-top vials at 23–25° C from April 26. The 30-plus-day pupal period perhaps indicates that the life cycle of *C. geometroides* may be somewhat prolonged.

Calobatina geometroides (Cresson)

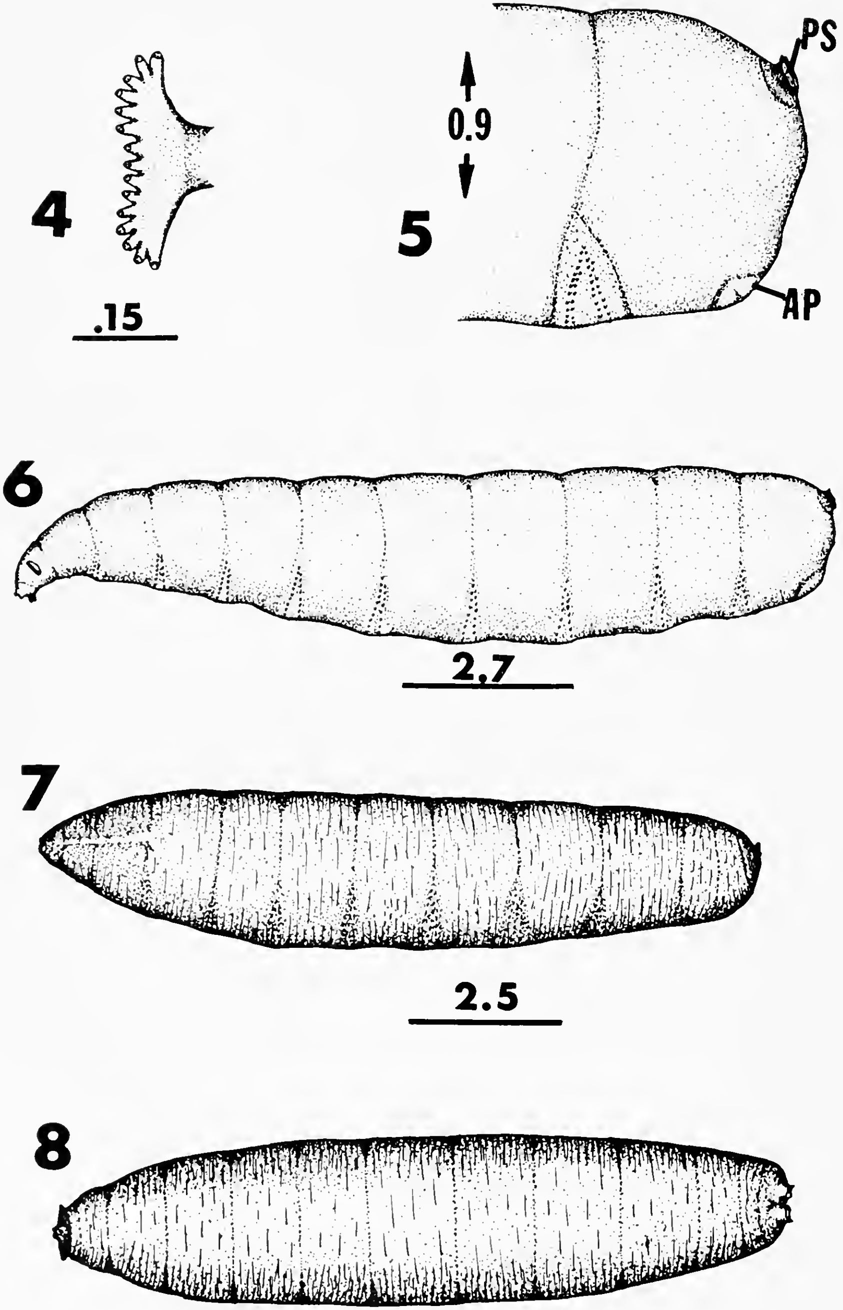
Third-instar Larva—cream white. Length 12.1–15.0 mm ($\bar{X} = 13.5$ mm), width 2.0–2.6 mm ($\bar{X} = 2.25$ mm). Maggot shaped with 12 apparent body segments (Fig. 6). Cephalopharyngeal skeleton; length = 1.15 mm (Fig. 1); with paired mouth-hooks, the apical portion of each hook somewhat "spoon-shaped" in ventral view (Fig. 2), each hook with two posterio-ventral branches. A crescent-shaped dorsal bridge lies between the parastomal bars interiorly with a similar shaped bridge occurring ventrad to the hypostomal sclerite. Dorsal cornua of pharyngeal sclerite slightly shorter than ventral cornua which bears a dorsobasal lobe. Second thoracic segment bearing an anterior spiracle dorsolaterally on each side (Fig. 4), each spiracle with 14–16 ($\bar{X} = 15$) papillae. Creeping welts with small, rounded spicules present ventrally on intersegmental lines of segments II–IV through XI–XII. Posterior spiracular plates proximate as in Fig. 3; each on a rather heavily sclerotized stigmatophore; each spiracle with a heavily sclerotized dorsolateral spine. Spiracular openings numbering 40 or more, irregularly arranged on each spiracle without separation into definite slits; each spiracle with a distinct stigmatic scar (STS) and four branched interspiracular processes (ISP) located around the margin of each spiracle.

Anal plate about twice as wide as long, with a few very small, scattered, rounded, spinules around the anterior and lateral margin of the plate. (Based on 7 specimens, Warm Springs, Georgia).

Puparium—(Figs. 7–8)—Dark brown. Length—10.1–11.5 mm ($\bar{X} = 11.1$); width —2.0–2.5 mm ($\bar{X} = 2.25$ mm); tapering at the anterior end in dorsal and lateral view. Anterior spiracles (Fig. 4) at each antero-lateral margin with distinguishable papillae numbering 14–16 ($\bar{X} = 15$) around the margin of each spiracle. Remains of spinulose area of creeping welts visible ventrally at intersegmental lines. Posterior ¼ of puparium ringed with small striae; striae also present anterio-ventrally. Posterior spiracular plates as two short, sclerotized projections at the posterior end of the puparium, distinctive shape, stigmatic scar, and spiracular openings still evident. Anastomosing remains of tracheal branches between individual spiracular openings and main tracheal trunk evident beneath the translucent spiracular surface. (Based on 5 specimens, Warm Springs, Georgia).

DISCUSSION

The larvae of *Calobatina geometroides* will correctly key to the subfamily Taeniapterinae in Steyskal's (1964) key to known micropezid larvae. However, a conflict will arise between his couplets 5 (*Rainieria antennaepes*) and 6 (leading to *Mimegralla* spp. and *Taeniaptera* spp.). Based on Steyskal's descriptions of these latter 3 genera, *Calobatina* has the following attributes that will readily distinguish it from *Rainieria antennaepes*: dorsal and ventral cornua approximately equal in length; posterior spiracle with irregularly arranged slits not in a winding configuration as in *Rainieria*



Figs. 4–8.

antennaepes. *Calobatina* can be separated from *Mimegralla* and *Taeniaptera* on the basis of the latter two genera having posterior spiracles arranged in 3 definite slits, whereas those of *C. geometroides* are as in Fig. 3.

The larval anatomy of *C. geometroides* appears to support Steyskal's (1964) delineation of Micropezidae sens. str. larvae. The stigmatophore of the posterior spiracles, openings of the posterior spiracles, anal plate with only a few very weak spicules and the dorsobasal swelling of the ventral cornua agree well with characters used by him to separate the larvae of Micropezidae from the Neriidae.

Acknowledgment

The author thanks Mr. G. C. Steyskal of the Systematic Entomology Laboratory, USDA, for identification of *C. geometroides* reared in this study.

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Figs. 4-8. Third stage larva and puparium of *Calabatine geometroides*. 4, anterior spiracles of 3rd-stage larva; 5, lateral view of posterior spiracular disc of 3rd-stage larva (AP, anal plate; ps, posterior spiracles); 6, lateral view of 3rd-stage larva; 7, puparium lateral view; 8, puparium, dorsal view. (All measurements in mm.)

DIE LONCHAEIDAE UND PALLOPTERIDAE ÖSTERREICHS UND DER ANGRENZENDEN GEBIETE. PART II: DIE PALLOPTERIDAE

By GÜNTER MORGE. Naturkundliches Jahrbuch der Stadt Linz, 1967: 141–213, 6 color plates, figs. 242–295.

The second part of Dr. Morge's monographic studies of Dipterous enemies of forest tree pests has appeared in the Naturkundliches Jahrbuch der Stadt Linz, Austria and should be of great significance to forest entomologists and to systematists. Both of these studies are excellent examples of thorough monographs of two rather poorly known and understood families of flies which obviously are of considerable importance as biological control agents against bark beetles and possibly wood boring beetles.

The author, Dr. Günter Morge, Deutsches Entomologisches Institut, Eberswalde, D.D.R., has had many years of research experience in forest entomology with a special interest in the biology and taxonomy of the flies which prey upon pests of forest trees. The present work has resulted from the compiling of an impressive amount of biological data gathered from carefully controlled field and laboratory studies.

The Lonchaeidae and Pallopteridae are commonly associated with forests over much of the world and probably play an important part in keeping populations of bark and wood boring beetles in check. Even though these studies deal largely with the Austrian fauna the work is so thoroughly done that it treats a large share of the European species and much of the information would be directly applicable to these flies in other parts of the world. It stands as an outstanding example of excellence in research and in the presentation of results.

The introduction discusses the background of this study and points out the need for revision of the Pallopteridae. Much misinformation has appeared in the past literature and many contradictions have resulted from misidentification of species. The need for a modern classification is made obvious. The main purpose for this research has been to bring up-to-date the knowledge of the family. The background work and previous studies by other authors are discussed and a review is given of the pertinent literature pertaining to the family. He discusses in detail the biology, habits, and characteristics of the species which are of most importance in the forests. Various species have a wide range of habits from those which are saprophitic or predaceous under bark; species which are phytophagous in fruits, leaves and other plant parts in pine, spruce, fir, and other forest trees. Some are also gall formers in grasses.

The principal taxonomic and diagnostic morphological and chaetotaxic characters of the adult and the importance of these flies as natural enemies of bark beetles are treated. The evolutionary significance of the morphological characters is discussed and a detailed phylogenetic arrangement of subfamilies and genera, and keys to the taxa are presented. I am not a specialist in this group and am not qualified to criticize his well presented phylogenetic charts.

The bibliography is excellent and should be very useful. The work is exceptionally well illustrated and contains six beautiful color plates and 56 line drawings which add greatly to the value of this work. The color plates are most unusual, the reproductions are well done and it is hoped will serve as a stimulus for other authors to use color reproductions. These are far superior to the ordinary black and white illustrations.—D. ELMO HARDY, *University of Hawaii, Honolulu, Hawaii 96822.*

A Modified Technique for Mounting Thysanoptera in Canada Balsam[1]

B. S. HEMING[2]

ABSTRACT

A technique is described for mounting Thysanoptera in Canada Balsam which overcomes most of the problems associated with the use of this mounting medium. It is unnecessary to puncture the animals prior to clearing them and usually the appendages are already spread. In addition the male external genitalia are extruded.

INTRODUCTION

Attempts have been made to shorten the process of mounting Thysanoptera on slides by using mounting media such as glycerine, glycerine-gelatin, Berlese's, Hoyer's, de Faure's, polyvinyl lactophenol etc. (Priesner, 1960). An important advantage that all of these media share is that the animals can be mounted into them directly, either alive or from alcohol. In addition, some of them (e.g., Hoyer's, Berlese's) are water-based and facilitate study of the animals by phase microscopy (Ross in Stannard, 1968). However, none of these preparations are permanent even if they are ringed. Also, the specimens tend to fade with time and frequently the taxonomically-important ocellar and epidermal pigments of the thrips dissolve (Priesner, 1960). For these reasons most thysanopterists agree that the best mounting medium for thrips is Canada Balsam (Hartwig, 1952; Bierne, 1955; Priesner, 1960; Faure, 1961; O'Neill and Bigelow, 1964; Stannard, 1968).

Unfortunately, the use of Canada Balsam has three major drawbacks. First, considerable time and patience is required to process the specimens properly prior to mounting them. Second, the specimens tend to crumple or shrink when they are transferred from 95%, 98%, or absolute alcohol to the usual clearing agents (xylol, carboxylol, oil of wintergreen, oil of cloves, etc.). To avoid this problem the usual procedure is to puncture the abdomen prior to transferring each specimen to the clearing agent (Hartwig, 1952; Priesner, 1960; Stannard, 1968). Unless the worker is experienced, this process often results in the damage or removal of structures (sclerites, setae) necessary for the identification of the thrips. Third,

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the appendages (wings, legs), of the specimen must be spread before the coverslip is applied. This operation is often unsuccessful and, again, frequently results in the destruction of useful characters.

Having recently begun a comparative morphological study of the male external genitalia of thrips, I have experimented with various mounting methods to find one the use of which would result in the preparation of specimens with everted genitalia. This search has resulted in the development of a technique which avoids some of the drawbacks of Canada

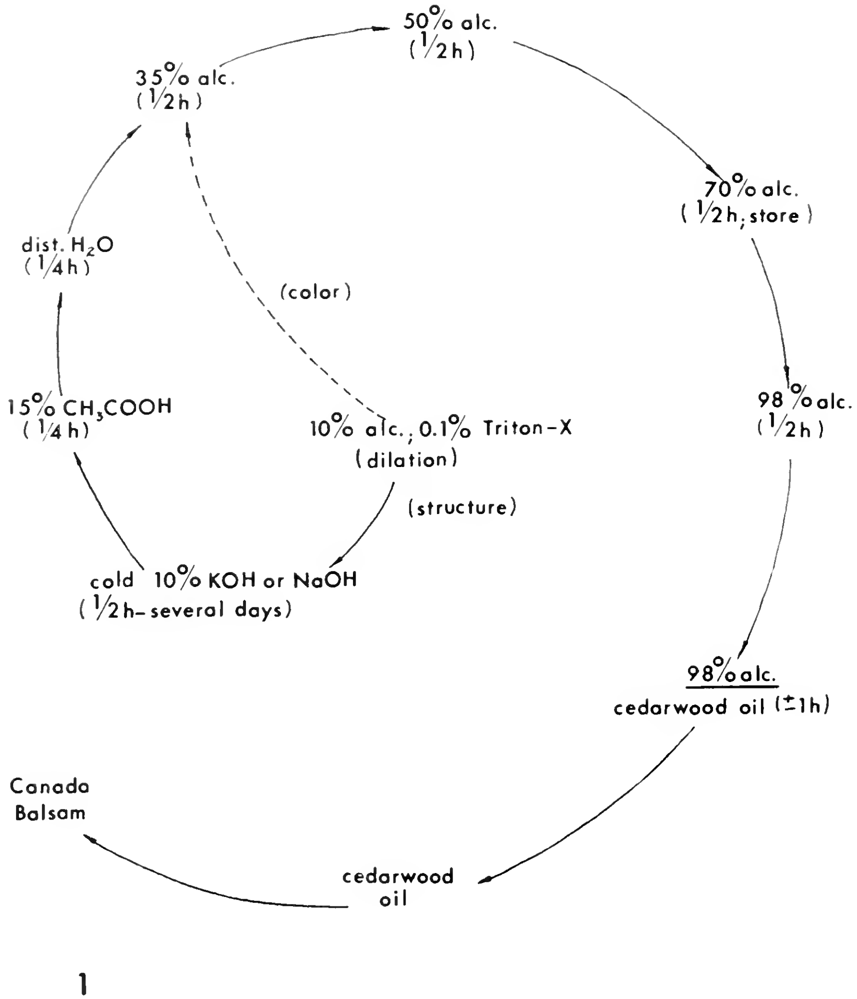

FIG. 1. Outline of mounting procedure.

Balsam noted above. The technique is basically that of Hartwig (1952) as modified by Faure (1958).

PROCEDURE

The mounting procedure is outlined in Fig. 1. Thrips are collected in the usual manner (Bailey, 1957; Priesner, 1960) into 10% ethanol (Hartwig, 1952) to which 0.1% Triton-X emulsifier has been added (Faure, 1958). The low alcohol concentration, over a period of two days to a week or more, distends the thrips, extends the wings (in Terebrantia; in Tubulifera the wings are often held over the abdomen by wing-holding setae) and legs and everts the male and female external genitalia (this also occurs in small Coleoptera, Hymenoptera, Diptera, etc. collected with the thrips). As Hartwig (1952) pointed out, distension is facilitated at higher temperatures (37° C) and by placing grass seeds (preferably germinating) in the collecting solution. The emulsifier acts as a wetting agent and causes the thrips to sink.

Further processing is best carried out in 70 mm watch glasses, each collection of thrips remaining in the glass as the succession of liquids are introduced and drawn off with a medicine dropper. Between changes a second, 100 mm, watch glass inverted over the first keeps out dust. The collecting label for each collection is placed under the watch glass. In this way one can process up to 15 collections, each containing many individuals, one after the other, thereby eliminating the time factor as a drawback in the use of Canada Balsam.

The thrips are passed successively through 35%, 50%, and 70% ethanol, leaving them in each concentration for at least ½ hour. The thrips can be stored in 70% ethanol, but over long periods (several months or more) the epidermal and ocellar pigments and later, the integumentary ones, fade (Priesner, 1960).

If the thrips are dark and heavily sclerotized (e.g., *Elaphrothrips*, *Haplothrips*, etc.) a few of the series should be macerated in cold 10% KOH or NaOH for from ½ hour to several days, depending on degree of sclerotization. This trea ment reveals many structures, necessary for identification, which would be invisible otherwise. Others of the series should not be macerated because of the importance of color. After maceration, the lye is replaced by 15% acetic acid followed by distilled water, both for 15 minutes. Following this the specimens are treated in the usual manner. (The amount of time the specimens were in lye should be indicated on the label after mounting, Stannard, pers. comm.).

The thrips are placed in 98% or absolute alcohol for at least ½ hour before infiltrating them with cedarwood oil. Cedarwod oil is used because it is much heavier than the alcohol. An embryological staining dish is half-filled with the oil. If the dish is then *slowly* filled to the top with absolute ethanol, the two liquids will remain separate for several hours, the lighter alcohol floating on the cedarwood oil. Each thrips is lifted out of the watch glass with a camel's hair brush and an insect pin is used to transfer it from the brush into the staining dish. The thrips sink through the alcohol and come to rest on the surface of the cedarwood oil. Over the next hour or so, as the thrips become infiltrated, they gradually sink through the cedarwood oil and, when completely clear, come to rest on the bottom of the dish. No shrinkage occurs and the male genitalia remain expanded. The entire collection is then transferred in a medicine dropper to a syracuse watch glass filled with pure cedarwood oil. Mounting, labelling and drying are carried out in the usual fashion (Hartwig, 1952; Bierne, 1955; Priesner, 1960; O'Neill and Bigelow, 1964; Stannard, 1968, pers. comm.), but it is usually unnecessary to spread the appendages except to flip the wings of phlaeothripids out from under the wing-holding setae. When the alcohol in the embryology dish starts to become milky (usually after three to four hours) the infiltration solution should be thrown out and a new one prepared.

OBSERVATIONS AND DISCUSSION

Figs. 2 and 3 are photomicrographs of a brachypterous male *Chirothrips patruelis* Hood and a macropterous female *Anaphothrips cameroni* (Bagnall) mounted according to the procedure outlined in this paper. Note that the antennae, legs and wings are nicely spread as in mounts prepared in the traditional manner by experienced thysanopterists. Since all speci-

FIG. 2. *Chirothrips patruelis* Hood, brachypterous male, dorsal aspect. FIG. 3. *Anaphothrips cameroni* (Bagnall), macropterous female, dorsal aspect. FIG. 4. *Chirothrips patruelis* Hood, extended male genitalia, dorsal aspect.

mens mounted in this way are distended, measurements for taxonomic purposes should be taken as outlined by Priesner (1960).

Fig. 4 is a photomicrograph, taken at higher magnification, of the distended male genitalia. Both Hartwig (1952) and Priesner (1960) advise separating the genitalia from the animal and mounting them separately under another cover slip on the same slide. If very little Canada Balsam is used, the genitalia flatten on drying, and the preparation is easier to study. The external genitalia are being used with increasing frequency in taxonomic studies of thrips, particularly the aedeagus or pseudovirga of the genitalia of male Phlaeothripidae (see recent papers of Priesner, Faure and zur Strassen). From my own work, I predict that the shape and ornamentation of the epiphallus or endotheca in Terebrantia will be of use in higher taxon evaluation (the terminology of the various parts of the genitalia is discussed by Hartwig, 1952; Priesner, 1956, 1960; and Heming, 1970).

This technique has two minor disadvantages. When female phlaeothripids are mounted in this way the terminal portions of the reproductive system are usually everted, bringing the spermatheca and aciculae and frequently the fustis outside of the animals. This makes comparison of these structures between specimens difficult.

The other problem is associated with the ovipositor of female Terebrantia. This structure is usually extended at right angles to the body when the animal is processed as outlined above. When the cover slip is placed on a specimen mounted with the dorsum uppermost, the ovipositor tends to be bent sideways, twisting the abdomen to one side or the other. However this makes lateral mounts of female terebrantians, necessary for studying ovipositor characters, easier to prepare.

The technique outlined in this paper should be useful for studying genitalia of other small insects, particularly those of small beetles.

ACKNOWLEDGMENTS

I thank A. W. Thomas for pointing out to me the advantages of cedarwood oil, Miss M. Wilkie for testing the method, J. S. Scott for taking the photomicrographs, Dr. G. E. Ball for reading, and Miss N. Daviduk for typing the manuscript. This study was supported by the National Research Council of Canada, Grant No. A5756. (Heming Trust.)

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The Buffalo Treehopper on a Mississippi River Island (Homoptera, Membracidae).—In a previous paper (1969, Ent. News 80: 32–33) I had described the incidences of treehoppers on islands in the Mississippi River between miles 621 and 623 on the Corps of Engineers navigation chart.

During late summer and autumn of the years 1967, 1968 and 1969 the buffalo treehopper, *Stictocephala bubalus* (Fabricius), was collected from an island at mile 619. This island is the southerly one of the pair just east of the 619 mile designation on the chart.

Goldenrod is growing on this island and hosts the membracid. Neither the buffalo treehopper nor this plant have been found on the islands between miles 621 and 623. Other plants from which this insect has been collected such as American elm, haw, nettle and wild plum grow on the latter islands but have failed to produce the hopper. There is an abundant growth of American elm; but haw, nettle and wild plum are uncommon. These four plants are not favored hosts of the insect in mainland areas; here alfalfa, apple, clovers and goldenrod are preferred. Apparently, when one of the preferred hosts is found, so is the insect.

It is a matter of conjecture how the islands were colonized by membracids in the first place. Perhaps some were left on the islands formed by rising water after the dams were built several years ago. Winds may have been responsible. Possibly they could have flown onto the islands. They are not good distance fliers and often when disturbed fly out a short way and return to near the point they had left. Still, they could have flown the short distance required in some places. And these insects could have arrived as eggs, nymphs or adults with vegetative debris during the flooding periods.

These observations were made during work supported in part by the Board of Regents of Wisconsin State Universities. I wish to express my thanks to the Board. —CLIFFORD J. DENNIS, *Wisconsin State University, Whitewater, Wisconsin 53190.*

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Sphaerophoria (Diptera: Syrphidae) desired for revision of genus for North America. R. G. Gunther, 124 Lauder, Peoria, Illinois 61607.

Wanted: News, notes, and reviews of less than one page for immediate publication in ENTOMOLOGICAL NEWS. Send to: R. H. ARNETT, JR., Editor, c/o Department of Entomology, Purdue University, Lafayette, Indiana 47907.

Rare Beetles, Butterflies from all parts of the World offered. Write: Michael Monguillon, 7 rue Berryer, Paris 8^e, France.

For Sale: Determined beetles of all families from Middle Europe prepared for scientific study. O. Marek, Žamberk 831, Czechoslovakia.

Russian Entomological Literature Translated into English. One cent per word plus postage. Dr. V. P. Gargav, Department of Entomology, Jawaharlal Nehru Agriculture University, Jabalpur 4 (M.P.), India.

Bonnet: Bibliographia Araneorum. Vol. I of this classic monograph, which is essential to all research on spiders, has been reprinted. 832 pp., bound. $30.00. Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740, U. S. A.

Sharp & Muir: The Comparative Anatomy of the Male Genital Tube in Coleoptera. The classic 1912 monograph and six other papers by the same authors have been reprinted. 304 pp., 43 pls., bound. $10.00. An essential book for all coleopterists. Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740.

Bibliography of New Guinea Entomology (Gressitt and Szent-Ivany). Annotated, 6,140 references, through 1967; all fields of entomology: New Guinea, Bismarcks, Solomons; all subjects indexed. Pacific Insects Monogr. 18, 674 pp., map, 1968. $12.50 bound; $11.50 wrappers. Bishop Museum Press, Box 6037, Honolulu, Hawaii 96818.

For Sale: Goliath beetles, 14 different aberrations, 200 other species of beetles. Russell Dunn, Box 468, Sedona, Ariz. 86336.

Wanted: Live spiders to photograph their eyes. Earl Broderick, 5305 Douglas Dr., Yakima, Washington 98902.

Exchange Spanish Lepidoptera and Coleoptera. Pedro A. Talavera Torralba, Avd. Tirso de Molina, No. 1–4A, Cartagena (Murcia), Spain.

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MANUSCRIPTS and all communications concerning same should be addressed to: **Prof. R. H. Arnett, Jr., Department of Entomology, Purdue University, Lafayette, Ind. 47907.** The receipt of all papers will be acknowledged and, if accepted, they will be published as soon as possible. Articles longer than eight printed pages may be published in two or more installments, unless the author is willing to pay the cost of a sufficient number of additional pages in any one issue to enable such an article to appear without division.

ILLUSTRATIONS: Authors will be charged for text-figures and the cost of engraving. Size limit, when printed, $4\frac{1}{2} \times 6\frac{1}{2}$ inches. The cost of setting tables will be charged to authors.

EDITORIAL POLICY: Manuscripts on insect life and related terrestrial arthropods are appropriate for submission to ENTOMOLOGICAL NEWS. Titles, to facilitate computer recording, should be limited, if possible to 80 characters including spaces and punctuation, and should include key words to the contents for indexing. A short informative abstract (not a description of the paper) of about 150 words or less should precede the article. The Editor may reword the abstract for brevity and scope for republication in **Biological Abstracts.** The author's complete mailing address, including zip code number, should be given as a footnote. All papers describing new taxa would be greatly improved by including illustrations of a part or the whole form, and by referring to existing keys, or if none exist, by including an identification key to related taxa. Immediate publication will be given to new distribution records, short field notes, and news in **"The Entomologist's Record"** section; literature notices and books received in **"The Entomological Library,"** and study notices, want items, for sale notices, positions open, and position wanted notices in **"The Entomologist's Market Place."** Articles of wide interest to the general entomologist and non-specialist on the subject of the article are especially desirable. Articles of an archival nature will be recommended for **"Data Documents."** Instructions for the latter will be furnished on request (see vol. 81, pp. 1–11).

Second-class postage paid at Lancaster, Pa.

3.0001 DATA DOCUMENTS: A NEW PUBLICATION PLAN FOR SYSTEMATIC ENTOMOLOGY[1]

Ross H. Arnett, Jr.[2,3]

The availability of the raw data of systematics in the form of journal-published descriptions of new taxa, redescriptions, distribution records, and the records of vouchered specimens, has been delayed in the past by several months to several years from author to user. In the early days of taxonomy, such documents could be distributed only by sailing ships, stage, or on foot, making a few months delay an ordinary occurrence and of little consequence. At that time there were so few taxonomists that the annual research reported even on large groups of organisms could be purchased and stored by all interested persons. A circulation of one or two hundred was the most that could be expected of a journal, and this was enough to pay the printer in those days. A taxonomist of the time found it possible through personal subscription to keep up with the literature in his field, assured that he had missed very little. Moreover, in those unhurried days interests were broad and journal subscribers were interested in and used most of the papers published in each issue. This firmly fixed tradition of publication continues as a procedural ritual without being influenced by the suggestion of changes in the light of modern techniques.

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[1] Approved by the Agricultural Experiment Station, Purdue University, Lafayette, Indiana, as Journal Paper no. 3976. Accepted for publication October 20, 1969. Since this was proposed as an Experiment Station Project nearly two years ago, at least four publications have appeared that support this idea: 1) a letter in *Science*, v. 166, no. 3901, pp. 43–44, October 3, 1969, by S. Fred Singer; 2) the SATCOM report published by the National Academy of Science (publication 1717), 1969. This report suggests in recommendation C 12 a publication very similar to the one described here. The generic term for this type of information processing is: Selective Dissemination of Information (SDI). 3) A editorial in *Datamation* (15(12): 183, 1969) shows a history of SDI as early as 1936. 4) Finally, there has appeared as this issue is going to press, an article by E. Yochelson in *Systematic Zoology*, 18: 476–480 which includes a fine discussion of the problems of SDI and the International Code of Zoological Nomenclature, and a proposed solution.

[2] I acknowledge with thanks the helpful suggestions made by Dr. Richard H. Foote, U. S. Department of Agriculture, and the manuscript review committee of the Department of Entomology at Purdue University, including Drs. Ronald L. Giese and Virginia Ferris.

[3] Department of Entomology, Purdue University, Lafayette, Indiana 47907.

The speed up of transportation and communication has been paralleled by an increase in scientific production. The result is that current literature accumulates in nearly disastrous proportions, resulting in an information explosion that alarms every scientist because of the consequential low level of current awareness even among specialists. Even with the speed-up of communication, little has been done to reduce the delay of information transfer from author to user. The publication lag remains the same as it was in sailing ship days. Yet, immediately available are many inexpensive means for the solution of this problem.

In a recent review by Brown *et al.* (1967) a computer-based system is proposed which will enable a subscriber to receive titles, abstracts, and specially selected documents to meet his personal, and perhaps frequently changing needs. The present paper deals with only one aspect of the problem of information communication, the publication of raw taxonomic data. At the same time, it is thought the principles suggested here might apply equally well to other areas of investigation.

In the belief that most taxonomic data reported as the result of original research are of direct interest only to a few specialists, and that these data should be made available almost immediately to this group, the "Data Document" concept is proposed for immediate use in insect taxonomy. By employing the principles already laid down by Brown, and modified slightly to meet the requirements of the International Code of Zoological Nomenclature, I feel certain the system is both functional and logical. Indeed, it is already in operation in some fields of science, even to the extent of utilizing computer storage.

Within a very few years, perhaps even by the end of this decade, information of the type currently found in most scientific journal articles will be stored for instant retrieval in national or international information centers. The Special Committee on Information Storage and Retrieval of the Entomological Society of America is investigating the feasibility of establishing a data center which, if established, could include the storage of information in the manner described herein. The Interuniversity Communication Council (EDUCOM) is deeply involved in the coordination and unification of a project which will result in the eventual change of procedures that will startle and be opposed by the traditional minded taxonomist.

Already I have heard the objection that long papers are needed for promotion. This is, of course, an administrative matter and not a logical argument against the proposed system. But it is of sufficient importance to prevent an easy and rapid change to the system proposed here. It appears that some wholesale revision of administrators' views must be made now and are going to be necessary in the future. The "publish or perish" mandate is undergoing serious review in many advancing organizations. The acceptance of the *Data Document* concept, or its equivalent by objective administrators, will be an indication of their true concern over the communication problem.

Further comments received lead me to believe that non-taxonomists will be glad to see taxonomic descriptions disappear from the pages of journals, but they do not believe that *their* data should be suppressed! Although this paper concentrates on a system for taxonomy, it is only because I feel competent to suggest a system for this area of study and not others. I feel equally certain that the same system is needed for all areas of entomology. No one can say that one kind of data is of less or greater general interest and usefulness than another kind. In fact, the entire logic behind this proposal is based upon the need to get information to where it is needed when it is needed by the best possible means.

NEW OPTIONAL SERVICE STARTED

In anticipation of this change, a new publication service is offered called *Data Documents for Systematic Entomology*. This will be available immediately on an optional basis for authors in the two publications, ENTOMOLOGICAL NEWS and *The Coleopterists' Bulletin*. The necessary procedures for the use of this service are described in this paper. Authors wishing to take advantage of this service may do so simply by indicating this at the time of submitting their papers. The respective editors will then prepare the typescript for *Data Document* processing. They may suggest to others who submit papers to these publications that they use this service, but for the time being, this will be an option selected by the author. Those who do select this service will receive the normal editing services, reviews, and proof of all data to be published in any form.

Scope of publication.—At present, the series of *Data Documents* will be restricted to articles on insect taxonomy, including biological information on insects, or any information treated as a supplement to the taxonomic data. The publication will cover the world fauna and be open to any author, with the provision that the article is acceptable to the editor and reviewers. Every article will be reviewed before acceptance into this system as it would be for traditional publications.

It is not intended that *Data Documents* will replace articles reporting synthesized data, reviews of groups, or biological phenomena information ordinarily published in conventional journal or book form. Works of general use will be published as complete articles. Archieval material should be treated as *Data Documents*. This will include isolated descriptions of new species not included in a revision and the extensive descriptive and locality data included in revisions.

Restriction of distribution.—It is obvious that the entire system will be destroyed if the distribution of *Data Documents* is not restricted in some manner. There is no way to restrict orders for *Data Documents* except by direct appeal to logic. Copies of these documents should be considered only as something to be used immediately, kept during the tenure of a specific project, and then discarded. Libraries and individuals cannot afford to store them and they should make no attempt to do so. Arrangements will be made for selected depositories as data centers which may take part in the retrieval processing.

Processing of Data Documents.—Authors will need to know format procedures before final typing of articles. They will be required to prepare a list of index terms or descriptors. When a manuscript is received and the author indicates that he wishes it to be treated as a *Data Document*, the editor will check the author's coding of the article. He will then be able to determine the number of copies needed to supply the subscribers to the topics included in the article. Each *Data Document* will be duplicated by a system permitting the production of only the number needed at the time of issue, i.e., required for advance subscription. The production method is chosen according to the number required by these subscribers, and additional copies are produced as needed. Low volume advanced production will be done by xerography. Higher numbers will be produced by other processes. A metal plate will be made and used for illustrations not suited for xerography. No provision will be made for mass distribution of reprints. Authors will be provided with a few copies for records as required by his sponsoring agency or employer.

Available formats.—Each article will be available in three formats. The titles and *Data Document* citation will be published either in the monthly issle of ENTOMOLOGICAL NEWS or the quarterly issues of *The Coleopterists' Bulletin* as soon as the article is processed. This assures very prompt publication. This citation will include the descriptors and interested persons may place orders according to their selection from these descriptors. In addition, if appropriate, either an informative abstract or an abbreviated article will be issued as soon as possible after the processing. Descriptive abstracts will not be produced. The abbreviated article will contain those portions of the full article deemed immediately useful to a large number of people. For example, keys to genera and species with brief diagnoses and distributional information, might be extracted from an article and published (with the authors permission and galley proof corrections). Thus the greater mass of data will be stored as a *Data Document.*

Price.—*Data Documents* will be sold at a fixed rate per document, which will include shipping and handling. These may be obtained either directly from the *Center for the Study of Coleoptera* (CSC) at Purdue University for *The Coleopterists' Bulletin* or from the Institute for the Study of Natural Species [4] for articles in ENTOMOLOGICAL NEWS. Advanced subscriptions at somewhat reduced rates will be provided. Subscribers will be charged only for the parts they select at the time of subscribing or according to their change of option which may be submitted at any time (sample subscription forms and details will be supplied upon request). The ordering procedure is indicated on forms provided.

Editing.—Articles will be edited in exactly the same manner as any article submitted to the respective publications. Reviewers will be asked to comment on the article. Changes required by the editors will need to be considered by the authors as with traditional publications methods. After any necessary changes have been made, and the article is accepted, instead of the usual marking for the printer, the editor will prepare a *Data Document* form as a cover. Illustrations will be reduced to the 8½ × 11 format. The title, code words, and any other necessary information, including the document number, will then be prepared for publication in the next issue of the parent publication.

Format.—Articles submitted should conform to the journal format [5] as closely as pratical to avoid any delays in processing. The title should be carefully thought out to indicate an exact description of the contents. As many keys words as possible should be included, and few non-descriptor words. Whenever possible, titles should be limited to 80 characters including spaces so that they may be fully permuted without loss of context by such services as B.A.S.I.C. (Bioscience Information Service, Inc.). An abstract should be prepared containing every descriptor, including all taxa. These abstracts must be limited to 1600 characters, a size selected because of future computer scanning of these abstracts. If all taxa cannot be listed because of these word restrictions, taxa of a higher category should be substituted to indicate the extent of the organisms included in the article.

The title should include the order and family of the insects discussed in the paper. If more than one order and/or several families are included, the title must reflect this by the use of appropriate descriptors. The geographical area covered and the nature of the data presented will serve to restrict the scope of the article.

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[4] 550 Elston Road, Lafayette, Indiana 47905.

[5] Articles using this format will appear in the next issue of ENTOMOLOGICAL NEWS.

Articles should be submitted in typewritten form, double spaced, on $8\frac{1}{2} \times 11$ [6] sheets, one side of the page only. In other words, the editorial policy of the respective journals should be followed exactly as before. Authors will be given the same format freedom as previously. However, they are strongly urged to conform with the indentations, centering, and underlining used in the journals because it will not be possible to make these adjustments by the editor's marks. A black, if possible, carbon ribbon on the typewriter is especially desirable. Authors are advised to follow the published format instructions reviewed here before final typing of the article.

The numbering system.—Data Documents of all kinds are numbered to permit instant identification. The system makes no attempt to code according to taxonomic category or taxa because there can be no agreement on this. The system is kept open-ended by the simple method of numbering each article received. These are logged in, and at the time of acceptance, the date recorded on the typescript as is done now. Numbers not appearing in the parent journal refer to papers withdrawn or papers to be published out of sequence. The date of publication is the date of issue of the respective journal, the actual data that the article become available to users. Distinction between the three types of awareness formats is made and is described below.

A. List of *Data Documents*. The complete list of titles and descriptors will be published in the periodical accepting the article. These titles are prefixed by the number 1, followed by a period, and then the document number. The location of deposits of copies will be indicated with the list. From time to time catalogues and indexes may be issued. The 1 will indicate that the title and descriptors are published in the awareness list. For example, this form of indication might appear as follows:

1.0021 Three previously unrecognized New World species of *Oxacis* (Coleoptera: Oedemeridae), by R. H. Arnett, Jr., Department of Entomology, Purdue University, Lafayette, Indiana 47907 (Data Document Center, ISNS). Descriptors [7]: Oxacis; Peru; Trinidad; California; dist.; ills.; keyr.

B. Abstracts. *Data Documents* are available separately as abstracts, either published in the parent journal, if warranted, or placed on file for subscribers or for individual orders. As explained above, they are re-

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[6] Some institutions may use a sheet size $8 \times 10\frac{1}{2}$ inches, which is permitted. However, sheets of this size reproduced by xerography will show a black margin, which is somewhat distracting. Sheets larger than $8\frac{1}{2} \times 11$ are not suited to xerography unless a special reducing lens is used.

[7] These abbreviated descriptors are explained below.

stricted to 1,600 characters for ease in storing and for future retrieval by computer scanning. If it is decided that an abbreviated article is to be published by the parent journal, this will be treated separately, as indicated in C below, and will not be considered as an abstract. Abstracts will be given the same document number as the title but they will be prefixed by the number 2. This will inform the user that the abstract, in addition to the title and descriptors, is published in the awareness journal.

C. Complete *Data Document*. Each *Data Document* is given the same number as the title and the abstract, but with the prefix number 3. Even if the entire article is published in the parent journal, this is done. If an abbreviated article is published, the same number will be given to this because exact excerpts will be taken from the complete document. The only change will be to indicate what has been omitted.

It is obviously necessary that each journal have its own series of numbers, so a complete citation must include the name of the journal, volume and page number (for priority purposes), and the name of the document center storing the document. When the system is adopted by other publications, numbers can easily be followed by a periodical number and issue number for short citation.

The Coding system.—The coding of documents is the most difficult procedure for all information storage systems. It must be done carefully, be open-ended, and provide for the matching of search requests both by individuals and by machine. Much might be said about this, but I am discussing this in a separate publication (Arnett, in press, 1970). Users should be warned, however, that no coding principles other than that for zoological nomenclature have been proposed and accepted by a working majority. The system used here may need to be changed at a later date, and time-consuming adjustment made to facilitate retrospective search.

The codes listed below are in addition to geographical locations and the names of taxa included in the title of the article. These code letters are used to describe the contents of an article in the list of documents. Four-letter words are used because of a computerized retrieval program already in operation at Purdue University that involves eight character words, up to ten retrieval words per computer pass. (This can be rewritten to allow for any number of descriptors for retrieval.) By using these four-character words, we are able to combine two concepts as a single request. Details of the system will be described elsewhere.

BIBL—Bibliography of references to taxa.

BIOL—Host information, habitat preferences, and similar observational biological information.

CATA—Catalog of references to taxa.

CSCO—The Center for the Study of Coleoptera, Purdue University.

DESR—Revised descriptions of taxa previously described (subsequent descriptions).

DIST—Distribution of a taxon, including lists of specimens examined.

ILLS—Illustrated.

ISNS—Institute for the Study of Natural Species.

KEYN—New key for identification of taxa.

KEYR—Reference to existing key.

NCOM—New generic assignment of a previously described species.

NGEN—The description of a previously unrecognized genus.

NSPE—The description and validation of a specific name including its generic assignment, designation and deposition of the holotype specimen.

ODRE—Reprint of the original description available for distribution by the retrieval service.

SYNN—New synonymy.

NDSR—New distribution records for the taxon.

TECN—New technique for the treatment of data specimens or observational data described.

Undoubtedly more code terms will be necessary as the system is put into operation and refined.

Method of citation.—Some authors may still feel that a new taxon is not validated unless it appears with a description in the parent journal. Until the matter has full acceptance, an abbreviated description will be published if requested by the author for the purpose of validation. This may take the form of a diagnosis usually found at the beginning of a formal description, similar to the Latin description required by the botanical code. However, once it is determined that validation is made by the stored document alone, the question of method of citation of the species arises. An example of a catalog citation is given here:

Oxacis marianna Arnett, 1970. Data Document 3:0000, Ent. News, 81: 00 (p. 0) (ISNS). The number in parentheses after the journal page citation indicates the document page showing where the description started.

Citing these documents in a bibliography also needs explanation. An example of this follows:

ARNETT, R. H., JR., 1970. 1:0000 Three previously unrecognized New World species of Oxacis (Coleoptera: Oedemeridae). Data Document 3.0000, Ent. News, 81: 00 (24 pp.) (Data Document Center, ISNS).

In this case, the number of pages after the journal indication shows the total number of document pages on file.

Author's copies.—Reprints, in the journal sense, for the full document are not available. Abbreviated articles may be reprinted as traditional journal articles. Abstracts and complete documents will be supplied in very limited numbers to authors, as explained above, to satisfy the needs of the individual's sponsoring organization. Further copies may be ordered if necessary, but this is discouraged as discussed above.

Personalized subscription service.—The entire concept of *Data Documents* is based upon the limited reproduction of documents and immediate availability of useful material. Although individual sales are possible and provided for, the most efficient method of distribution is through a personalized subscription service, eventually to be computer controlled. Subscribers may select any combination of articles or abstracts according to the code words they select. They are thereby assured of immediate awareness of material needed for their research. To do this, the subscriber must first indicate exactly the taxa and topics of interest to him, and the geographical restrictions, if any, that he wishes. For example, he may wish to subscribe to all articles on North American Coleoptera, and abstracts of all other Coleoptera articles, except for the families Elateridae and Oedemeridae for which he wants all articles. He may desire abstracts for all articles on pollen feeding insects, or some other combination. Each subscriber will have a code number that will indicate his requirements. Articles corresponding to this number will be sent to the subscriber automatically. The cost of the documents supplied will be deducted from his subscription balance. As soon as subscription money is used, a new subscription bill will be issued. In addition, subscribers may purchase coupons to be used for payment for complete documents they may wish in addition to those they automatically receive. Consequently, subscriptions will be based on quantity and not volume or year. Changes in subscription requests may be made at any time without additional charge. However, additional articles ordered, but not previously subscribed to, will be subject to the document fee.

Advantages and disadvantages of Data Documents.—The advantages of the system seem apparent: speed of information dissemination; economy of space required to store entire issues of a publication; economy of production; readily available copies at anytime—never "out-of-print." The system meets the present demands for a solution to the bulging library. The limited but effective circulation also conserves the user's time.

The apparent disadvantages are: high cost of individual copies and resulting lack of private reprint circulation; varying composition, i.e., type writer differences, possible format variation and lack of pleasing typographical art; a greater possibility of alteration of master typescript copy so that exact reproduction of each copy is not assured; the elimination of the "browsing" aspect with current journals; the possibility that libraries will demand the full text of each document and thus defeat the space saving feature of the system.

I believe that the apparent disadvantages are greatly outweighed by the advantages. The high cost of individual articles is more than balanced by the reduced expense for journal subscriptions due to the saving of space and reduction of total pages. Even with the disappearance of the publication of raw data, typographical art continues in the synthesis publications which will continue to be widely circulated. The alteration of the master copy can be controlled by the requirement that verified copies be deposited in key information centers, and this is planned. This will assure also that the terms of the International Code of Zoological Nomenclature are met. "Browsing" actually can be enhanced because more time can be spent reading synthesis articles and noting the *Data Documents* in the references cited. Except that the method of presentation of data may be missed, wider coverage of the literature is possible for any individual through the use of the system, and of course, there are other ways to learn how to present data. The matter of libraries subscribing to the entire series of documents may be discouraged by the price of the publications, and by a clear understanding with librarians of the nature of the system.

The future of the system.—The format is designed for easy and eventual automatic data processing. It is not beyond the margins of possibility that all existing systematic entomology data can be gathered, coded, and reprocessed for storage and retrieval by the use of this system. The same principles apply to all other kinds of publications including those with physiological, ecological, and experimental data. Once this is done, there will be no need for the traditional literature search and no need for the complicated rules of nomenclature now so laboriously followed.

SUMMARY

This plan provides an open-ended and flexible system fitted to automatic data processing, awaiting only the increased availability of computer time and a unified processing procedure. The *Data Document* concept is essentially a refinement and wider application of the same system used by Dissertation Abstracts® for theses, except that it eliminates the need for microfilming. I feel that both *Data Documents* and the xerography edition of Dissertation Abstracts meet all of the requirements of publication required by the Code and that to republish any of this material for the sake of meeting Code requirements is redunant. A thesis, like a *Data Document*, should be prepared for final publication and treated as such when it becomes available in either form. Citations should be made to these documents and priority established on the basis of the date of issue of each.

Data Documents are currently produced by the Center for the Study of Coleoptera (CSC) and the Institute for the Study of Natural Species (ISNS). Other information centers are planning similar publications and services. To be effective, however, all data centers must be linked together (a network) or a chaotic situation will soon result.

LITERATURE CITED

ARNETT, R. H., JR., in press. Entomological Information Retrieval Aids, Institution for the Study of Natural Species.

BROWN, W. S., PIERCE, J. R., and TRAUB, J. F., 1967. The future of scientific journals. Science, 158: 1153–1159.

2.0001 Data Documents, a new publication plan for systematic entomology.

ABSTRACT.—Data Documents is a selective dissimination of information system (SDI) used to control the distribution of information. Documents are stored in a data document center for reproduction and distribution as needed. Awareness of the existence of these documents is published in the parent journal either by title, by title and abstract, or by complete publication. The system is optional, but authors are requested to use the system of storage of data not immediately and generally useful. Descriptors that serve as retrieval codes are provided for each document for automatic data processing. Subscribers may order documents by these descriptors. The system is immediately effective for two journals, ENTOMOLOGICAL NEWS, and the *Coleopterists' Bulletin*.—R. H. ARNETT, JR.

Descriptors: Data Documents; Systematic Entomology; SDI.

3.0002 The Columbian Timber Beetle, Corthylus columbianus (Coleoptera: Scolytidae). X. Comparison of Yearly Mortality and Dispersal Losses with Population Densities[1]

D. H. Milne[2] and R. L. Giese[3]

Few insects offer as appealing an opportunity for analysis of population dynamics as does the Columbian timber beetle, *Corthylus columbianus* Hopkins. This native North American beetle rears its progeny in tunnel systems (galleries) bored in hardwood trees, and is unique in leaving the host trees unharmed in the process. Within the gallery system a developmental chamber or cell persists for each egg that was laid in it. Since annual growth increments are added during subsequent seasons the year of establishment of a gallery system can be determined precisely by dendrochronology. Thus, host trees attacked by this insect over long periods of time contain, in their preserved galleries, year-by-year indices of former beetle population densities and natalities. Dissection of such trees immediately reveals all of the beetle population records accumulated throughout the lifetimes of the trees, and provides the observer with population data seldom, if ever, obtainable for other insect species.

The present paper utilizes the biological observations of several workers to develop a set of equations describing beetle population dynamics. The equations allow preserved gallery characteristics to be used to compare mortalities suffered by former beetle populations with population densities. An application to observed data is made.

METHODS

Aspects of timber beetle biology utilized in the following development are taken largely from a study by Milne and Giese (1969), and also from papers by Wilson (1959), Kabir and Giese (1966), and Hopkins (1894). Biological features which are incorporated into the equations as assumptions are a) the male:female ratio is 1:1 (Kabir and Giese, 1966; Milne

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and Giese, 1969); b) each male-female pair of beetles establishes a single reproductive gallery system and rears a single discrete brood of progeny in it (Milne and Giese, 1969); c) exactly one egg is laid in each cradle of each gallery system (Milne and Giese, 1969; Beal and Massey, 1945; Kabir and Giese, 1966; Hopkins, 1894); d) no offspring are reared in gallery systems which lack egg cradles (Milne and Giese, 1969); e) male beetles initiate gallery excavation (Milne and Giese, 1969); f) discrete generations of beetles occur during each season (Milne and Giese, 1969; Wilson, 1959; Hopkins, 1894; Kabir and Giese, 1966).

Preserved gallery data to which the equations are applied were taken from a red maple tree (*Acer rubrum* L.) near Jasper, Indiana (woodlot described earlier by Crozier and Giese, 1967a, 1967b). This tree, mentioned by Milne and Giese (1969) as one totally dissected by them, was felled and examined in January, 1967. It had served as a focus of intense beetle activity throughout the two-year period in which these workers studied the woodlot.

Derivation of the Equations

Development of equations relating beetle population densities and mortalities to features of gallery systems left by the beetles in trees is best begun by consideration of a simple hypothetical situation, to which complexity is added step by step.

If we consider an isolated tree harboring an infestation of *C. columbianus*, and which is insulated from immigration, it is clear that the number of galleries bored by adult male beetles of any generation i into the annual ring representing year h is related to the number of egg cradles in all of the galleries bored by males of the previous generation, i-1, of the same year. Let $g_{i,h}$ represent the number of galleries established by beetles of generation i in year h, and $C_{i-1,h}$ be the number of egg cradles in galleries established by the previous generation (i.e., the cradles in which the ith generation adults were reared). If the male:female ratio is 1:1, then $\frac{1}{2}C_{i-1,h}$ is the number of pairs reared in i-1 generation galleries and is the maximum number of ith generation pairs available to re-infest the tree. If $m_{i,h}$ ith generation pairs are lost to mortality sources and $e_{i,h}$ pairs emigrate, then the number of galleries established by adults of this generation will be given by

$$g_{i,h} = \tfrac{1}{2}C_{i-1,h} - (m_{i,h} + e_{i,h}). \qquad (1)$$

If we now consider all ith generation gallery records for year h in all of the trees of an isolated cluster which is insulated from immigration, equation (1) is seen to describe this more complex situation, as well.

The number of galleries established by *i*th generation pairs of beetles in a sample of trees in a woodlot, or other location in which immigration must be considered, is equal to the number of pairs of beetles reared in galleries of the previous generation in those trees ($\frac{1}{2}C_{i-1,b}$) minus the number of those pairs lost by mortality and emigration ($m_{i,b} + e_{i,b}$) plus the number of pairs immigrating to the sample trees and establishing galleries there ($I_{i,b}$). Thus, an equation describing the number of *i*th generation galleries to be expected in the annual growth rings for year *b* in a typical sample of trees is

$$g_{i,b} = \tfrac{1}{2}C_{i-1,b} - (m_{i,b} + e_{i,b}) + I_{i,b}. \qquad (2)$$

A numerical example to which this equation is applied is diagrammed in Fig. 1.

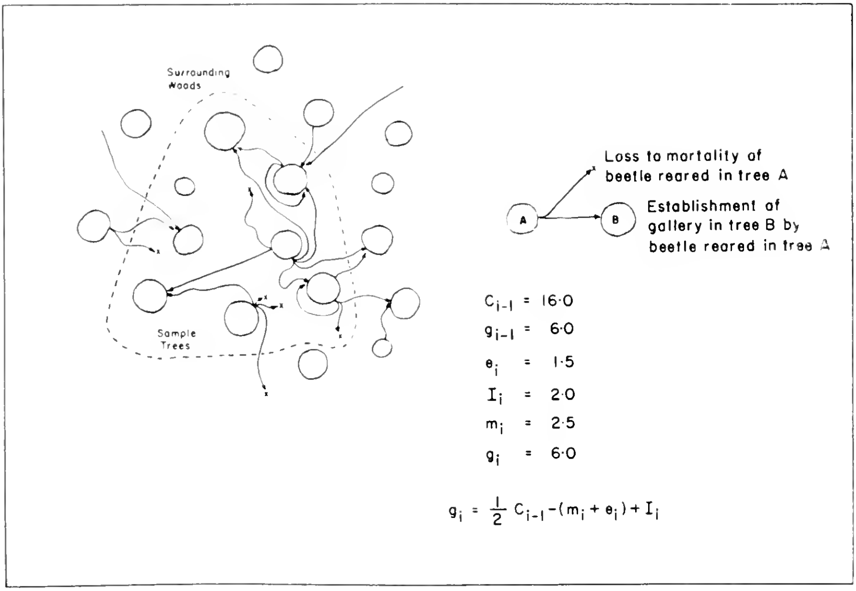

FIGURE 1. The effects of mortality and dispersal on numbers of galleries established by beetles of generation i.

If N_a and N_b represent the numbers of beetle generations in consecutive years *a* and *b*, and if year *c* follows year *b*, a set of equations similar to (2) can be written to relate mortality and dispersal losses to population density for each generation of year *b*. Such equations are:

$$\begin{aligned}
g_{1,b} &= \tfrac{1}{2}C_{X_a,a} - (m_{1,b} + e_{1,b}) + I_{1,b}\\
g_{2,b} &= \tfrac{1}{2}C_{1,b} - (m_{2,b} + e_{2,b}) + I_{2,b}\\
g_{3,b} &= \tfrac{1}{2}C_{2,b} - (m_{3,b} + e_{3,b}) + I_{3,b} \qquad (3)\\
&\vdots\\
g_{X_b,b} &= \tfrac{1}{2}C_{X_b-1,b} - (m_{X_b,b} + e_{X_b,b}) + I_{X_b,b}\\
g_{1,c} &= \tfrac{1}{2}C_{X_b,b} - (m_{1,c} + e_{1,c}) + I_{1,c}
\end{aligned}$$

Each equation in the set (3) can be solved for m. Quantities C and g in the equations are preserved within the trunks of trees attacked by *C. columbianus*, and thus can be observed. Immigration to and emigration from sample trees by previous generations of beetles cannot be observed. If all of the trees from a sufficiently large unit of beetle habitat are studied, however, the gains and losses due to immigration and emigration may be presumed to cancel, thus leaving mortality as the only significant unknown factor in equations (3). What constitutes a "sufficiently large" unit of habitat is, at present, unknown. Since several workers (Hopkins, 1894,

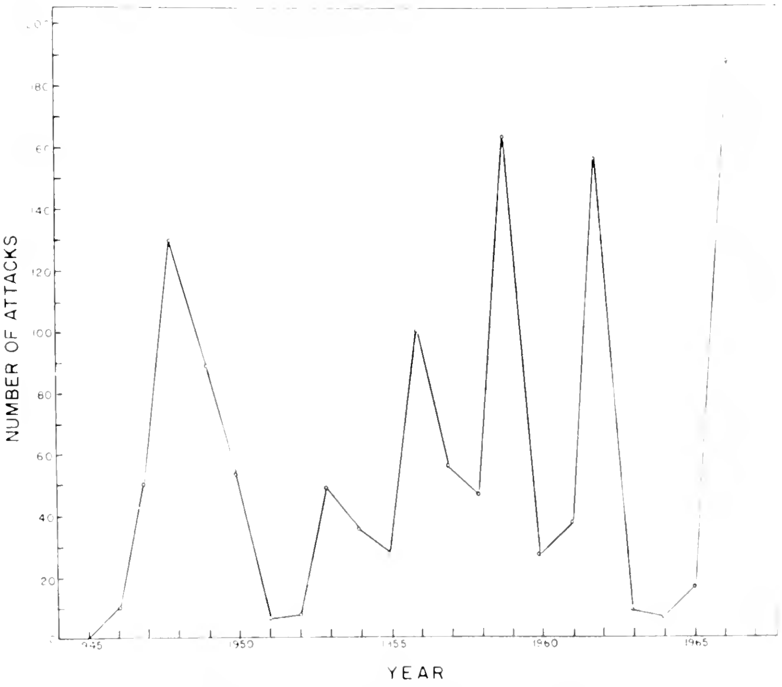

Figure 2. Attack history of tree 3-5B.

1903; Wilson, 1959; Schuder, 1960) suggest that the beetles commonly re-infest the tree in which they were reared, a single carefully chosen tree might constitute such a unit.

As can be seen from the derivation, equations (3) can only be used meaningfully if a way can be devised of distinguishing between the different generations of galleries initiated within each year of a tree's lifetime. Sources of mortalities are not revealed by the equations, nor do they indicate whether mortalities are experienced early or late within the development of a particular generation.

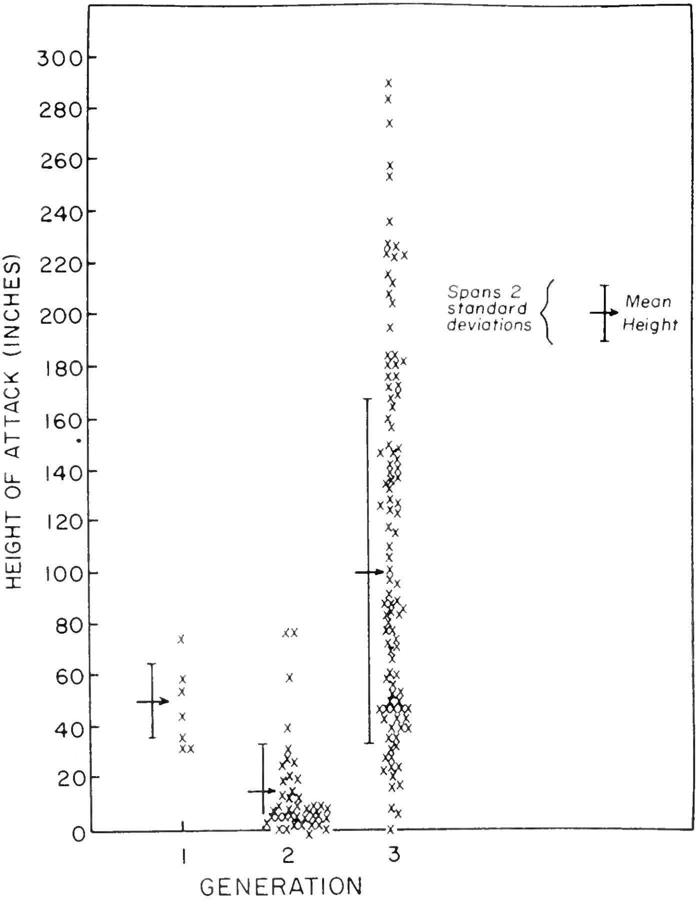

FIGURE 3. Heights of first, second and third generation galleries established during 1966 in tree 3-5B.

APPLICATION OF THE EQUATIONS

Biological Basis of the Application.—In the following, an application of an equation from set (3) is made which illustrates the nature of the results which can be obtained. The historical beetle gallery data to which it is applied were taken from a large tree, designated 3–5B, which grew in sector 5B of the Indiana woodlot studied by Milne and Giese (1969) and others. As mentioned above, this tree was felled and dissected in January, 1967, after having been observed for two years by Milne and Giese (1969). The tree was 48 years old when felled.

A total of 1,254 beetle galleries were found within tree 3–5B. Their distribution in time, as determined by dendrochronology, is shown in Fig. 2. The remarkable yearly fluctuations in numbers of galleries established in this tree throughout the 20-year period in which beetles infested it parallel the pattern observed in the rest of the woodlot within which it stood (Crozier and Giese, 1967a).

Three well defined generations of beetles were observed to excavate galleries, both in tree 3–5B and in its neighbors, in the summer of 1966 (Milne and Giese, 1969). Later dissection of these galleries revealed that the height of the gallery in the host tree is one feature which was fairly characteristic of second and third generation galleries. Second generation beetles were observed to place their attacks near the bases of their host trees, whereas third generation beetles infested the higher portions. This pattern was less pronounced, although still unmistakable, in trees less than 12″ in diameter, and was observed both in lightly and in heavily infested trees. Tree 3–5B (20.3″ dbh) exhibited this pattern in 1966 (Fig. 3).

Identification of Gallery Generations.—If we assume that the last and next-to-last generations of beetles in the Indiana woodlot always inflicted their attacks upon the highest and lowest portions of their host trees, respectively, then the next-to-last equation of set (3) can be used to determine the net gains or losses due to mortality plus dispersal suffered by beetles reared in next-to-last generation galleries of tree 3–5B each year. Note that if this assumption is true, it is not necessary that the last and next-to-last generations always be third and second generations, respectively, as was true in 1966, in order to use the equation.

Since tree 3–5B probably experienced significant net gains and losses of beetles due to dispersal throughout its history, the equation must be used in its entirety. Solving for the combined losses due to mortality and dispersal,

$$m_L + e_L - I_L = \tfrac{1}{2}C_{NL} - g_L. \qquad (4)$$

where subscripts L and NL mean "last" and "next-to-last," respectively. Equation (4) thus applies to all galleries esetablished by last and next-to-last generation beetles within tree 3–5B within a particular year. In the following, $(m_L + e_L - I_L)$, is referred to as beetle "loss" due to effects of mortality plus dispersal. Where negative losses occur, immigration effects greater than the effects of mortality plus emigration are indicated.

Interpolation of values presented by Milne and Giese (1969) indicates that $\frac{2}{3}$ or more of all galleries established in trees observed by them in 1966 at heights greater than 41″ were established by third generation beetles. Similarly, $\frac{2}{3}$ or more of all galleries established less than 8″ above the ground in infested trees were established by second generation beetles. For the purpose of this illustration, these heights were arbitrarily selected as reference points. All galleries found in tree 3–5B at heights of 41″ or more were designated "last" generation galleries, and those occurring below 8″ were designated "next-to-last" generation galleries. Generations of galleries occurring at intermediate heights cannot be determined by this scheme. As can be seen from Fig. 3, the great majority of the 1966 galleries of known dates of origin are identified correctly as "last" and "next-to last" generation galleries by this particular technique.

Since the relationship between a gallery's generation and its height in a tree is less well defined in trees less than 12″ in diameter than in larger trees, all galleries established in years prior to 1952 (the year tree 3–5B first exceeded 12″ dbh) were excluded from this analysis. Similarly, galleries found to terminate in the wood between annual growth rings and associated with a set of annual ring deformations characteristic of this type of gallery (Milne and Giese, 1969) were excluded from this analysis on the basis that they were probably early-season galleries.

RESULTS

The results of classification of the galleries in tree 3–5B by height are shown in Table 1. Early-season galleries are those associated with annual ring deformations mentioned above; non-reproductive galleries are those which lacked egg cradles. Values of C for application of equation (4) are the numbers of cradles found in the next-to-last generation galleries; values of g are the numbers of reproductive last generation galleries.

All galleries established in tree 3–5B in 1964 were placed either low enough or high enough in the tree to be classified as next-to-last or last generation galleries. For 1964, $C = 21$, $g = 3$, and $(m_L + e_L - I_L) = \frac{1}{2}C_{NL} - g_L = 7.5$. Thus, events in the woodlot during that period were such that tree 3–5B suffered a net loss of 7.5 of the 10.5 pairs of beetles

TABLE 1. Assignments of galleries to generations.

Year	Gallery Characteristics	Gallery Generations			Unclassified (Intermediate Heights)
		Early Season	"Next-to-Last"	"Last"	
1966	Nonreproductive	0	2	24	5
	Reproductive	0	24	98	35
	Number of cradles	0	303	1049	358
1965	Nonreproductive	0	0	2	1
	Reproductive	0	5	7	2
	Number of cradles	0	33	87	10
1964	Nonreproductive	0	0	1	0
	Reproductive	0	3	3	0
	Number of cradles	0	21	31	0
1963	Nonreproductive	0	1	1	0
	Reproductive	2	0	3	3
	Number of cradles	14	0	35	38
1962	Nonreproductive	0	6	17	7
	Reproductive	0	28	42	54
	Number of cradles	0	295	477	602
1961	Nonreproductive	1	0	1	2
	Reproductive	0	4	13	15
	Number of cradles	0	30	175	174
1960	Nonreproductive	3	0	3	3
	Reproductive	1	1	12	3
	Number of cradles	5	8	108	25
1959	Nonreproductive	2	9	13	9
	Reproductive	3	29	52	45
	Number of cradles	24	267	519	483
1958	Nonreproductive	0	1	5	1
	Reproductive	2	6	22	8
	Number of cradles	14	50	262	88
1957	Nonreproductive	0	3	16	2
	Reproductive	4	6	10	14
	Number of cradles	37	40	81	104
1956	Nonreproductive	1	3	7	9
	Reproductive	7	17	34	21
	Number of cradles	78	139	232	160
1955	Nonreproductive	0	3	5	2
	Reproductive	0	5	8	3
	Number of cradles	0	71	69	37

TABLE 1.—(*Continued*)

Year	Gallery Characteristics	Gallery Generations			Unclassified (Intermediate Heights)
		Early Season	"Next-to-Last"	"Last"	
1954	Nonreproductive	0	1	9	7
	Reproductive	0	5	6	7
	Number of cradles	0	52	42	57
1953	Nonreproductive	0	1	21	2
	Reproductive	0	5	11	8
	Number of cradles	0	55	94	62
1952	Nonreproductive	0	0	2	0
	Reproductive	0	3	0	3
	Number of cradles	0	32	0	23

which were reared there, and which were therefore available to re-infest it.

In all other years, certain galleries were established at intermediate heights, and could not be classified by generation. These galleries introduce uncertainty into the application of equation (4) which may be dealt with as follows.

In any year in which N generations were present and in which n galleries cannot be classified, there are N^n ways in which these galleries can be assigned to N generations. One conceivable way is that in which all n belong to generations other than the last and next-to-last. In such a case, values of C and g can be read from Table 1 as it stands. Other conceivable possibilities are that all n could be last generation galleries (giving the minimum possible loss) or next-to-last generation galleries (giving a maximum loss figure). The n galleries could also be last, next-to-last and other generation galleries in various combinations. Beetle losses can always be easily calculated in the first three instances, and, when n is small (3 or less, as in 1952, 1955 and 1965) for all other combinations, as well. These calculations establish the limits of the population density of the last generation, and the limits of the mortality plus dispersal losses experienced by that generation.

In 1955, for example, the three reproductive galleries established between heights 8″ and 41″ contained 19, 14 and 4 cradles, respectively. If all of these had been galleries bored by beetles of a generation other than the last or next-to-last of 1955, then values of C and g would be those shown in Table 1: $C = 71$ and $g = 8$. If all three had been last generation galleries, C would remain as shown in Table 1, whereas g would be increased by three galleries. If all had been next-to-last generation galleries, g would remain as shown in Table 1, whereas C would be increased by 37 cradles. The losses (numbers of pairs) calculated in these three instances are 27.5, 24.5 and 46.0 pairs, respectively. Per cent losses $[(|m_L + c_L - I_L|/\frac{1}{2}C_{NL}) \times 100]$ are, respectively, 77.5%, 69.0%, and 85.2%. Last generation per cent losses for the 24 other distinguishable ways in which the three questionable galleries could have been distributed in time are plotted against last generation population density (as are those for 1952 and 1965) in Fig. 4.

If the galleries which were assigned, by heights, to generation categories for 1952, 1955 and 1965 were correctly identified, then one point in each of the clusters produced by considering the unidentified galleries (Fig. 4) is precisely the beetle loss for that year. Which point is the correct one can only be established if the generations to which the questionable galleries belong can be identified. But the wedge-shaped figures formed by connecting the extreme points span the entire cluster containing the desired point. For years in which large numbers of galleries were established at intermediate heights, the extreme points may still be calculated and plotted to indicate the orders of magnitude of the last generation beetle losses. These extremes, for all years following 1951 (except 1960 and 1963) are shown in Fig. 5. The extremes for the excepted years are so broad, and extend off scale in the direction of negative loss to such an extent, that they are of little value in estimating precise population trends for these years.

Negative "losses" indicated for three of the years in Fig. 5 (1957, 1958, 1961) as well as for 1960 and 1963 suggest that immigration may have outweighed mortality plus emigration during those years. Fig. 2 indicates that all of these were years following population declines. If there were reason to believe that immigration and emigration were negligible throughout the other years, then Fig. 5 could be interpreted to show evidence for density independent regulation of the Indiana beetle population. Since the method of gallery generation identification used here was not precise, however, and since the derivation of Fig. 5 is based upon many assumptions, the results presented in the figure should probably not be cited as support for any theory of population regulation.

Discussion

Figure 5's comparison of the densities of former beetle populations with their losses due to mortality plus dispersal rests upon many assumptions and is clouded by the uncertainty due to lack of precision in gallery generation identification. It demonstrates the type of data which is potentially

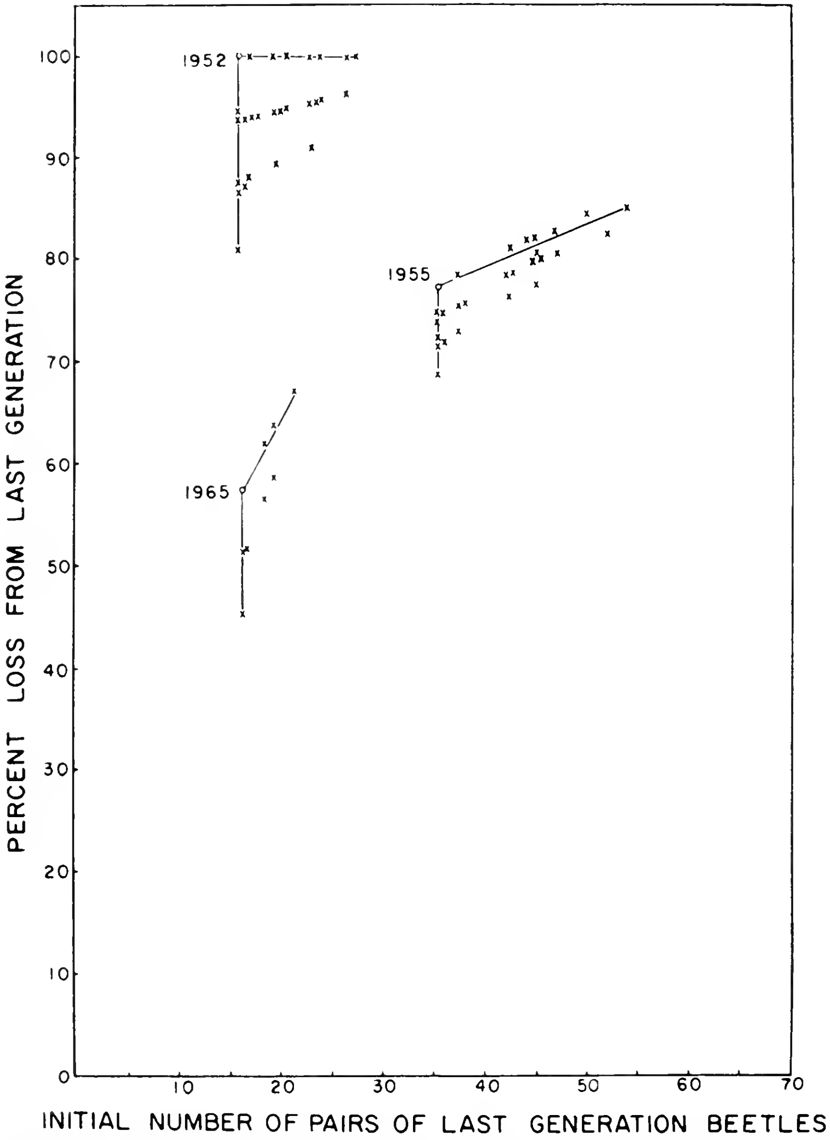

FIGURE 4. Last generation percent losses from tree 3–5B in 1952, 1955 and 1965.

attainable, given a more refined understanding of the biology of *C. columbianus* and its tree hosts. To remove the uncertainties encountered above, further investigations of all aspects of the beetle's biology are needed. Of

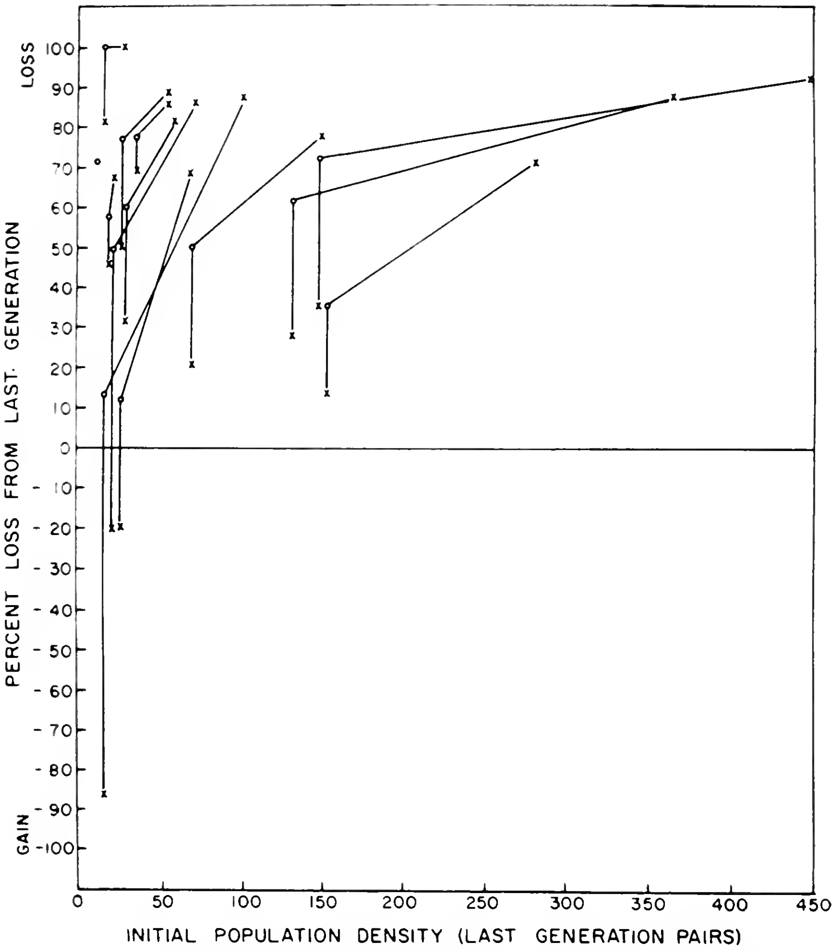

Figure 5. Last generation per cent losses from tree 3-5B in all years.

particular importance are observations of the numbers of beetle generations per year, whether or not they are always discrete, and the distances over which adult beetles characteristically disperse. The development of a precise way of distinguishing generations of galleries is indispensible to application of equations (3). Studies of the responses of tree tissues to beetle attack may provide a promising approach to this problem (Milne and Giese, 1969).

Of the assumptions upon which equations (3) are based, only the last is critical. The equations can be adjusted to account for lopsided sex ratios and consistent excavation of more cradles than are usually provided with eggs. Absence of discrete distinguishable generations of beetles within each growing season would prove to be a more fundamental obstacle to their application.

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2.0002 Corthylus columbianus (Coleoptera: Scolytidae). X. Yearly mortality and dispersal losses.

ABSTRACT.—*C. columbianus* leaves gallery systems containing egg cradles imbedded in living trees. Equations of the form $m_i + e_i - I_i = \frac{1}{2}C_{i-1} - g_i$ were derived, linking observable features of these preserved artifacts to mortality and dispersal losses suffered by beetle populations. Quantities C and g are numbers of cradles and galleries; I, c, and m are beetle pairs gained and lost via immigration, emigration and mortality. The equations link ith and i–1)th generation artifacts.

Beetle mortality and dispersal losses are difficult to compare with population densities over a 14-year period. Research objectives needed to improve the precision of this technique involve studies of the responses to tree tissues to beetle attack.—D. H. MILNE and R. L. GIESE.

Descriptors: Columbian timber beetle; *Corthylus columbianus;* Coleoptera, Scolytidae; population densities; mortality; dispersal; gain and loss equation.

3.0003 Diplocentrus spitzeri, A New Arizona Species of Scorpion [1]

HERBERT L. STAHNKE [2]

Diplocentrus spitzeri, NEW SPECIES

This new species is a medium sized diplocentrid scorpion. Venom characteristics are those of the family as previously reported (Stahnke, 1967). The fresh venom, upon exposure to air, develops a reddish tinge that migrates rapidly through acrylamide gel electrophoresis column without contributing to pherogram. The lyophilized venom is a blackish brown, flocculent solid while that of other families is whitish.

Holotype.—♂, length 46 mm, ASU #65-223, ASU repository. Locality: 8.8 mi. E. Nogales, Arizona. Microhabitat: Under stones. Collectors: Carl Spitzer family. Date: July 17, 1965.

Allotype.—♀, length 50 mm, ASU #66-026, ASU repository. Locality, microhabitat and collector same as for holotype. Date: February 22, 1966.

Paratypes.—Thirty-three ♂s, lengths 12 to 46 mm. All but two collected from same locality by Carl Spitzer family on the following dates: (3) March 27, 1965; (25) July 17, 1965; (10) February 22, 1966; (2) November 6, 1967. One collected by Bob Wesson, October 2, 1938 in the Atascos Mts. Another by Robert Flock, near the Mexican border in the same mountains on November 3, 1938. Forty ♀s, lengths 14 to 52 mm. All but three collected by Carl Spitzer family from same locality on the following dates: (12) March 27, 1965; (13) July 17, 1965; (16) February 22, 1966; (1) July 3, 1966; (2) November 2, 1967. One was collected by W. von Hagen on March 12, 1933 at Patagonia, Arizona; one on September 21, 1963 by Gregory Noel and another by William Manzavedo on November 26, 1963 about 5 mi. N. of Nogales, Arizona on Grand Avenue.

DIAGNOSIS

The only two previously described diplocentrids in the size range are *Diplocentrus keyserlingi* Karsch, 1880 and *D. whitei* Gervais, 1844. According to the original description and the examination of the types the following comparative data have been obtained:

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[1] Accepted for publication August 30, 1969.

[2] Poisonous Animals Research Laboratory, Arizona State University, Tempe, Arizona 85281.

	D. keyserlingi	*D. whitei*	*D. spitzeri*
1. General coloration	Blackish brown	Dark brown	Light to medium brown
2. Adult length	40 mm	63 mm	50 mm
3. Tarsomere II spine formula	♂ $\frac{44}{55}:\frac{55}{55}:\frac{66}{66}:\frac{66}{66}$	♀ $\frac{55}{66}:\frac{66}{77}:\frac{77}{88}:\frac{88}{88}$	♂, ♀ $\frac{66}{77}:\frac{66}{77}:\frac{77}{77}:\frac{77}{77}$
4. Digital keel	Very strongly dev.; absent on finger	♀ well dev. & extends along finger	♀ weakly represented ♂ well dev. but absent on finger
5. Pectinal teeth	♂ 9 9	♀ 16 15	♂ 15 15; ♀ 12 12
6. Ratios:[3]			
a. $\frac{6.4}{6.3}$	♂ 0.89	♀ 1.09	0.77 0.66–0.88
b. $\frac{6.7}{6.9}$	♂ 1.26	♀ 1.03	1.07 1.02–1.14
c. $\frac{4.3\text{–}4.1}{4.0}$	♂ 0.35	♀ 0.40	0.52 0.46–0.69

[3] See code on last page.

DESCRIPTION

General appearance.—Both sexes range from a light yellow brown in juveniles to a medium brown in adults. Legs of adults lighter than other structures. Pectines yellow. All ages moderately hirsute, very few punctations and sparsely granular; female less granular than male.

Prosoma (Cephalothorax).—*Carapace.* Indefinite fuscous pattern; most noticeable on lighter specimens. Three pair lateral eyes; first pair smaller or about same diameter as second pair; third pair at about 170° angle to other two. Anterior median notch does not extend beyond level of posterior margin of second pair of eyes; somewhat shallower in very young specimens. Ratio of *distance* between anterior margin of carapace and anterior edge of median eyes and *depth* of median notch: 5.56 (4.00–7.90). Male surface covered with very minute granules with small granules scattered along anterior margin. Minute granules absent on female. Moderately hirsute along lateral and anterior margins. Median ocular tubercle dark brown to black and flanked on each side with an elongate, light spot. Furrows: Anterior median broad and shallow; median ocular slight vestige; lateral ocular shallow; central median broad but distinct; vestige of posterior transverse; posterior median deep, narrow, almost slit-like; posterior marginal and posterior lateral well developed but not interconnected.

Sternum. Subpentagonal with lateral sides subparallel. Relatively broad, steep sided median furrow extending over approximately one-third posterior length and abruptly spreading anteriorly into depressed, subdiamond shaped area.

Appendages: Chelicera. Movable finger forked; inferior tine approximately four times length of superior tine; inner superior margin with one large tooth flanked by two considerably smaller subequal teeth; the most distal one on base of superior tine, the base of most proximal one connected to large, median tooth. Fixed finger not forked; bearing two teeth, most proximal one with two subequal cusps, most distal one with apex directed distad. Ventral surface of entire chelicera very densely covered with long whitish bristles.

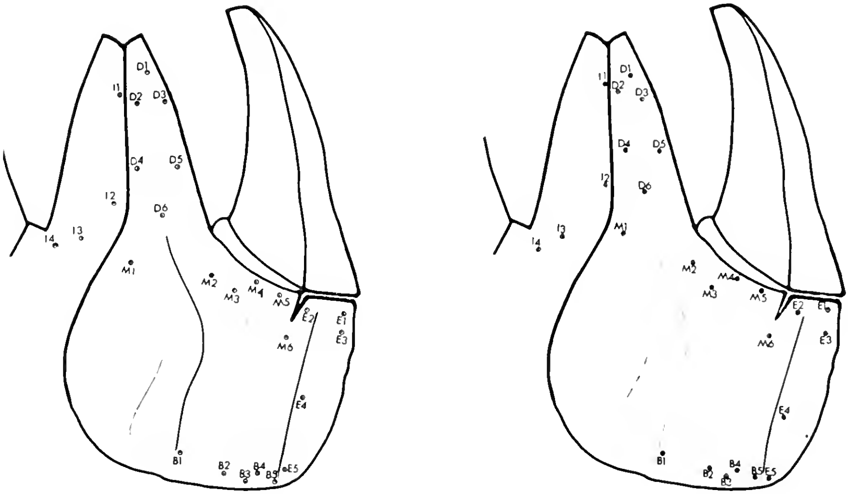

Figure 1 **Figure 2**

FIGURES 1 and 2. Right pedipalp chela showing trichobothrial patterns of ♂ (1) and ♀ (2). Although the patterns are essentially the same they differ in $D_{1,2,3}$– D_6 $M_{1,2}$ and $I_{2,3,4}$. The distances vary also between trichobothria in the basal (B) and exterior (E) sets.

Pedipalps: Chela. Tarsus (movable finger) slightly reddish on light specimens; moderately to densely hirsute. Basal lobe small—somewhat larger on female—but bearing relatively large tooth; somewhat coarsely punctate.

Tibia. Fixed finger like tarsus in general appearance. Four trichobothria (Figs. 1 & 2) inner surface (I); six on exterior surface (D). D_1 slightly distal to D_3. *Manus* of ♂ adult with well developed costate reticulum on superior surface; moderately so on inferior surfaces; ♀ faintly costate on both surfaces. Costate reticulum primarily absent on younger instars. Superior surface with scattered coarse punctations. Moderately to densely hirsute on inner and exterior margins and lightly so on superior surface. Fifteen trichobothria (Figs. 1 & 2) arranged in three clusters of 5 each (M, B & E). Keels: Exterior marginal strongly developed and diagonal with distal terminus nearer E_2; superior exterior moderately developed on ♂ but only slight vestige on ♀; superior digital very strongly developed on ♂ with only a slight vestige on fixed finger, moderately developed on ♀; superior inner secondary like superior exterior; interior marginal of ♂ well developed and coarsely granular on distal two-thirds, ♀ same but granular on distal one-half. *Patella* (brachium): Dorso-inner keel of ♂ strongly developed and agranular, weaker on ♀, bears three trichobothria; dorso-exterior and exterior median only a slight vestige on distal one-half and agranular on both sexes; ventral inner well developed with widely spaced large, broad granules on both sexes; ventral exterior well developed on ♂, weakly so on ♀, and agranular on both. Dorsal surface agranular and somewhat rugose; distal two-thirds of inner surface densely covered with small granules and one large, cone-shaped granule and one macrochaete on proximal margin; ♂ ventral surface smooth except for a few scattered granules, ♀ agranular and bearing 3 trichobothria along proximal half of exterior margin; exterior surface agranular and bearing 13 trichobothria: 5 proximad, followed by two groups of 2 each plus a widely spaced distal cluster of 4.

Femur (humerus). Three trichobothria: One on extreme proximal margin of dorso-inner edge; another on superior surface on exterior margin about 0.2 length from proximal margins; a third, approximately 0.35 of femur length from proximal end just below superior-exterior edge. Keels: Dorso-inner, dorso-exterior, ventral inner well developed and bearing large coarse granules; exterior median lightly vestigial and agranular; ventral exterior absent. Dorsal surface with vaulted area on proximal one-third, bearing a few large granules and a macrochaete; inner surface covered with minute to large granules; one-half of ♂ ventral surface covered with scattered granules, ♀ surface almost entirely agranular; exterior surface almost entirely agranular.

Walking legs. Tarsal claws and pedal spurs well developed; median claws moderately developed. Lateral terminal lobes well developed and bearing 3 pair spines. Median lobes extend distally beyond lateral lobes; bear a terminal and one or two superior macrochaetes. Exterior surface of femurs with scattered small granules; inferior edge bearing larger granules with legs I and II bearing the largest. Tarsomere II spine formula typically $\frac{6\ 6}{6\ 6}:\frac{6\ 6}{7\ 7}:\frac{7\ 7}{7\ 7}:\frac{7\ 7}{7\ 7}$; with slight variations.

Opisthosoma.—Mesosoma (preabdomen):

Terga. Sparely hirsute; ♂ minutely and densely granular, ♀ agranular, both with some large granules posteriad on VII. Very faint vestiges of median keels and vestiges of two pair of laterals on VII.

Sternites. VII with four lateral keels which bifurcate posteriorly and bear confluent granules. Stigma elongate, narrow.

Genital operculum. Ovoid (Figs. 3 & 4); width-length ratio: ♂ 2.24 (1.62–3.32), ♀ 2.23 (1.73–3.10); ratio decreases with increase in age. Operculum undivided on ♀; divided on ♂ and bearing genital papillae.

Pectines. Lightly hirsute, generally 3 small middle lamellae; angle of basal margin of middle lamellae: ♂ 90°; ♀ 45° (Figs. 3 & 4). Marginal lamella III longer than II. Pectinal teeth typically ♀ 12 (10–13), ♂ 15 (14–16). Sinnesborsten cover about 85% of length of inner ventral surface of ♂ and about 33% of inner edge of ♀ teeth. Basal piece with anterior-posterior margins subparallel; ratio of length to width: ♂ 0.49 (0.32–0.55), ♀ 0.50 (0.38–0.59); ratio of basal piece length to genital operculum length: ♂ 0.89 (0.67–1.40), ♀ 0.96 (0.52–1.31); the ratio decreases with increase in age.

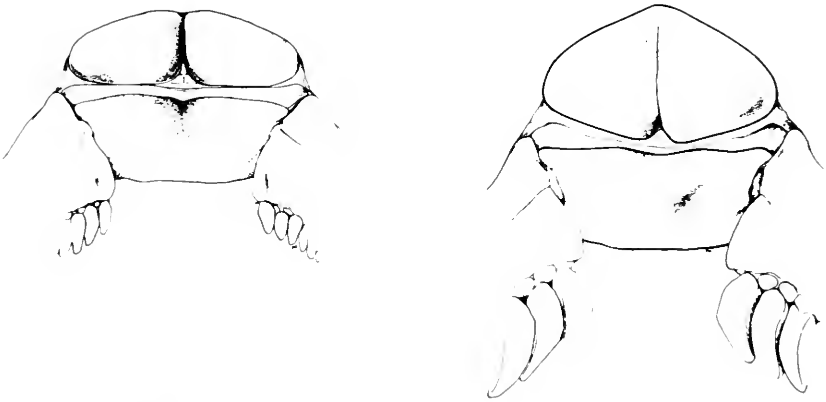

Figure 3A **Figure 3B**

FIGURE 3. Developmental changes in male genital operculum, basal piece and base of pectines. A, 19 mm juvenile; B, 45 mm adult.

Metasoma (cauda: postabdomen plus telson). Intercarinal space very minutely and densely granular on ♂; mostly agranular on ♀; lightly hirsute except telson; dorsal furrow moderately developed on segments I–IV; vestigial on V. Keels: Dorsal and superior laterals well developed and bearing confluent granules; median laterals well developed and granular on segment I, weakly developed and granular on segment II, absent on all other segments; inferior laterals strongly developed, granular and tapering posteriorly on segments I and II; well developed and bearing confluent granules on segment III, vestigial and agranular on segment IV, strongly developed with large granules on segment V; inferior laterals like the preceding except that for the tapering on segments I and II and the absence of the keels on segment IV. Crescentic area strongly developed and outlined by large granules; on ♂ these granules nearly all cone-shaped but on ♀ granules are chisel-shaped. Intercrescentic area bears a cluster of large cone-shaped granules. Anal arch well developed. Anterior crest well developed and bears about 14 large chisel-shaped granules. Posterior crest well developed and densely covered with moderately large granules of various shapes.

Figure 4A **Figure 4B**

FIGURE 4. Developmental changes in female genital operculum, basal piece and base of pectines. A. 17 mm juvenile; B. 45 mm adult.

Telson. Moderately to densely hirsute. Agranular except for clusters of 3:2:3 very large granules on ventro-proximal margin. Aculeus short, sharply curved with large, blunt subaculear tubercle. Ampulla about same width as caudal segment V.

DISCUSSION

The ratios on Table 1 indicate little sexual dimorphism. Only ratios 14, 15 and 16 are indications and these deal exclusively with the pectines, basal piece and genital operculum. Subjectively sexual dimorphism is indicated by the well developed digital keel and costate reticulum of the

TABLE 1. Ratios[4]

	Type		Means and Ranges	
	Holotype	Allotype	♂	♀
1. $\frac{4.0}{4.3}$	0.95	0.96	0.94 (0.80–1.00)	0.94 (0.87–1.03)
2. $\frac{4.0}{6.51}$	1.27	1.36	1.37 (1.23–1.58)	1.42 (1.32–1.50)
3. $\frac{4.0}{6.7}$	1.14	1.28	1.25 (1.10–1.41)	1.32 (1.24–1.40)
4. $\frac{4.0}{6.9}$	1.21	1.36	1.35 (1.17–1.53)	1.41 (1.33–1.50)
5. $\frac{4.5}{4.11}$	0.54	0.62	0.55 (0.46–0.60)	0.56 (0.46–0.63)
6. $\frac{4.2}{4.9}$	6.67	7.12	6.28 (5.05–7.50)	6.44 (5.22–7.67)
7. $\frac{4.3\text{–}4.1}{4.0}$	0.51	0.52	0.52 (0.46–0.69)	0.52 (0.45–0.62)
8. $\frac{6.2}{6.4}$	2.13	2.08	2.12 (1.89–2.43)	2.08 (1.86–2.38)
9. $\frac{6.2}{6.6}$	1.59	1.69	1.68 (1.59–1.78)	1.68 (1.60–1.76)
10. $\frac{6.4}{6.5}$	1.62	1.70	1.56 (1.35–1.68)	1.55 (1.35–1.70)
11. $\frac{6.51}{6.6}$	0.71	0.72	0.78 (0.67–0.82)	0.75 (0.68–0.81)
12. $\frac{6.7}{6.9}$	1.06	1.06	1.08 (1.04–1.27)	1.07 (1.02–1.14)
13. $\frac{6.9}{6.10}$	2.35	2.27	2.20 (2.00–2.44)	2.17 (2.00–2.39)
14. $\frac{6.12}{7.21}$	0.93	1.36	1.14 (0.93–1.55)	1.42 (1.31–1.60)
15. $\frac{7.21}{7.22}$	1.00	1.29	1.02 (0.98–1.09)	1.25 (1.20–1.85)
16. $\frac{7.6}{7.8}$	0.69	0.67	0.89 (0.67–1.40)	0.96 (0.52–1.31)
17. $\frac{3.00}{4.00}$	4.39	3.66		
18. $\frac{4.00}{8.13}$	1.05	1.21		
19. $\frac{6.1}{6.11}$	0.97	0.97		
20. $\frac{8.13}{8.1}$	1.80	1.87		

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[4] See code on last page.

male in contrast to a much weaker development of these structures on the female. The male genital operculum is divided and genital papillae are present. These conditions do not exist on the female. In the adult the male pectinal teeth are both longer and wider. The basal margin of the middle lamellae at all ages above first instar forms nearly a 90° angle with the dentate margin on ♂s and about a 45° angle on ♀s. Caudal segment V which is very frequently much longer on the ♂ shows some sex dimorphism in ratio with the carapace length (ratio #18).

ACKNOWLEDGMENTS

The author wishes to acknowledge the technical assistance of R. DeRose, A. Bebee, and T. Lutz. Figures 3 and 4 by P. McLynn.

NUMERICAL CODE

3.0	Metasoma (caudal) length
4.0	Carapace length
4.1	Anterior width of carapace
4.2	Carapace width at level of median eyes
4.3	Posterior width of carapace
4.9[5]	Width of median ocular tubercle
4.11	Distance between posterior margin of median eyes and posterior margin of carapace
6.1	Pedipalp length less coxa
6.2	Length of pedipalp tibia
6.3	Length of pedipalp manus
6.4	Width of manus
6.5	Thickness of manus
6.51	Length of exterior margin of manus (underhand)
6.6	Pedipalp tarsus length
6.7	Pedipalp patella length
6.9	Pedipalp femur length
6.10	Pedipalp femur width
6.11	Leg IV length
6.12	Leg IV coxa length
7.21	Length of pecten
7.22	Length of dentate area of pecten
7.6	Length of pecten basal piece
7.8	Width of pecten basal piece

[5] This is not the width of ocular diad which technically would be the sum of the diameters of the two median eyes. The width of the median ocular tubercle is the distance between the lateral margins of the median eyes.

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2.0003 Diplocentrus spitzeri, a new Arizona species of scorpion.

ABSTRACT.—A medium sized species, light yellow brown to medium brown; pectines yellow; moderately hirsute, very few punctations and sparsely granular; type locality: 8.8 mi. e. Nogales; collected: July 17, 1965.—R. H. ARNETT, JR.

Descriptors: scorpion; Diplocentridae; *Diplocentrus spitzeri*, nspe; Arizona.

The **December 1969** issue was mailed February 20, 1970.

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OMING NEXT ISSUE: Sexual dimorphism in the head structure of Mutillidae

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ENTOMOLOGICAL NEWS

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3.0024 UNUSUAL CASE BUILDING BEHAVIOR OF HYDROPSYCHE OCCIDENTALIS LARVAE (TRICHOPTERA: HYDROPSYCHIDAE)[1]

John O. Mecom[2,3]

During the course of an investigation of the distribution and productivity of Trichoptera larvae in a Colorado mountain stream unusual case building behavior was noted in the net-spinning larvae of *Hydropsyche occidentalis* (Banks). Over 700 larvae of this species were hand picked from the substrate of the St. Vrain River in Boulder County, Colorado at elevations of 1750–2050 m (T3N, R71W, S26) (T2N, R71W, S6) from June, 1968, to May, 1969.

From late May to late October the larval case of *Hydropsyche occidentalis* consisted of a loosely woven tube 7–12 mm in length supported by small pebbles and vegetable matter. A net was spun by this species in front of the case to aid in the capture of food. With the onset of colder temperatures in November, *H. occidentalis* remained inactive in a highly modified overwintering case or hibernaculum. The food net was not present and the case was reinforced with larger pebbles to form a dense, more convex house rarely exceeding 7 mm in length. Pupal cases were found infrequently in late spring and early summer and consisted of an elongate tube in which large anchoring stones were utilized at the lateral margins.

Authors such as Hynes (1961) have reported the seasonal habits of Trichoptera larvae and Copeland and Crowell (1937), Fankhauser and Reik (1935), and Milne (1938) have investigated the case building behavior of many species. Elliott (1968) reports that some genera overwinter as fifth instar "resting larvae" but no special case modifications are present.

It is difficult to speculate on the adaptive value of the hibernaculum of *Hydropsyche occidentalis* but such a structure could aid in resisting ice

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[1] This is contribution number 58 of the University of Colorado Limnology Laboratory. Final preparation of the manuscript was made through the facilities of Southern Methodist University. Accepted for publication, February 6, 1970.

[2] ACKNOWLEDGMENTS.—I am indebted to Dr. Robert Pennak (University of Colorado) for his helpful suggestions and to Dr. H. H. Ross (University of Georgia) for his identification of the larvae of *Hydropsyche occidentalis*.

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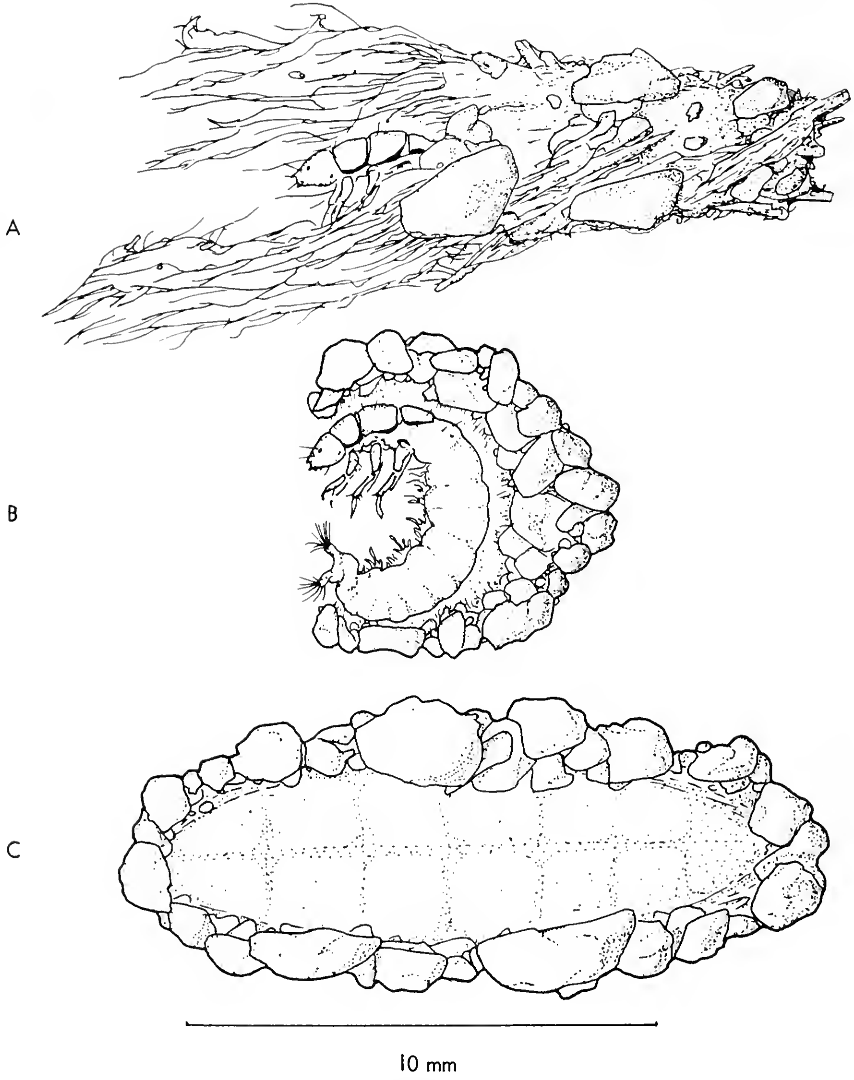

FIG. 1. The summer case (A), winter case or hibernaculum (B), and pupal case (C) of *Hydropsyche occidentalis* in the St. Vrain River of Colorado.

and flooding. *Brachycentrus americanus* and *Ecclisomyia maculosa* were common at the same elevation as *Hydropsyche occidentalis* but the standing crops of both of these species were sharply reduced with the appearance of anchor ice in November and again during heavy flooding in early May.

There was no significant reduction in the number of *H. occidentalis* larvae during ice cover and this species suffered far less mortality during spring runoff than did *B. americanus* and *E. maculosa*.

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2.0024 Case building behavior Hydropsyche occidentalis larvae (Trich., Hydropsychidae)

ABSTRACT.—During the course of an investigation of the distribution and productivity of aquatic insects in the St. Vrain River of Colorado unusual case building behavior was noted in the net-spinning larvae of *Hydropsyche occidentalis*. During the warmer months (April to October) the larval case consisted of a loosely woven tube of small stones and vegetable matter. A net was spun by this species in front of the case to aid in the capture of food. The pupal case of *H. occidentalis* had a rigid closed construction in which large anchoring stones were utilized at the lateral margins. The unusual aspects of case construction were seen during the winter months. With the onset of cold temperatures in November *H. occidentalis* destroyed the food net and reinforced its case with pebbles to form a thicker, more convex house in which the animal remained inactive until spring. The adaptive significance of this behavior is unknown but perhaps it serves to resist heavy icing.—J. O. MECOM

Descriptors: Trichoptera; Hydropsychidae; Hydropsyche occidentalis; behavior; case; Colorado; hibernaculum.

3.0008 Studies of Partially Double-Brooded Silkmoths in Cape May County, New Jersey (Lepidoptera: Saturniidae)[1]

C. Brooke Worth[2]

Cape May County, New Jersey, lies in a zone where single- and double-brooded populations of some species of silkmoths overlap. It appears to me that *Actias luna* is totally double-brooded here, while *Hyalophora cecropia* limits itself strictly to one annual generation. However, both *Antheraea polyphemus* and *Callosamia promethea* exhibit both phases.

It may be fallacious to speak of single- and double-brooded *populations* of the latter two species within this region, for in reality only a single genetically-mixed population of each may occupy the area. It certainly seems unlikely that there could be physiological or behavioral barriers that prevented mating between two such sympatric contingents. The only way they could be effectively separated is for their times of emergence to be sharply limited to different periods. Obviously this does not happen, for once the short-lived adults appear in late May, the two species are constantly present until early September, an indication that fresh individuals are continuously emerging. Hence it does not seem likely that isolation is achieved.

Under those circumstances one wonders how the phenomenon of double-broodedness is regulated. My studies of the subject were made by rearing and observing sibling broods, on the assumption that brothers and sisters, maintained under identical conditions in nets as caterpillars and in individual cubicles of a large box as cocoons, should in those uniform confines have the best opportunity for disclosing genetic variations. Or, if they were genetically similar, they should then behave as units, *all* members of a given sibling spring brood either emerging as a second summer generation or entering directly into overwintering diapause.

Data pertaining to the performance of progeny of spring moths are presented in Table 1. Inspection of the table discloses immediately that sibling broods may consist of a mixture, so far as their immediate or delayed emergence is concerned. It is apparent also that the trend is away from double-broodedness as maternal emergence takes place on later spring dates.

As a further observation, I found that summer moths emerged from cocoons that were, on the average, spun earlier than those in the same brood

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[1] Accepted for publication November 12, 1969.

[2] Eldora, R. D., Delmont, N. J. 08314.

that proceeded to overwinter. These summer moths, of both sexes, averaged lighter in weight than their overwintering siblings. Hence it would appear that the smaller, earlier-maturing ones were "constitutionally" different from the larger, more deliberate contingent. Since environmental conditions were identical, the difference might be a genetic one, rather than metabolic and/or physiological.

TABLE 1. Emergence patterns of sibling Polyphemus and Promethea broods relative to their mothers' dates of spring emergence

Moth	Moth Emerged	Progeny Emerged	
		Same Summer	Following Spring
Poly 185–1969	May 30	20 (32%)	43 (68%)
Poly 78–1968	June 2	29 (91%)	3 (9%)
Poly 190–1969	June 13	0 (0%)	72 (100%)
Poly W–1967	June 19	21 (25%)	63 (75%)
Poly 76–1968	June 22	0 (0%)	19 (100%)
Prom 44–1968	May 16	46 (88%)	6 (12%)
Prom 154–1969	May 19	19 (39%)	30 (61%)
Prom 67–1967	June 21	0 (0%)	56 (100%)

Overwintering sibling cocoons showed a protracted emergence pattern over a two-month period in the following spring. Those earliest to emerge again produced mixed broods, while the last ones left only overwintering descendants. Since emerging females must perforce mate with short-lived males sharing the same emergence period, one would expect to obtain pure lines from at least some of the earliest pairs—as well as from the latest ones. That this does not occur throws some doubt on the genetic interpretation of the regulation of bivoltine behavior in Cape May County. These studies suggest the need of a more extensive schedule of breeding tests for elaborating the problem.

ACKNOWLEDGMENTS

I wish to thank Dr. Neal A. Weber of Swarthmore College and Dr. Lincoln P. Brower of Amherst College for helpful comments during the course of this work.

2.008 Partially Double-Brooded Silkmoths in New Jersey (Lepidoptera: Saturnidae).

ABSTRACT.—Double brooded and single brooded silkmoths occur together at Cape May County, New Jersey, with no discernible isolation.—R. H. ARNETT.

Descriptors: Lepidoptera; Saturnidae; New Jersey; double broods; single broods; bivoltine behavior; isolation.

3.0007 A Fossil Crab Spider from West-central Wyoming (Araneae: Thomisidae)[1]

BRUCE CUTLER [2,3]

In 1966 a fossil spider carapace was obtained from a copropelic sediment from an excavation on the south shore of Whimpy Lake. The lake is in a small kettle hole that has no outlet. It lies on a moraine just west of the Bridger Wilderness Area, in Sublette County, Wyoming, and about three miles northwest of New Fork Lake. At present sagebrush covers the moraine, and *Populus* sp. and *Salix* sp. grow around the lake's margin. Two miles east in the Wind River Mountains, spruce-fir forest is present. The specimen is estimated as being 6,000 ± 2,000 years old on the basis of an unpublished pollen diagram of R. C. Bright. The pollen diagram from the lake indicates that the vegetation was similar to that which now occurs around Whimpy Lake.

The specimen consists of an almost complete carapace, Fig. 1–2, of a species of *Coriarachne* (Araneae: Thomisidae). It is dark brown and glossy; the surface is rough owing to many raised pits (spine sockets) and small wart-like protuberances. The eyes are blackish-brown. The diameter of each of the anterior median eyes is 0.14 mm, each of the anterior lateral eyes 0.25 mm, each of the posterior median eyes 0.11 mm, each of the posterior lateral eyes 0.16 mm. Clypeus height 0.16 mm. Distance between posterior median eyes 0.27 mm, between anterior median eyes 0.28 mm. Length of the median ocular area 0.15 mm. Distance between the posterior lateral eyes and the posterior median eyes 0.34 mm. Distance between the anterior lateral eyes and the anterior median eyes 0.13 mm. Both eyerows are recurved. The carapace is from a penulti-

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mate or a mature individual. The species cannot be determined definitely on morphological criteria because the genitalia are missing; however, it may be possible to determine the species as soon as statistical data accumulates for recent specimens in museum collections.

There are six members of the genus *Coriarachne* in North America, one in Europe, and two or three in Asia (Gertsch, 1953). He divides the North American species into two groups, A and B. Four species are in group A. Group B may be eliminated, because in this group the posterior median eyes are much closer together than they are to the posterior lateral eyes.

The four members of group A and their present geographical distribution are as follows: *C. aemula* O. P. Cambridge, eastern Mexico and southern Texas; *C. floridana* Banks, southeastern United States and the Atlantic coastal plain to New York; *C. utahensis* Gertsch, all of North America west of the Rocky Mountains, and east across Canada and the extreme northern United States to the Atlantic coast; *C. versicolor* Keyserling, all of North America east of the Rocky Mountains, one record from Arizona, and several from Alaska. On a zoogeographic basis alone, it would appear that the carapace is that of *C. utahensis.* This is the only species recorded from Wyoming (Lowrie and Gertsch, 1955, Grand Teton area, and Levi and Levi, 1951, Yellowstone area). Unfortunately the width of the median ocular area (0.27 mm) is so much larger than the length (0.15 mm) that the ratio of width to length (0.27/0.15) falls far outside the known range of any American species of *Coriarachne.* The only species whose measurements approach this ratio is *C. floridana,* whose present range lies 1,500 miles to the east of Whimpy Lake. Furthermore, *C. floridana* has the lower margin of the anterior eyes in a straight line, while the lower margin of the anterior eyes of the Whimpy Lake specimen are slightly recurved. It is possible that the fossil represents a new species, but I would not wish to designate it as such until data from non-American species of *Coriarachne* are made available. The difficulty with the Asian members of the genus is the uncertainty of the number of species in that part of the world, and the strong possibility of unidentified species occurring in the central Asian and Siberian areas. Hence measurements would indicate little in the face of these unknowns.

This genus of crab spiders is very much flattened dorso-ventrally. Specimens are most commonly taken under the loose bark of dead trees and logs. They are also seen in houses, on stone walls, wooden fences, or under rocks and stones lying on the ground. An occasional specimen is found while sweeping. They are colored with mottled shades of gray and brown, remaining immobile among debris and seizing any small arthropod that blunders into their outstretched front legs. The average length of mature specimens of several species is about 5.5 mm.

This is the first fossil record of the genus *Coriarachne*.

Fig. 1–2. Carapace of *Coriarachne* sp. coated with ammonium chloride. Fig. 1. Dorsal view × 6¼. Fig. 2. Anterior view × 6¼.

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2.0007 A fossil crab-spider from west-central Wyoming (Araneae, Thomsidae).

ABSTRACT.—The first fossil record of the crab spider genus *Coriarachne* is recorded. A carapace was found in a copropelic lake sediment from Whimpy Lake, Sublette Co., Wyoming. The estimated age of the specimen is 6,000 ± 2,000 years old.—BRUCE CUTLER.

Descriptors: Crab spider; Wyoming; Fossil spider; Araneae; Thomisidae.

3.0010 Isomira Mulsant in America North of Mexico (Coleoptera, Alleculidae): Redescriptions, New Synonymies, and Taxonomic Notes on Eastern North American Species [1]

JAMES D. MARSHALL [2, 3]

Below are redescriptions and new synonymies and other taxonomic notes for four species occurring in eastern North America. Terminology used in discussing the male genitalia is in keeping with that of Campbell (1966). The drawings provided in Figs. 1–4 represent lateral views of male genitalia. A full lateral view of the apical piece is shown, but only the distal portion of the basal piece is illustrated. The size of the eyes is expressed as the ocular index, a quantitative character discussed fully by Campbell and Marshall (1964). In showing the geographic distribution records of the various species, the label data of specimens examined are summarized for each locality and presented in the following order: locality; month; number of specimens. Seasonal distribution is given as the earliest and latest dates on the labels of specimens examined.

Isomira valida Schwarz

Isomira valida Schwarz 1878: 370.—Casey 1891: 152.
Isomira similis Blatchley 1910: 1278. NEW SYNONYMY.

DIAGNOSIS.—The moderately large size (at least 8.5 mm long) of both sexes, and the large eyes of the males (ocular index less than 35) serve as good characters for distinguishing this somewhat uncommon species from its relatives.

DESCRIPTION.—Body ovate; elliptical, strongly convex in cross-section; color medium brown throughout; integument shining, pubescence short and dense, uniformly

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[3] This paper is a part of my continuing series bearing the general foretitle, "*Isomira* Mulsant in America North of Mexico (Coleoptera, Alleculidae)" through which the United States and Canadian members of the genus *Isomira* are being revised. Other parts are in press, or else are in preparation. The last part will be a concise illustrated synopsis containing keys, distribution maps, and full recognition of the individuals and institutions who made this study possible.

distributed over entire dorsal surface. Head finely and moderately punctate, distance separating punctures two times average diameter of punctures; terminal segment of maxillary palpi wide, less than twice as long (16:9) as greatest width, angle formed at junction of inner and basal sides obtuse; antennae with third segment as long as fourth, remaining segments slender, three times as long as greatest width; eyes moderate; ocular index: $\bar{x}$ (males) = 29.9; $\bar{x}$ (females) = 40.8. Thorax finely, deeply, and densely punctate; two times as wide as long; cephalic margin slightly arcuate, three-fifths as wide as caudal margin; sides evenly rounded; basal foveae almost imperceptible, widely separated. Elytra as wide at base as caudal margin of pronotum, four times as long as pronotum and one-and-two-fifths as long as their greatest width; striae marked by series of almost imperceptibly impressed punctures which are dark piceous in color; striae not at all impressed basally, only faintly so apically; shallowly and somewhat sparsely punctate, punctures separated by a distance two times the diameter of a puncture. Abdomen polished, finely and densely punctate. Length: 8.5 to 9.4 mm.

Male genitalia: Fig. 1.

Location of type: valida, United States National Museum; *similis,* Purdue University, Lafayette, Indiana.

Type locality: valida, Enterprise, Florida; *similis,* Posey County, Indiana.

Seasonal distribution: March 10–July 23.

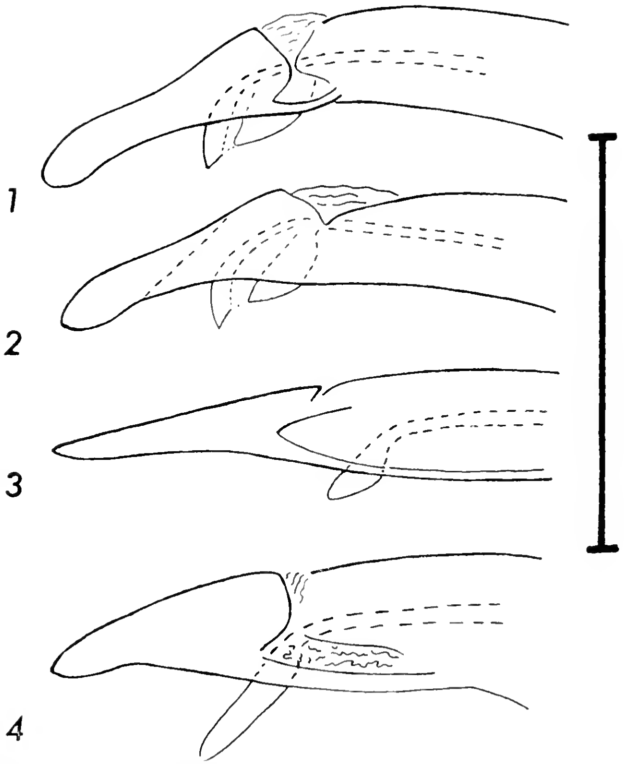
Geographic distribution: This species is found on the East Coast from New Jersey south to Florida. West from Florida it seems to range along the Gulf Coast. Actual records show that it occurs in southwest Arkansas from which point it probably ranges northward to the Wabash Valley in Indiana and eastward through the Ohio Valley. There is a literature record of *valida* being taken in Cincinnati, Ohio (Dury 1902). One specimen from Point Pelee, Canada, was examined.

Specimens examined: 20 males, 18 females from the following localities: CANADA: Point Pelee, June, 1. UNITED STATES: *Alabama:* Mobile, May, 1. *Arkansas:* Hope, May 1; "Southwest," no date, 3. *Florida:* State label only, 1; Marion, no date, 1; Paradise Key, March–April, 9; St. Augustine, no date, 1. *Illinois:* Mason Co., Mason State Forest, June, 2. *Kansas:* Douglass, no date, 2. *Maryland:* State label only, 1; Plummer's Island, June–July, 5; *New Jersey:* Anglesea, June, 2; no date, 1. *South Carolina:* Aiken, May, 1. *West Virginia:* Berkeley Co., April, 1.

DISCUSSION.—There is little variation in size. The shining, medium brown color is more or less uniform over its entire range, but dark brown specimens are occasionally taken. The ocular index varies from 24 to 34 for males and 35 to 47 for females.

The male genitalia have the median strut ventrally lamellate and resembling that of *texana*, but can be distinguished by the moderate swelling on the dorsal side of the basal half of the apical piece (Fig. 1).

The eyes of *valida* are in general larger than those of *texana*, although some overlap in the ocular indices occurs in both sexes (see discussion under *texana* below). The last segment of the maxillary palpi in *valida* is shorter in relation to width than that of *texana*. In *valida* the angle formed at the junction of the inner and basal sides is obtuse, with the inner side only one-half as long as the outer side; in *texana* the angle at the junction of the inner and basal sides is almost 90°, and the inner side is three-fourths as long as the outer side.



Figures 1–4. Lateral views of male genitalia of *Isomira* spp. (1) *I. valida;* (2) *I. texana;* (3) *I. pulla;* (4) *I. sericea.* Heavy black line = 0.5 mm.

Isomira texana Casey

Isomira texana Casey 1891 : 153.

DIAGNOSIS AND DESCRIPTION.—This species is similar in general appearance to *valida*, but may be distinguished as follows: eyes smaller and more widely separated, ocular index: $\bar{x}$ (males) = 42.0; $\bar{x}$ (females) =

47.3; terminal segment of maxillary palpi elongate, two times as long as greatest width, angle formed at junction of inner and basal sides only slightly obtuse, almost 90°; prothorax one-and-two-thirds as wide as long; elytra parallel on basal two-thirds; striae feebly but distinctly impressed for entire length. Length: 8.5 to 10.2 mm.

Male genitalia: Fig. 2.

Location of type: United States National Museum.

Type locality: "Texas."

Seasonal and geographic distribution: Specimens are known to have been taken between May 5 and July 12. Records are only from Texas as follows: Alpine, May 1, Big Bend Nat. Park, Green Gulch, 5,300′, May, 6; Jeff Davis Co., July, 1; Kerrville, May–July, 2.

DISCUSSION.—Variation in size is slight. The color, which is usually medium brown, is darker in the specimens from Kerrville, Texas. The ocular index of the males varies from 34 to 42 and that of the females from 44 to 52.

The male genitalia have the median strut ventrally lamellate resembling that of *valida*, but they lack the small basal swelling on the dorsal side of the apical piece, see Fig. 1 (*valida*) and Fig. 2 (*texana*).

The eyes of *texana* are in general smaller than those of *valida*, although some overlap in the ocular indices occurs in both sexes (see discussion of *valida* above). The last segment of the maxillary palpi in *texana* is longer in relation to width than that of *valida*. In *texana* the angle formed at the junction of the inner and basal sides is almost 90°, and the inner side is three-fourths as long as the outer side; in *valida* the angle at the junction of the inner and basal sides is obtuse, and the inner side is only one-half as long as the outer side.

Isomira pulla (Melsheimer)

Cistela pulla Melsheimer 1846: 60.
Isomira pulla, Casey 1891: 149.
Isomira ignora Blatchley 1914: 144. NEW SYNONYMY.

DIAGNOSIS.—In this species the last segment of the maxillary palpi is moderately robust, with the angle formed at the junction of the inner and basal sides obtuse and the inner side one-half as long as the outer side. This character, in combination with the small eyes (ocular index of 55 or more) and the distribution east of the 100th meridian, should serve to separate both sexes of *pulla* from other species of *Isomira*.

DESCRIPTION.—Broadly oval, convex; brown throughout; integument minutely punctate, slightly shining; pubescence pale, very short, dense, and appressed. Head with terminal segment of maxillary palpi moderately robust, one-half as wide as long, angle formed at junction of inner and basal sides obtuse, inner side one-half as long as outer side; antennae less than one-half length of body; third segment elongate, as long as fourth, remaining segments elongate, slender, two times as long as greatest width; eyes small, ocular index: $\bar{x} = 59.6$. Thorax two times as wide as long, sides gradually and unevenly rounded from base to cephalic margin; cephalic margin slightly rounded, almost truncate, one-half as wide as caudal margin; caudal margin sinuate; basal foveae feebly impressed; basal angles almost 90°. Elytra at base equal in width to pronotum; sides becoming slightly broader on posterior one-third; not quite twice (12:7) as long as their greatest width; striae not visible on disk; two sutural striae visible apically, intervals of these very feebly convex. Abdomen polished throughout. Length: 5.6 to 7.7 mm.

Male genitalia: Fig. 3.

Location of type: Museum of Comparative Zoology.

Lectotype: Here designated. Male, "Pennsylvania." (?) Museum of Comparative Zoology no. 30868.

Seasonal and geographic distribution: Collecting data indicate a seasonal distribution of February 22 to November 11. Examined were 84 males, 397 females, and 107 sex not determined from the following localities: CANADA: *Ontario:* Port Credit, July, 1; Toronto, June, 3. UNITED STATES: *Alabama:* Chambers Co., Langdale, no date, 2; Decatur, May, 2; Thomasville, April, 1. *Arkansas:* Ozone, June, 1; "Southwest," no date, 3. *Delaware:* Bridgeville, June, 4; Glasgow, June, 2; Harrington, June, 1; Millsboro, June, 1; Milton, June, 1; Newark, June–August, 2; Petersburg, June, 1; Smyrna, no date, 1; Wyoming, no date, 1. *District of Columbia:* District label only, June, 7. *Florida:* State label only, 2; Atlantic Beach, no date, 1; Crescent City, no date, 1; Dunedin, February–April, 4; Interlacken, April, 2; New Smyrna, April, 1; Okeefanokee, May, 1; Orlando, March, 3; Ormond, April, 1. *Georgia:* State label only, 1; Atlanta, May, 1; Clayton, 2–3,000, June, 2; Dunwoody, no date, 18; Rabum Co., July, 1; St. Catherine Isl., April, 2; St. Simons Isl., April–May, 1. *Illinois:* Goreville, June, 1. *Indiana:* Clark Co., State Forest, June, 2; Tippecanoe Co., June, 2. *Iowa:* Glenwood, spring, 1; Spirit Lake, June, 1. *Kentucky:* State label only, 1. *Maine:* Lincoln Co., July, 1. *Maryland:* State label only, 9; Baltimore, June–July, 27; Bladensberg, May, 2; Dorchester, near Lloyds, July, 6; Fair Hill, July, 1; Odenton, June, 2; Sparrows Point, July, 10. *Massachusetts:* Boston, no date, 1; Dennis, July, 6; Marion, July, 2; Winchester, June, 1; Woods Hole, July, 1. *Michigan:* Detroit, June, 1; 5 mi. E. Brighton, Kensington Park, June, 1; Gill Lake Biol. Sta., July, 2; Grand Ledge, July, 1; South Haven, July, 1. *Minnesota:* State label only, 2; Cass Co., no date, 1; Winona Co., June, 2. *Mississippi:* Lucedale, April, 1. *New Jersey:* State label only, 1; Anglesea, May, 7; Atlantic City, July, 12; Atsion June, 2; Boonton, June, 1; Cape May, July, 2; East Plains, June, 2; Franklin, June, 1; Greenwood Lake, June, 3; Hopatcong, no date, 1; Lakehurst, May–July, 13; Lake Marcia, June, 1; Linwood, July, 1; Malaga, June, 5; South Orange, June, 1. *New York:* State label only, 2; East Hampton, June, 1; Long Island, July, 1; Orient, L. I., June–July, 5; Pinelawn, L. I., June, 2; Staatsburg, June, 1; West Danby, May, 1; West Point, June, 5. *North Carolina:* Cherokee, Soco Valley, June, 2; Holly Shelter, April, 1; Murphy, May, 1; Southern Pines, no date, 2. *Ohio:* Delaware Co., June–July, 71; East Liverpool, no date, 1; Franklin Co., May, 2; Greene Co., May, 8; Hocking Co., June, 36; Ironton, May, 1; Marietta, June, 1; Scioto Co., June, 20; Shawnee Forest, June, 5. *Pennsylvania:* State label only, 12; Allegheny Co., June, 20; Cresson, July, 2; Glenolden, no date, 4; Jeannette, May–June, 119; Pittsburgh, May, 13. *Tennessee:* State label only, 1; Burrville, May, 4; Erwin, June, 1; Great Smokey Mt. Nat. Park, June, 1; Knoxville, May, 1; Memphis, May, 6; 1 mi. W. Vonore, June, 1. *Virginia:* State label only, 2; Cape Henry, May, 4; Fort Monroe, May, 1; Fredericksburg, June, 2; Lake Drummond, June, 3; Mt. Vernon, June, 1; Nelson, June, 1; near Plummers Isl., June, 1.

DISCUSSION.—The variation in this species is moderate. The color varies from a uniform tan to dark piceous brown. Usually the intervals of the sutural striae are of lighter color than the remainder of the dorsal surface. There is no significant difference in the ocular index of males and females; the observed range for both sexes is 56.0 to 63.0.

Isomira quadristriata Couper also has an ocular index of over 55 and is the eastern species most likely to be confused with *pulla*, but the broadly triangular terminal segment of the maxillary palpi of the former have the angle at the junction of the inner and basal side almost 90° which is quite distinct from the obtusely angulate condition of that segment in *pulla*. *Isomira ruficollis* Hamilton also has a comparable ocular index range, but its distinctive coloration, the combination of a ferruginous prothorax and shining black elytra, serves to distinguish it from *pulla*.

A very distinctive characteristic of the male genitalia is the very short ventral strut which is only two times as long as wide (Fig. 3).

Isomira sericea (Say)

Cistela sericea Say 1824: 285.—Leconte 1866: 139.

Isomira sericea, Casey 1891: 146.—Blatchley 1910: 1277.—Papp 1956: 149.

Isomira tenebrosa, Casey 1891: 146. NEW SYNONYMY.

DIAGNOSIS.—The normal coloration of *sericea* is ochreous, but specimens are frequently taken which are yellowish-brown or brown; and when this coloration occurs, the specimens are difficult to separate from some females of *iowensis* Casey. A subtle but apparently constant character for separating the females of *iowensis* from *sericea* is the parallel-sided condition of the head in front of the eyes in the former and the slightly tapering form in the case of the latter species.

DESCRIPTION.—Elongate-elliptical in outline, convex in cross-section; color ochreous, integument shining; pubescence very fine, extremely short and dense throughout. Head minutely and very densely punctate throughout; terminal segment of maxillary palpi two times as long as greatest width; inner side one-half as long as outer, angle formed at junction of inner and basal sides obtuse; antennae slender, two-thirds as long as body, filiform, third joint as long as fourth; eyes moderate in size, ocular index: $\bar{x} = 50.2$. Thorax minutely and densely punctate; one-and-one-third times as wide as long, sides straight and subparallel on basal half, becoming strongly rounded toward cephalic margin; cephalic margin subtruncate, slightly rounded, one-half as wide as caudal margin; caudal margin feebly and broadly sinuate; basal foveae distinct; basal angles right angles. Elytra minutely and sparsely punctate; their bases slightly wider and at middle one-third wider than caudal margin of prothorax; four times as long as pronotum and two times as long as their own greatest width; discal striae feebly but visibly impressed, intervals flat basally, very feebly convex apically; sutural striae conspicuous throughout length. Abdomen more shining than dorsal surface; pubescence of visible sterna four and five longer and more conspicuous than that of basal sternum. Length: 5.5 to 7.8 mm.

Male genitalia: Fig. 4.
Location of type: Presumably destroyed. Neotype not designated.
Type locality: "United States."

Seasonal and geographic distribution: 319 males, 954 females, and 150 the sex of which was not determined were examined. Seasonal distribution was established as March 3 to September 7. Geographic distribution is as follows: CANADA: *Nova Scotia:* Annapolis Royal, July, 2. *Ontario:* Bells Corners, July, 1; Chatterton, July, 5; De Cew F., May, 1; Grand Bend, July, 1; Grimsby, June, 2; Leamington, June–July, 17; Muskoka, July, 1; New Glasgow, July, 2; Port Credit, July, 1; Toronto, June, 4; Vineland Sta., July, 1. *Quebec:* Queen's Park, Aylmer, July, 3. UNITED STATES: *Arkansas:* Ozone, June, 1; "Southwest", no date, 3. *Connecticut:* Cornwall, July, 3; Litchfield, July, 3; New Haven, July, 1; Norwalk, July, 1; Sound Beach, July, 2; Storrs, June, 2; Wallingford, July, 3. *District of Columbia:* June, 7; Rock Creek Park, June, 2. *Delaware:* Cheswold, May, 1; Ellendale, June, 1; Laurel, June, 1; Millsboro, June, 1; Newark, May–August, 6; Roboboth Beach, July, 1; Water Gap, no date, 2; near Wilmington, June, 1. *Florida:* Dunedin, March, 3; Enterprise, no date, 1; Torreya State Park, May, 1. *Georgia:* Atlanta, May, 14; Blue Ridge, June, 3; Clarkesville, May, 1; Clayton, 2–3,000', June, 5; Dallas, June, 1; Dunwoody, no date, 44; Kennesaw Mt., May, 1; Neel Gap, July, 3; Rabun Co., July, 2; Rockmart, June, 1; Sotolah, July, 1; Stone Mtn., May, 5; Tray Mt., June, 1; Yonah Mt., June, 3. *Illinois:* State label only, 7. *Indiana:* Clark Co., St. Forest, June, 1; Hessville, July, 4; Indian Dunes St. Park, July, 12. *Iowa:* Iowa City, June–July, 2. *Kentucky:* Christian Co., Pennyroyal, June, 6; Prestonburg, June, 1. *Maine:* Casco, August, 3. *Maryland:* State label only, 5; Baltimore, June–July, 32; Beltsville, July, 1; Breton Bay, Potomac River, July, 1; Corner Conduit and Potomac Roads, June, 1; Glen Echo, no date, 1; Montgomery Co., July, 1; Odenton, June, 69; Plummers Island, June, 7; Sparrows Point, July, 2. *Massachusetts:* State label only, 6; Arlington Hts., July, 4; Beach Bluff, July, 7; Boston, no date, 1; Framingham, July, 1; Marblehead, July, 1; Marion, July, 19; Milton, July, 1; North Adams, July, 1; North Saugus, no date, 1; Sunderland, Mt. Toby, July, 1; Swampscott, no date, 1; Tyngsboro, no date, 42; Wayland, July, 1; Wilbraham, no date, 4; Woods Hole, no date, 1. *Michigan:* Allegan Co., July, 1; Barry Co., Yankee Springs Game Area, July, 6; Chelsea, July, 1; Cheboygan Co., Douglas Lake, July, 10; Detroit, no date, 1; Fennville, no date, 10; Huron Mt. Club, June, 1; Kalamazoo Co., Gull Lake Biol. Station, June–July, 11; Lake Co., Basswood Lake, July–August, 9; Olmstead, no date, 1; South Haven, July, 1. *Minnesota:*

Eaglenest Lake, July, 1; Goodhue, July, 1; 4 mi. S. Lamoille, July, 1; Minneapolis, June, 2; Ramsey, July, 1; Winona Co., Kings Bluff, June, Twin Bluffs, Lamoille, July, 5. *Mississippi:* Lucedale, April–May, 3; Richton, May, 1. *Missouri:* Big Spring St. Park, June, 1. *New Hampshire:* Carroll Co., July, 1; Rumney, July, 2. *New Jersey:* State label only, 14; Anglesea, no date, 1; Barnegat Bay, July, 4; 5 mi. Beach, July, 1; Boonton, July, 17; Browns Mills, June, 5; Chatsworth, July, 1; Chester, July, 2; Englewood, no date, 1; Fort Lee, no date, 3; Lakehurst, June–July, 40; Lakewood, July, 10; Malaga, July, 2; May's Landing, June, 2; Nutley, July, 2; Oak Ridge, July, 1; Paterson, June, 2; Plainfield, July, 17; Rahway, September, 1; Ramsey, July, Bear Swamp near Ramsey, July, 11; Ridgewood, June, 3; Riverton, July, 1; Sand Hills, no date, 1; Spring Lake, July, 1. *New York:* State label only, 22; Allegany St. Park, July, 2; Brooklyn, June–July, 3; Buffalo, no date, 1; Callicoon, June, 3; Catskill, July, 1; Colden, July, 1; Crugers, June, 1; Dryden, Ringwood, July, 3; East Aurora, July, 1; East Hampton, L.I., July, 3; East Islip, L.I., no date, 1; Farmingdale, L.I., June, 2; Flatbush, L.I., June, 36; Forest Park, Queens, June, 1; Gowanda, June, 1; Hyde Park, June, 3; Ithaca, June–August, Coy Glen, August, Six-Mile Creek, August, 40; Jamesburg, July, 1; Darner (near Albany), August, 1; Sancaster, June, 1; Massapequa, L.I., no date, 3; Mosholu, no date, 1; Mt. Kisco, July, 1; New York City, June, 5; North Castle, June, 3; Olcott, July, 12; Packville, L.I., June, 8; Peekskill, June, 1; Port Jervis, July, 5; Ramapo, July, 1; Riverhead, June, 1; Salamanca, July, 5; Scarsdale, July, 2; Southold, L.I., June, 4; Staatsburg, June, 10; Tompkins Co., McLean Bogs, June, Six-Mile Creek, July, Taughannock, August, 8; Ulster Co., Slide Mtn., June, 4; West Point, 2; Whitehall, June, 6. *North Carolina:* State label only, 2; Aiken, June, 16; Black Mts., June, 61; Blue Ridge Parkway, July, 3,500′, July, 21; Cherokee, June, 2; Doughton Park, June, 12; Franklin, 2,000′, June–July, 12; Graybeard Mt., June, 1; Highland, July, 3,800′, June, Whiteside Cove, 2,900′, June, 4; Jackson Co., 3 mi. SW Cashiers, 2,700′, June, 68; Linnville, 3,500′, July, 10; Mitchell Co., no date, 3; Round Knob, June, 1; Southern Pines, May, 1; Swannonoa Valley, June, 1. *Ohio:* State label only, 1; Amherst, July, 1; Ashtabula Co., Jefferson, Aug., 1; Delaware Co., July, 1; Fairfield Co., August, 1; Greene Co., June, 3; Hocking Co., June, 26; Lucas Co., June, 1; Marietta, June, 1; Wayne Co., Wooster, June, 2. *Pennsylvania:* State label only, 6; Allegheny Co., no date, 7; Angora, June, 1; Clarks Valley, June, 1; Cove Mt., July, 1; Crisp, no date, 3; Easton, July, 11; Glenolden, June, 26; Hanover, June, 1; Heckton Mills, July, 1; Jeannette, May–July, 121; Lashley, July, 6; Lehigh Gap, July, 1; Lime Park, no date, 1; Overbrook, June, 1; Philadelphia, June, 6; Pittsburgh, June–July, 15; Water Gap, no date, 3; Westmoreland Co., July, 1. *Rhode Island:* East Greenwich, July, 1; Washington Co., July, 1; Watch Hill, July, 2; Westerly, no date, 1; Woods Hole, July, 4; Batesburg, May, 4. *Tennessee:* State label only, 1; Crabtree, July, 14; Cumberland Co., Black Mts., no date, 1; Great Smokey Mt. Nat. Park, June, 6,500′, July, 4; Lookout Mtn., no date, 2. *Virginia:* Cobham, no date, 1; Falls Church, June–July, 11; Farmville, June, 6; Floyd, June, 15; Laurel Fork, June, 1; Massanutten M., Waonage Peak, June, 1; Pennington, no date, 1; Pennington Gap, no date, 3; Shenandoah National Park, 1,600–1,800′, July, Big Meadows, July, Blue Ridge, 3,000′, July, Lesic Falls, July, 20. *West Virginia:* White Sulphur Springs, July 5. *Wisconsin:* Bayfield, no date, 1.

DISCUSSION.—Variation in color is considerable. The usual coloration is pale yellow, but frequently specimens are taken in which the coloration is yellowish brown. On rare occasions specimens are encountered in which the color is very dark piceous throughout. Such a series of dark-colored specimens constituted Casey's *tenebrosa*. The ocular index varies from 44 to 54 with no apparent difference in the value of this character between the sexes.

ACKNOWLEDGMENTS.—I owe special thanks to the following: Leland Chandler, Purdue University, allowed me access to the Blatchley Collection; P. J. Darlington, Jr., Museum of Comparative Zoology, permitted me to examine the Melsheimer material; and T. J. Spilman, United States National Museum, granted me permission to study the Casey and Schwarz types.

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2.0010 Isomira (Coleoptera, Alleculidae) of eastern North America

ABSTRACT.—Four of the several species of eastern North American *Isomira* are: *I. valida* Schwarz (with *I. similis* Blatchley as a synonym); *I. texana* Casey; *I. pulla* (Melsheimer) (with *I. ignora* Blatchley as a synonym); and *I. sericea* (Say) (with *I. tenebrosa* Casey as a synonym).—J. D. Marshall.

Descriptors: Coleoptera; Alleculidae; eastern North America; Isomira.

Data Documents for Systematic Entomology

The following articles are available to specialists in complete form or as abstracts from The Institute for the Study of Natural Species (ISNS), 550 Elston Road, Lafayette, Indiana 47905, U. S. A. Copies are deposited in other Data Document centers as well. These documents are in addition to Data Document numbered articles and abstracts published in other sections of Entomological News.

Data Document numbers.—A number is assigned to all *original* documents in the Data Document files. The prefix number 3 is given to these typescripts. If the entire document, or an abbreviated document with some data held in the file as indicated in the published paper, is published, this record is prefixed by 3. Published or filed abstracts of these documents are prefixed by 2, indicating that the complete typescript is available. Titles and descriptors are prefixed by the number 1, indicating, however, that abstracts and complete documents are available from the Data Documents for Systematic Entomology document center. All unnumbered items published are news announcements only and are not filed or indexed further by descriptors. All numbered and indexed records may be retrieved from computer storage by requests using numbers or descriptors.—R. H. A.

2.0021 Three previously unrecognized New World species of Oxacis (Coleoptera: Oedemeridae).—The following three species are described for the first time:

Oxacis marianna, new species. Male. This species is easily distinguished from *O. nitidicollis* (type loc., Oaxaca, Mex.) by the immaculate pronotum. It is shiny and the elytra are rounded posteriorly which makes it quite distinctive. In general appearance it resembles *Xanthochroina bicolor* (type loc., Oregon), but it is definitely an *Oxacis.* Type locality: Miami Range Station, Mariposa Co., California.

Oxacis triados, new species. Male. The merging of the pronotal markings into a triangle occupying the major portion of the disc is the most obvious recognition feature of this species. The surface is shiny and the fuscous staining of the otherwise cream buff body is diagnostic. It resembles *O. nitens* (type locality Grand Canyon, Arizona) in general habitus. Type locality: Simia Trinadad.

Oxacis fuscus, new species. Male. The moderately elongate body, uniform fuscous color, and the slightly raised elytral costae distinguish this species from most of the others of the genus. It is most similar to *O. xerensis* (type loc. Punta Prieta, Baja California, Mex.) but it may be easily separated from that species by the presence in *O. fusca* of coarse pronotal punctation and finer pubescence; the sides of the pronotum are only slightly constricted in this species in contrast to the more strongly constricted condition in *O. xerensis.* Type locality: La Valle, Mendosa, Argentina.

Data Document Center, ISNS, 6 pp.—R. H. ARNETT, JR.

Descriptors: Coleoptera; Oedemeridae; Oxacis; California; Trinidad; Argentina; dist.; ills.; keys.

1.0025 Asymetric Papilio and Colias, by ARTHUR M. SHAPIRO, Department of Entomology and Limnology, Cornell University, Ithaca, N. Y. 14850 (Data Document Center, ISNS, 1 p.).

Descriptors: Lepidoptera; Papilionidae; Pieridae; Papilio; Colias; abnormalities; illus.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

The 14th International Congress of Entomology.—A preliminary circular giving information on the Congress will be issued in May, 1970. Anyone wishing to receive this circular should write to the Secretary of the Congress, who will be pleased to answer enquiries. The address is: MR. C. N. SMITHERS, Secretary, 14th International Congress of Entomology, The Australian Museum, 6–8 College Street, Sydney, N.S.W., Australia, 2000.

The Insects of Virginia.—A new series of bulletins with this title has been initiated by Michael Kosztarab of the Department of Entomology, Virginia Polytechnic Institute, Blacksburg, Virginia. The objective is to provide a systematic treatment including records on biology and ecology of the different insect orders and families in Virginia. The general policy for the series is described in the introductory article of the first bulletin. Only the results of unpublished, original research dealing with insects in Virginia can be printed in this series. The Board of Review includes James McD. Grayson, Richard L. Hoffman, and Michael Kosztarab. Manuscripts should be submitted to Dr. Grayson. One hundred reprints of bulletins are offered free to authors. Publisher is the Research Division, Virginia Polytechnic Institute.

The bulletins are printed with a yellow cover in a uniform style and size so that several may be bound together in a book form. The tiger swallowtail butterfly, collected in "Virginia" and the first insect to be described from North America, symbolizes the series; and appears on the cover of each bulletin.

The first issue (September 1969) includes two titles: I—Introduction to the series of bulletins on the insects of Virginia, with a literature review, by Michael Kosztarab; II—The biotic regions of Virginia, by Richard L. Hoffman. The second issue (October 1969) was written on the "Mosquitoes of Virginia" by William J. Gladney and E. Craig Turner, Jr. This latter article deals primarily with the distribution and bionomics of each species in Virginia, since excellent references are available on their taxonomic treatment.

Both bulletins will be sent free on request from the Publication Office, 405 Hutcheson Hall, Virginia Polytechnic Institute, Blacksburg, Virginia 24061. Exchanges are encouraged.—RELEASE BY PUBLISHER.

Entomological News ranked 14th as a primary or core journal seen and used by respondents to the Entomological Society of America questionnaire, "A system designed entomological data center," sent out a year ago by their special Committee on Information Retrieval.—R. H. A.

Nomenclature notice.—Possible use of plenary powers by the International Commission on Zoological Nomenclature is announced for the following cases pertaining to insects and spiders, the case number in parenthesis: (see Bull. Zool. Nomencl.

26, pt. 2, 8th August, 1969 and pts. 3/4, 24th October, 1969): Acarina (1864) suppression of *Acaris telarois* Linnaeus, 1758, and of neotype designation for that species; Arachnida (1881) type-species for *Platybunus* C. L. Koch, 1839; Insecta, Orthoptera (1650) type-species for *Poekilocerus* Audinet-Serville, 1831, and *Pamphagus* Thunberg, 1815; grant of precedence to Pyrgomorphidae Brunner von Wattenwyl, 1874, over Poekilceridae Burmeister, 1840, and Phymateidae Burmeister, 1840; Lepidoptera (1876) type-species for *Agrotiphila* Grote, 1875; (1876) suppression of *Papilio saportae* Huebner, 1828–1832; Coleoptera (1882) type-species for *Rybaxis* Saulcy, 1876; Diptera (1885) suppression of *Scaeva arcuata* Fallen, 1817. Send comments in duplicate, citing case number, to the Secretary, International Commission of Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.—W. E. CHINA, *Assistant Secretary.*

3.0004 Hazards of Insect Collecting.—For the past number of years I have been conducting some experiments with various kinds of simple light traps for night flying insects, chiefly moths, at a location about half way up the slopes of Hanging Rock Mountain (el. 5,237 ft.), Watauga County, North Carolina, at an elevation ca 4,000 feet.

On Saturday July 5, 1969 I used a light blue black light tube which surprisingly attracted literally thousands of various sized moths, from micros to macros such as Lunas, Sphinx's, and many Cercropias. This is fine for quantity, but for an entomologist it seemed similar to a large swarm of bees flying around one's head. Around 11 o'clock a moth (Noctuidae) flew to my ear and unfortunately began to move in. The moth kept going deeper inside my ear in spite of my quickest efforts to extract it. Heavy and loud sounds like the motor of an airplane or tractor began to emit within my hearing apparatus. I knew that I had to do something immediately as the live moth had reached the tympanic membrane and I was concerned about tympanic trauma. Anxiety and pain developed each time the moth fluttered. The first aid kit contained no tweezers, oil, or anything that might be safe to kill the moth and not injure the ear. Finally my wife used hot salt water and after several applications killed the moth—but could not extract it. Everything settled down now without pain or anxiety so I waited until Monday July 7 when we arrived back in Raleigh to see an ear specialist who extracted the moth which measured 20 mm wing spread and 15 mm length. Besides all the pain and the doctor's fee the hazards of collecting moths became apparent. Now I wear ear plugs or ear-muffs to keep insects out of my ears if they are swarming around black lights like bees!

Dr. Ross Arnett, Purdue University, states that they have had the same experience and now carry ear oil and recommend cotton ear plugs under similar circumstances in the field.—DAVID L. WRAY, Systematic Entomologist, Entomology Division, N. C. Dept. of Agriculture, Raleigh, North Carolina 27602. *Descriptors:* collecting; medical; moths; Lepidoptera; black light; technique.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

3.0009 The Animal World of Germany: Gregarines parasitic in Arthopods.—This publication,[1] a part of the series "The animal world of Germany and adjacent nearby sea according to their characteristics and mode of life," deals with gregarines which are parasitic in arthropods. The treatment of the subject is divided into two sections. The first, general discussion, deals with such topics as morphology of gregarine bodies, fine structure of the plasma membrane, development and growth of the sporozoite, reproduction, and pathogenesis. The section, thirty-five pages in length, concludes with several paragraphs about the materials and methods used in this study.

The second section is concerned primarily with the taxonomy and identification of the Gregarinida. Dr. Geus recognizes the Gregarinida as a subclass with two orders: Eugregarinida and Schizogregarinida. His study in this volume deals only with members of the first order. In a series of tables the author presents keys to the families, genera and species. The bulk of the second section (and of the book) is devoted to descriptions of these sporozoa found in middle Europe. The text contains line drawings and literature citations for each species. Included are the descriptions of new genera and species.—JOHN M. FERRIS, *Department of Entomology, Purdue University, Lafayette, Indiana.*

Descriptors: Gregarines; parasites of arthropods.

3.0017 World Crop Protection.—The authors of this volume[2] have undertaken a tremendous task to survey the major pests and diseases of world crops and methods that are being used to combat them. Dr. Lee Ling, in his foreword, states "Even a long journey starts with a first step. . . ." Unfortunately the road is long and many steps are required. This volume will at least serve as a pathfinder to any other intrepid souls who are willing to tackle the Herculean labors of detailing the pests that effect our food production.

This volume should be required reading for all parties involved in the current DDT squabble. Every crop mentioned, with the possible exception of citrus, require either DDT or BHC to control the insect pests! Without these chlorinated hydrocarbons there evidently would be no control sections in the book, and probably no control in the field.

The authors state they have limited the book to the principal crops (apple, banana, barley, citrus, cocoa, coconut, coffee, cotton, grape, maize, oats, oil palm, olive, peach,

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[1] GEUS, ARMIN. 1969. Sporentierchen, Sporozoa Die Gregarinida. V. E. B. Gustav Fischer, Verlag Jena, v. 57, 608 pp., 338 figs.

[2] STAPLEY, J. H. and GAYNER, F. C. H. 1969. World Crop Protection, vol. 1, CRC Press, Cleveland, Ohio, 44128, 270 pp., cloth, $18.50.

potato, rice, rubber, sorghum, sugar beet, sugar cane, tea, tobacco) of the world, however, some other important agricultural crops have been omitted, i.e., groundnuts or peanuts, pineapple, mango, forage crops, legumes, grasses, tomatoes, crucifers and many other vegetable crops. The text is concise and nontechnical. The authors have had considerable experience in Europe, the Middle and Far East and Africa, resulting in a rather thin treatment of the pests of the Western Hemisphere. There is a lack in depth in listing or describing pests of certain crops. A recent work lists 74 major citrus pests, in contrast to a total of 29 citrus pests mentioned in the text.

The authors have attempted to bring together "the whole subject within the confines of one single volume . . . to be of value to agricultural research institutes, university departments of agriculture, agricultural colleges and to students of agriculture and horticulture in different parts of the world . . . a quick reference to pests and diseases of crops, their distribution and importance." Though they did not reach their goal, they have brought together under one cover a general review of the world wide pest problem, with suggested (in cany cases obsolete) control methods. This text does provide one with "a better understanding of the importance of crop pests and diseases in the world today." It is a good reference book.—EUGENE J. GERBERG, *Insect Control & Research, Inc., Baltimore, Maryland 21228.*

Descriptors: Crop protection; DDT; BHC.

3.0027 The Brown-tail Moth.—About three decades following the introduction of the Gypsy moth, a familial relative, *Nygmia phaeorrhoea* (Donov.), the Brown-tail moth appeared in North America. Both species threatened to become widespread destructive pest species and during the ensuing years were subjected to rigorous controls. A reprint [3] of the history of this moth comes as a timely reminder that, with restrictions on convenient chemical suppression techniques, we are again confronted with the likelihood of invasion to new and broader geographic areas. Two chapters lead up to the rationale for the book—a facsimile of an eighteenth century paper. The opening chapter presents a professional biography of the eminent naturalist William Curtis. It is followed by entomological notes which bring the reader up to date on distribution, outbreaks in Europe and North America and control programs.

The finale is a facsimile of Curtis's 1782 article on the Brown-tail moth. An epiphytotic of this tussock moth had aroused the press to suggest that the caterpillars were presaging the plague, would fill the air and destroy all the vegetation thus starving the cattle. Curtis responded with his natural history paper to allay the imaginary terrors of the public. Without the advantage of professional entomologists, or a large bank of information, he demonstrated phenomenal insight into ecological problems at a time when integrated systems were not recognized or studied. He discussed life history, host preference, feeding behavior and natural control mechanisms. A semiquantitative notion of numbers is even given in his description of the Clapham parish where 80 bushels of webs were collected in one day (collectors received about 14 cents per bushel).

The Short History is touted as a pioneer essay in economic entomology and indeed its general format was followed by numerous governmental reports on pests in

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[3] CURTIS, WM., 1969 (reprint). A short history of the Brown-tail moth. (With an introduction by W. T. Stearn and entomological notes by D. S. Fletcher.) Entomological Reprint Specialists, P.O. Box 207, East Lansing, MI 48823. Cloth, $9.30.

America. It was exceptional in its time, showing careful observation, good intuition, and an integration of knowledge from other disciplines. Published as a private paper, it is generally unavailable; certainly it is appropriate to have it reprinted. Perhaps the only flaw is the horrible color registration on the single plate. Considering the normally excellent quality of antique British prints of the era, most of which were hand colored, one suspects this is a modern error.

The book is worthy as a historic document and provides delightful reading.—Ronald L. Giese, *Department of Entomology, Purdue University, Lafayette, Ind. 47907.*

Descriptors: Brown-tail moth; Lepidoptera; Nygmia phaeorrhoea; epiphytotic.

New journal.—"Cicindela, a quarterly journal devoted to Cicindelidae" published by Ronald L. Huber, 11921 Champlin Road, Osseo, Minnesota 55369. $3.50 for each annual volume.

Volume 1, numbers 1 to 4 have been received, dated 1969. They contain keys to genera, keys to some species, illustrations, checklists, and notes on morphology, distribution, habitats, and behavior.

Publications received.—The following annotated list of publications have been received for notation in this section. Papers dealing only with taxonomic changes and additions that will be fully indexed in *Zoological Record* are not included. The notations are designed to bring attention to features of the publication that may not be apparent from the title.

Behavior

Alexander, Richard D. and Daniel Ottle, 1967. The evolution of genitalia and mating behavior in crickets (Gryllidae) and other Orthoptera. Misc. Publ., Mus. Zool., Univ. Michigan no. 133, 62 pp.

Introduction contains general information on sexual behavior, especially during copulation, relating to insects in general as well as the specific topic. The evolution of the groups of Orthoptera is discussed.

Andrews, Sir Christopher, 1969. The lives of wasps and bees. American Elsevier Publ. Co., Inc., 204 pp., pls. $5.75.

Eberhard, Mary Jane West, 1969. The social biology of Polistine wasps. Misc. Publ. Mus. Zool., Univ. Michigan no. 140, 101 pp.

In addition to the definitive behavioral study of two species of *Polistes*, considerable data is presented to show the origin of the genus.

Pace, Ann E., 1967. Life history and behavior of a fungus beetle, *Bolitotherus cornutus* (Tenebrionidae). Occ. Pap. Mus. Zool. Univ. Michigan, no. 653, 15 pp.

Important details previously unavailable to students of behavior and Tenebrionidae sheds new light on the speciation of the group. The significance of sound production during mating remains unstudied.

Identification Aids

Diptera

Hall, Jack C., 1969. A review of the subfamily Cylleniinae with a world revision of the genus *Thevenemyia* Bigot (*Eclimus* auct.) (Diptera: Bombyliidae). Univ. California Publ. Ent., 56, 85 pp.

Johannsen, O. A. (part V by Lillian C. Thomsen), 1969 (reprint). Aquatic Diptera. Entomological Reprint Specialists, P.O. Box 207, East Lansing, MI 48823, 370 pp., 757 figs. Cloth $11.25.

Hymenoptera

Timberlake, P. H., 1969. A contribution to the systematics of North American species of Synhalonia (Hymenoptera, Apoidea). Univ. California Publ. Ent., 57, 76 pp., incl. 80 figs. Paper, $3.00.

Lepidoptera

Forbes, William T. M., 1969 (reprint). The Lepidoptera of New York and neighboring states (part 1: primitive forms; microlepidoptera; Pyraloids; Bombyces). Entomological Reprint Specialists, P.O. Box 207, East Lansing MI 48823, 729 pp. Cloth $17.50.

Mosher, Edna, 1969 (reprint). Lepidoptera pupae; five collected works on the pupae of North American Lepidoptera. Entomological Reprint Specialists, P.O. Box 207, East Lansing, MI 48823, vii + 323 pp. Cloth $9.95.

Schmid, Michael and Bradford M. Endicott, 1968. Mariposas de Venezuela. Entomological Reprints Specialists, P.O. Box 207, East Lansing, MI 48823, xi + 67 pp., 142 color illus. Bound $9.95.

Beautiful color photographs and short descriptions of showy butterflies and moths of Venezuela, in Spanish and in English.

Information Retrieval

Committee on Scientific and Technical Communication, 1969. Scientific and Technical Communication, National Academy of Sciences, Washington, D. C., xiii + 322 pp. Paper, $6.95.

A pressing national problem, the information explosion, is discussed with recommendations for its solution.

Local Society Publication

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ENTOMOLOGICAL NEWS

Vol. 81 MARCH, 1970 No. 3

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3.0016 SEXUAL DIMORPHISM IN THE HEAD STRUCTURE OF MUTILLIDAE HYMENOPTERA: A POSSIBLE BEHAVIORAL EXPLANATION[1]

Joseph K. Sheldon[2, 3]

A striking sexual dimorphism involving modifications of the clypeus of males occurs in many species of Mutillidae. This dimorphism is especially pronounced in members of the genus *Timulla*, and is often diagnostic of the species (Mickel, 1937). For example, most of the lower median clypeal surface of *T. vagans* (Fabricius) forms a shallow, smooth, transverse concavity, while the upper median margin is elevated into an arcuate ridge which slopes smoothly into the concave area (Fig. 1). In males of *T. dubitata* (Smith), however, the smooth concave portion does not extend as far laterally, and the ridge rises more abruptly (Fig. 2). In addition to these specializations, the males of some species show a modification in the basic structure of the mandibles. Those of *T. vagans*, for example, are strongly excised beneath, have a large tooth near the base, and have the dorsal surface flattened (Fig. 1). In *T. dubitata* the excised area is absent, the tooth is poorly developed, and the dorsal surface lacks the large flat area (Fig. 2). To my knowledge no attempt has yet been made to provide a functional explanation for these peculiarities of structure. A recent observation of a portion of the courtship behavior of *T. dubitata* has suggested that the adaptive value of the peculiar head modifications of the males of some mutillids may be found in a study of the details of their reproductive behavior. A survey of the scanty literature dealing with this behavior in mutillids provides additional support for this idea.

The first significant report of courtship in the Mutillidae was by Bischoff (1927), who stated that mating in mutillids takes place in flight. The method of carriage was not mentioned. Crevecceur (1930) presented a detailed description of the mating behavior of the European species *Smicromyrme rufipes* Fabricius. He reported that mating in this species

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[3] I wish to express my thanks to Dr. Ellis G. MacLeod for his constructive criticism of the manuscript; to Mrs. Alice Prickett, staff artist for the School of Life Sciences, who prepared the figures; and to Dr. Arnold S. Menke for his help in determining the Mutillidae.

occurs on the ground, although the male often flies some distance with the female grasped in his mandibles prior to copulation. Well developed mandibular teeth are present in this species and apparently aid in grasping the female. Crevecceur stated that the male tries to grasp the female's pronotum with his mandibles and catch its lateral boarders with the mandibular teeth. Immediately preceding copulation in this species the male, carrying the female in his mandibles, climbs a small herbaceous stem and it is there that copulation takes place.

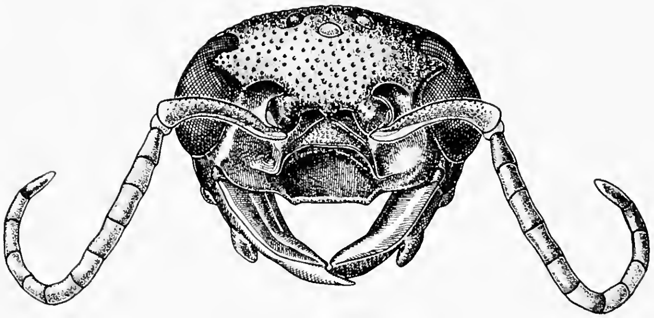

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FIG. 1. Head of male mutillid wasp *Timulla vagans* (Fabricius). FIG. 2. Head of male mutillid wasp *Timulla dubitata* (Smith).

Only two observations of the mating behavior of American Mutillidae have been reported. Linsley (1960) observed a mating pair of *T. oajaca* (Blake) in which the male was carrying the female in flight by means of his legs and affixed genitalia. He did not mention any use of the mandibles. A more detailed account of the courtship behavior of *Sphaeropthalma blackeii* (fox) was presented by Ferguson (1962). When a virgin pair of this species was confined under a 65 mm diameter petri dish the male, upon overtaking the female from the rear, "climbed on her back, seized her neck region with his mandibles, and her body with some of his legs." He then prodded the tip of her abdomen with his extruded genitalia.

During the summer of 1967 at Mason State Forest, near Havana, Illinois, I observed an attempted mating of *T. dubitata.* Upon capturing a large male, which had been flying at a height of about three feet, I discovered that it was carrying a female less than half its size in its mandibles. The female was grasped by the male's mandibles in her cervical region (Fig. 3). Whether or not his legs were used to support her while in

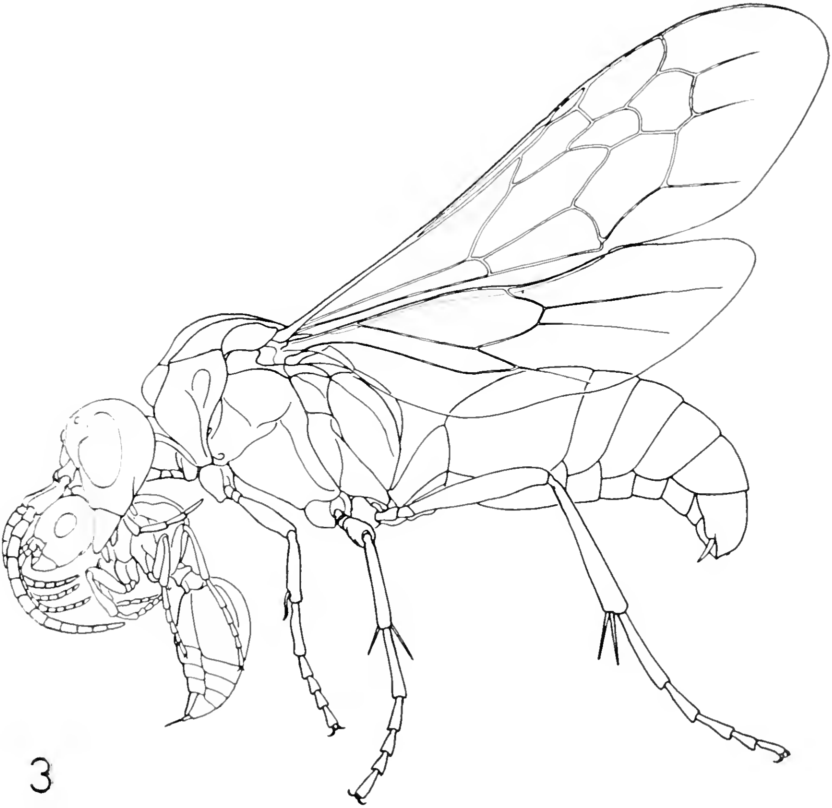

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Fig. 3. Mandibular carriage in *Timulla vagans* (Fabricius)—as preserved, the male (winged) having been pinned. The relative positions of *Timulla dubitata*, discussed in the text, are the same. The specimens illustrated here were collected by H. A. Scullen at Ames, Iowa and are located in the Oregon State collection.

flight was not observed. Shortly after the pair was placed in a 2 dram vial, the male began copulatory attempts while still grasping the female in his jaws. These attempts consisted of shaking the female from side to side violently five or six times and then stroking her sides with his fore legs while standing on his middle and hind legs. After a few seconds of stroking he curved the tip of the abdomen down and forward and prodded the tip of the female's abdomen, apparently attempting to induce her to open her genital chamber. After a few seconds of unsuccessful prodding the sequence was repeated. During the prodding the male's antennae were extended forward over the female's head and were bent down and back so as to press against her venter. Occasionally his antennae were lifted straight up and held rigid. After several minutes of futile attempts the male dropped the female.

DISCUSSION

The importance of the concave clypeal surface of the male becomes apparent when the details of the mandibular carriage of the female by the male are examined. In *T. dubitata*, when the male grasps the female's cervix with his mandibles the convex postocular ridge of the female rests against the male's concave clypeus. This adaptation serves to reduce a point of friction and may, in fact, "lock" the female into the correct position for subsequent steps in the behavioral pattern.

Once the behavior pattern of grasping the cervix of the female by the male's mandibles has arisen in a species, this behavior could serve as a preadaptive step for a whole series of additional morphological changes aimed at improving or modifying the details of this carriage. The parts most directly involved, the face and the mandibles, should be the areas to undergo the most change. The evolutionary step from simply picking up the female as a courtship manoeuvre to flying with her as a portion of the full epigamic behavior is easily understood when the reproductive advantage of dispersal is considered.

In a recent paper dealing with phoretic copulation in Hymenoptera, Evans (1969) suggested that the dispersal capacity which seemingly has been lost in the groups with wingless females is maintained in some species by the male carrying the female in flight during copulation, by means of their affixed genitalia. He argued that this phoretic behavior should have a high selective advantage, since it would enable the dispersal of the wingless females to new, unexploited populations. He presented examples of such behavior from the Bethylidae and thynnine and myrmosine Tiphiidae, and noted that phoretic copulation may also occur in *Timulla*

(Mutillidae). Evans' arguments for the selective advantage of genitalic transport in these wasps should hold equally well for the mandibular carriage discussed in this paper.

The full extent to which the male's mandibles are utilized in the courtship of Mutillidae is unknown. Considering the details of the structure of the head, however, it would seem unlikely that extensive use is made of mandibular carriage in certain groups. For example, in *Dasymutilla occidentalis* (Linnaeus) there are no obvious modifications of either the mandibles or the clypeus which would suggest such usage; indeed, there is a pair of horn-like projections arising from the clypeus in the same area which is concave in species of *Timulla*. These projections would seem to interfere with the male's grasping the female in the manner of *T. dubitata*. At the present time information about the courtship behavior of only a few species of *Smicromyrme*, *Sphaeropthalma*, and *Timulla* is known. In these species we now know that there is a close correlation between certain aspects of their courtship behavior and the structure of the male's mandibles and clypeus. It is likely that a study of the morphology of these structures in species of other genera will predict information about their courtship behavior.

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2.0016 Sexual dimorphism head structure Mutillidae possible behavior explanation.

ABSTRACT.—The presence of a marked sexual dimorphism involving the surface of the clypeus and the mandibular structure occurs in males of certain genera of Mutillidae. These modifications appear to be correlated with a portion of the courtship behavior in which the male grasps the female with his mandibles. In some species the male is known to carry the female in flight while grasping her in his mandibles, thus providing a means of dispersal otherwise unavailable to the wingless females.—J. K. SHELDON

Descriptors: Hymenoptera; Mutillidae; Head; Sexual dimorphism; behavior.

3.0020 Notes on the Palaearctic Grasshopper, Meconema thalassinum (De Geer), (Orthoptera: Tettigoniidae: Meconematinae) Established in Long Island, New York[1]

D. E. Johnstone[2]

An unusual tettigoniid was recently discovered in a group of miscellaneous insects collected for the Lyman Entomological Museum at King's Park, Suffolk County, Long Island, New York, August 2, 1968, by R. M. Emberson. The specimen, a slightly teneral adult male, was determined by Dr. D. K. McE. Kevan as *Meconema thalassinum* (DeGeer) Figs. 1 & 2).

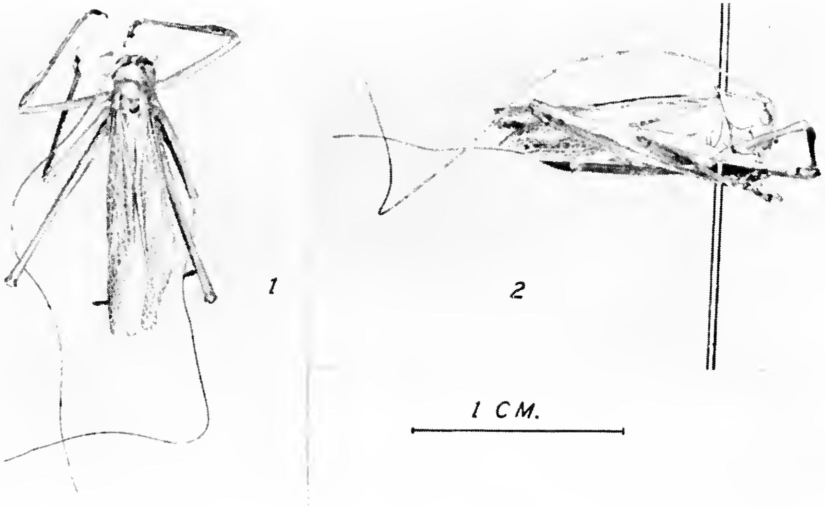

FIG. 1. *Meconema thalassinum* (DeGeer), male, dorsal view; FIG. 2. *Meconema thalassinum* (DeGeer), male, lateral view.

The previous records in North America, by A. B. Gurney (1960, 1960a), include two males, two females, July and August 1957; one female

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[1] Accepted for publication February 7, 1970.

[2] Lyman Entomological Museum, Macdonald College of McGill University, Macdonald College, P. Q., Canada.

and one male July, 1959; all collected by John K. Terres at Little Neck, close to the border of Queens and Nassau counties, Long Island, New York. The specimen recorded here indicates that *M. thalassinum* is established and has increased its distribution on the island.

The genus *Meconema* is not native to the Nearctic or Neotropical fauna. *M. thalassinum* is widely distributed in Europe. The Meconematinae, a very small group, has been ranked at various levels by several authors but was placed as a subfamily by Ragge (1965) (see also Beier, 1966). There are but two additional species of *Meconema*, *M. meridionale* Costa, 1860, found in southern Europe, and *M. subpunctatum* Motschoulsky, 1866, from Japan. There is some doubt concerning the true status of the latter species.

No Nearctic records of *M. thalassinum* are known other than the present one and those recorded by Gurney (1960, 1960a).

M. thalassinum is arboreal, frequenting a variety of deciduous trees, including oak. In England, the common name for this species is Oak Bush Cricket (Kevan, 1952, 1961; Ragge, 1965). The Long Island property of Mr. John K. Terres contains introduced trees and shrubs, and introduction into the United States could well have been by eggs deposited in imported plant material (Gurney, 1960). The female oviposits within the uneven surfaces of tree bark and among lichenous material covering the trunks of trees (Lucas, 1912, fig. 3; Chopard, 1938; Gurney, 1960; Ragge, 1965).

The insect is nocturnal and, in England, maturity is reached during the latter part of July and in August. Its life-span is relatively long, often enabling it to survive until late fall months.

Some confusion exists as to the feeding habits of this tettigoniid. Ragge (1965) states that it chooses principally animal matter upon which to feed, such as small insect larvae and aphids, but, in captivity, leaves are apparently accepted although survival is poor. This is at variance with Currie (1953), who stated that it could easily be kept in captivity devouring readily leaves of oak, rose and birch. Currie (*op. cit.*) had also observed it in the field, feeding upon sawfly larvae. Lucas (1912) reported this species to be occasionally carnivorous. It is apparently omnivorous, like many nemobiine crickets, and this may also contribute to its seasonal longevity.

The principal morphological characters of *M. thalassinum* are the tegmina of the male, which resemble those of the female and lack the characteristic sound-producing organs of most other males of the Tettigoniidae. Although small, fine teeth are found close to the inner tegminal margin, the exact function of these has not been determined. The veins in this area are not specialized. The insect does, however, stridulate in a unique manner. A male erects its tegmina and hind wings above the body, while the abdomen is vibrated extremely rapidly and could possibly be struck repeatedly against a leaf or twig upon which the insect is situated. Many of those who have attempted to study this aspect of behavior of *M. thalassinum* are doubtful that the abdomen is necessarily brought into contact with any surface. Currie (*op. cit.*), who assiduously observed drumming phases over a period of time, stated that the body is raised and that any part of the abdomen which contacted anything during the vibratory phases would be the subgenital plate or the cerci which he described as being depressed. (See also Kevan, 1954.)

However, Ragge (1965) states that the first tarsal joint of the hind leg of the male, which is provided with a hard, specialized area, is used to strike against the substratum in a manner causing a vibrating sound, the other hind leg being extended for support. The abdominal movements occur simultaneously, and normally without contact with any surface. An audiospectogram of the sound pattern of *M. thalassinum* is clearly depicted by Ragge (1965, fig. 38), showing that the stridulation is muted, unvarying in pitch, and occurs in short, extremely rapid pulses, the first few brief pulses lasting a little over ½ second, followed by 1 second pulses with 2 to 2½ second periods of silence between each pulse.

The specimen at hand, from Long Island, is faded, but the dorsal, yellow, median stripe and the two oblong, brownish-black spots on the hind third of the pronotum are clearly defined. The sub-acute fastigium is abnormally depressed between the antennal sockets due to some shrinkage of tissue. The eyes are typically swollen and globular; the diagnostic, ovate-elongate auditory organs are clearly seen on the proximally expanded frontal tibiae; the cerci are typical of *M. thalassinum*, being conspicuously long, curved upward, with simple apices. The subgenital plate is short, apically truncate, and bears two small movable lateral appendages. The tegminal length from the hind edge of the pronotum, is approximately 11 mm. The length of the body from the frontal region of the head, and excluding the cerci, is 10 mm.

ACKNOWLEDGMENTS.—I wish to thank Dr. A. B. Gurney, who has informed me that he knows of no additional North American records for this species; Dr. D. K. McE. Kevan for determination of the specimen; Dr. V. R. Vickery for assistance with the manuscript; and Miss N. Brown for the typescript.

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2.0020 Palaearctic Meconema thalassinum in N. Y. (Orth., Tettigoniidae, Meconematinae)

ABSTRACT.—Records confirm the establishment of *Meconema thalassinum* (DeGeer), a Palaearctic species, in Long Island, New York.—R. H. ARNETT, JR.

Descriptors: Orthoptera; Tettigoniidae; Meconematinae; Meconema thalassinum; Grasshopper; Long Island, N. Y.; Introduced species; Palaearctic.

3.0022 Swarming in an Undescribed Enicocephalid (Hemiptera) from Costa Rica[1]

TOBY SCHUH[2]

In August of 1969, while collecting on the Cerro de la Muerte, Costa Rica, at an elevation of about 2,700 meters, I observed the swarming flight of a previously unknown species of *Systelloderes* which will be described by Dr. Pedro Wygodzinsky in a forthcoming revision. This phenomenon has been previously observed in the Enicocephalidae by Knab (1908), Johannsen (1909), Usinger (1945) and others and recorded for two species of *Didymocephalus* in Africa by Villiers (1963); however, little is known about the habits of the family and very few records on their biology are present in the literature.

My first observations were on August 2, 1969, in and around an uncut forest of *Quercus copeyensis* about 5 km SE of Villa Mills, Cartago Province. This forest type is the dominant vegetation at approximately 2,500–3,000 meters elevation on the Cordillera de Talamanca. It consists mostly of *Q. copeyensis* with occasional specimens of other species such as *Podocarpus* sp. The close spacing of the trees, which was seldom over 10 meters, coupled with high rainfall (about 2 meters annually) and cool temperatures (mean about 12° C) produced a very damp forest, luxuriant with mosses, ferns, orchids and bromeliads. Some low areas with standing water were present. Shafts of sunlight struck the forest floor through opening in the oak canopy which was about 25–30 meters in height.

At about 10:00 A.M. with a clear sky and a temperature of 16° C, swarms of what were thought to be chironomids were seen. After collecting some I determined that they were in fact enicocephalids. The numbers of individuals in each swarm were probably from 200–500; the largest swarms were observed in the forest, but smaller swarms were seen in cleared areas adjacent to the forest and in another open area at Villa Mills. The swarms themselves moved little in a horizontal plane and shifted from 1–2 to 3–4 meters above the ground. The flight of individuals was hovering and rather clumsy. Members of the swarms had two distinct types of movements: most of the time they seemed to maintain their relative positions with respect to one another; periodically the entire swarm went into a swirling-mixing movement, and a few individuals would drop from the swarm and then fly back up into it.

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[1] Accepted for publication February 7, 1970.

[2] Biological Sciences Group, U-43, University of Connecticut, Storrs, Connecticut 06268.

During the latter behavioral stage mating was apparently taking place. I was able to collect copulating pairs by standing under the swarms and allowing the individuals to land on me. Mating position was with the male and female oriented in the same direction and the male situated on top of and slightly to one side of the female. Of a total of 441 individuals collected, only 7 were females!

The forest was visited on August 5 to look for specimens and gather additional ecological information. The entire morning was spent searching possible habitats and no specimens were found. The only data on the habitat was collected by Douglas Futuyma on August 3, in the Oak Forest, where he found a few specimens in the forest floor litter layer which contained some mosses and ferns. Usinger (1945) comments that he encountered swarms of hundreds of thousands of individuals of *Systelloderes angustatus* (Champion) in Southern Mexico, but careful searching on subsequent days yielded only a very few specimens. Wygodzinsky (personal communication) notes that he has found rather large numbers of enicocephalids on and in the ground after swarming, but only with considerable effort. (The species referred to by Usinger as *S. angustatus* is actually undescribed and more closely related to the species discussed in this paper than to any other (Wygodzinsky, personal communication).)

Swarming in this species appears to involve a rather precise timing mechanism. Observations were made in the forest on August 2, 3 and 5; the insects were observed flying only on the first day. This does not negate the possibility that swarming did not take place on days previous to August 2, but since such large numbers were present on the one day and none on subsequent days I suspect that this was not the case. Usinger (1945) implies that swarming, as he observed it in Mexico, was of rather limited duration. Johannsen's (1909) observations of *S. biceps* (Say) over a considerable number of sequential summer evenings, would indicate, however, that some species may have "seasonal" swarming habits.

The observations of Knab (1908) and Usinger (1945) in southern Mexico and Johannsen (1909) in New York indicate that swarming took place in the evening just before sundown. My observations in Costa Rica show swarming taking place in the morning. If climatic (weather) factors are important in initiating swarming, it may be that it could not take place in the afternoon on the Cerro de la Muerte, because, at least during certain parts of the year (including August) torrential rains lasting throughout the afternoon are the rule.

Little information is available on reproductive behavior in the Heteroptera, but no records indicate mating behavior similar to that of the enicocephalids in other members of the order. Usinger and Matsuda (1959) cite records of what are apparently dispersal flights for California species of Aradidae, but do not indicate that these have any particular significance for mating. In the Enicocephalidae swarming definitely seems to involve mating and dispersal. This swarming has been likened to that of Nematocerous Diptera (Knab, 1908), and does in fact seem to be a very similar phenomenon.

Barring the possibility of a very specialized habitat which I may have overlooked, population density would appear to be low, judging from my sampling. I would think that the inability to find specimens in an area where apparently extremely large numbers are present is a result of cryptic coloration, seclusive habits, clumped distribution or an even redistribution after swarming, rather than the insects having mated, oviposited and died, which does not appear to be what happens in most Heteroptera.

This peculiar type of behavior in the Heteroptera further substantiates the isolated nature of the Enicocephalidae in the Heteroptera as indicated by the work of Cobben (1968) on the eggs of Heteroptera and that of Leston, Pendergrast and Southwood (1954).

ACKNOWLEDGMENTS.—I would like to thank Dr. Pedro Wygodzinsky of the American Museum of Natural History, New York, for his very generous and valuable advice and the Organization for Tropical Studies which made this work possible.

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2.0022 Swarming in undescribed Enicocephalid (Hemiptera) from Costa Rica

ABSTRACT.—The swarming behavior of the Enicocephalidae, unique in the Heteroptera, is discussed for an undescribed species of *Systelloderes* from the mountains of Costa Rica. Previous records of this phenomenon are cited.—T. SCHUH.

Descriptors: Hemiptera; Enicocephalidae; Systelloderes; swarming; Costa Rica; mating behavior.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

3.0005 A Note on Some Very Old Specimen Storage Vials.—In 1954 our Entomological Collections and facilities were moved from the first floor of the old Agriculture Building (Raleigh), where they had been for over thirty years, to the third floor of a new building annex housing the State Museum of Natural History. In the course of going over some old materials we came across a box of old glass vials containing specimens which we are fairly sure have not been opened since the date of collection. We were amazed that the fluid (grain alcohol) was still in all the vials. The vials were all much smaller in diameter than the kind we presently use (3 dram, patent-lip). Most vials measured 10 mm width by 59 mm height and had an indented neck. Black rubber stoppers had been used and these had become about as hard as the surrounding neck of the glass vial so that they could not be removed without breaking the whole vial. Evidently this adhesion of rubber to the glass had preserved the fluid in these vials for at least sixty-eight years! The specimens had no doubt been placed in these vials by Mr. Franklin Sherman, Jr., our first state entomologist who came to North Carolina in 1898. The labels were written in his characteristic handwriting. Small red-bordered labels with numbers were placed at the top of the vials and square white labels with collection data were attached below.

Out of the lot I picked out 8 vials as examples which I thought might be of interest to show the condition of the specimens, the collection data, and the amount of fluid remaining in the vials. The data for these vials is as follows:

1. "No. 321—Chilocorus bivulnerus, adult & larvae. From scale-infested peach. Gastonia, N. C., May 1, 1902, F. Sherman, Jr., collector." In good shape except larvae and adults dark in color; fluid full in vial.
2. "No. 206—Larvae from nest on chestnut tree. Highlands, August 6, 1901, Sherman, col." Larvae dark, fluid one-third full in vial. 1c.
3. "No. 165—Sannina exitiosa, 6 from one peach tree. Southern Pines, N. C., Jan. 8, 1902, Sherman, collector." Fluid in vial (full) and larvae in good shape, not darkened as others, 1c.
4. "No. 122—on pine, T. R. Manning, Henderson, N. C., May 13, 1901." Larvae in excellent shape showing stripes and markings very distinct; liquid full in vial.
5. "No. 119—Sawflies on pine, M. B. Prince, Henderson, N. C., May 10, 1901." Larvae in excellent shape, markings very clear; fluid in vial; rubber stopper hard as glass vial.
6. "Weldon, July 1903." Unnumbered vial, ca. 2.5 dram size, with 2 adult Neuroptera in fluid; excellent shape.
7. "On pine, Otto Katzenstein, Pinehurst, N. C., May 30, 1902." Larvae in excellent shape with clear markings; fluid three-fourths full in vial; rubber stopper as hard as glass vial neck.
8. "No. 336—Pupa from Exp. 4. 1902?." Pupa in excellent shape; fluid three-fourths full in vial; rubber stopper hard as glass vial.

The above information would indicate that with the use of rubber stoppers in comparison to cork specimens can be kept longer in fluid without serious evaporation. This conclusion is supported by my experience in recent years with the use of various kinds of neoprene stoppers. White neoprene stoppers are preferable to colored ones because of less discoloration to the fluid and/or the specimens due to chemical reaction caused by the fluid (grain alcohol or various mixtures) on the stoppers. Cork stoppers tend to either shrivel or deteriorate and become brittle with age.—DAVID L. WRAY, Division of Entomology, N. C., Department of Agriculture, Raleigh, N. C. 27602. *Descriptors:* technique; N. C. State Collection; storage vials.

3.0015 Loxosceles rufescens (Dufour) (Araneae: Scytodidae) in Pennsylvania.—On September 26, 1969, a Luzerne County housewife discovered a mature male *Loxosceles rufescens* (Dufour) in a new plastic pitcher purchased from a retail store in Wilkes-Barre, Pennsylvania. The plastic pitcher was introduced in a shipment from Chicago, Illinois, where *L. rufescens* is reported from the southern part of that state (Gorham, 1968. Coop. Econ. Ins. Rept. 18(10): 171–175, figs. 1–2). *L. rufescens*, although supposedly rare, was also taken from buildings in New York, New York, and from College Park, Maryland, the nearest localities to this record. Taxonomy and distribution records were given for United States *Loxosceles* spp. by Gertsch (1958. American Mus. Nov. (1907) 46 pp.).

Loxosceles spp. are small, light brown spiders, about ½ inch in length. The eye group consists of three diads arranged semi-circularly, with a dark brown fiddle-shaped marking on the mid-dorsal line, extending through the anterior median occular area. Specific determination is based on genital characteristics.

Although the brown recluse spider, *L. reclusa*, has been implicated as the main cause of necrotic arachnidism in the United States, other species of *Loxosceles* of both sexes have been shown to have similar cytotoxic effects in experimental animals (Micks and Smith, 1963. Bull. Ent. Soc. America 9(3): 174).

Fortunately loxoscelesism is a rare occurrence. However, with the widespread publicity of each reported case and with the behavior of these spiders lending themselves to easy transportation (Gertsch, 1967. Bull. American Mus. Nat. Hist. 136(3): 117–174), a constant vigilance should be maintained for all *Loxosceles* spp., with distribution records reported immediately.

Appreciation is extended to Dr. Charles Reif of Wilkes College who recognized the spider as Scytodidae, and brought it to the attention of the Supervising Sanitarian of the Wilkes-Barre State Health Center and to Robert Snetsinger, Ph.D., Assistant Professor of Entomology, Pennsylvania State University, who confirmed identification of *Loxosceles rufescens* (Dufour).—GEORGE WHITMYRE and WILLIAM WILLS, *Medical Entomologists, Office of Research and Demonstration Services, Bureau of Housing and Environmental Control, Department of Health, P.O. Box 90, Harrisburg, Pennsylvania 17120.*

3.0012 Three species of shore flies (Diptera: Ephydridae) previously unreported from Ohio.—Intensive collecting during September, 1969, around several highly saline pools at Rittman, Ohio (Wayne County) has resulted in the discovery of 3 species of shore flies not previously known from the state. The records also constitute significant range extensions for the 3 species.

The salt pools are just south of the city and were formed by drainage from a brine storage pool on the property of the Rittman Plant of the Morton Salt Company. Some drainage undoubtedly occurs also from the few brine wells scattered through the area. All pools are quite shallow and have muddy shores, as there is very little vegetation cover.

Ephydra cinerea Jones previously was reported only as far east as Texas and Utah, and *E. niveiceps* Cresson as far east as Kansas and Quebec (Wirth, 1965, USDA Agric. Handbook 276, p. 754). The first species frequently is abundant around saline lakes and seepage areas in the western states, whereas the second is usually found around freshwater habitats. The third species, *Atissa litoralis* (Cole), has been considered to be a rather scarce inhabitant of western saline lakes (Sturtevant and Wheeler, 1954, Trans. Am. Entomol. Soc. 79, p. 247; Wirth, *loc. cit.* p. 735) although Deonier (1964), Iowa State J. Sci. 39 (2), p. 120) recently has reported it from Iowa.

E. cinerea and *E. riparia* Fallén were by far the most abundant species in the area. Massive numbers of adults were present around all pools, and thousands of puparia were floating or submerged in the water or formed windrows along the shores. Only a single specimen, a male, of *E. niveiceps* was obtained. Numerous adults of *A. litoralis* were reared during late September from a floating mass of ephydrid, sphaerocerid, and syrphid puparia that had accumulated along one side of a small pool.

We wish to thank Mr. Richard E. Winkler, Office Manager of the Rittman Plant of the Morton Salt Company, for permission to collect on the property.—J. F. Scheiring and B. A. Foote, *Department of Biological Sciences, Kent State University, Kent, Ohio 44240.*

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

Biogeography

Holt, Perry (ed.) 1969. The distributional history of the biota of the Southern Appalachians, part 1: invertebrates. Research Division Monograph 1, Virginia Polytechnic Inst., viii + 297 pp.

Several groups are considered, including Mecoptera and the Carabidae of Coleoptera; includes drainage maps and a discussion of the Cenozoic era.

Karlstrom, Thor N. V. and George E. Ball (eds.) 1969. The Kodiak Island Refugium. Published for the Boreal Institute, Univ. Alberta, by the Ryerson Press, Toronto, xv + 262 pp.

The pleistocene period is discussed using illustrations from many groups including the Carabidae among the insects.

Genetics

Wheeler, Marshall R. (ed.), 1969. Studies in genetics, V. Univ. Texas Publ. no. 6918, 339 pp.

This volume contains 16 papers on the genetics of Diptera, mostly on species of *Drosophila*, including taxonomy, new species, radiation-induced dominant lethals, translocations, enzymes, interspecific hybridization, and behavior.

Pest Management

Mallis, Arnold, 1969. Handbook of pest control, 5th ed. McNair Dorland Co., 101 W. 31st St., N. Y., N. Y. 10001, 1158 pp.

MEMOIRS OF THE AMERICAN ENTOMOLOGICAL SOCIETY

No. 20. *Howard E. Evans*—A Revision of the Mexican and Central American Spider Wasps of the Subfamily Pompilinae (Hymenoptera: Pompilidae). 433 pages, 11 plates, 80 maps.....$12.50

No. 21. *Eric G. Mathews*—A Taxonomic and Zoogeographic Survey of the Scarabaeinae of the Antilles (Coleoptera: Scarabaeidae). 134 pages, 144 figures.............................$4.00

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No. 24. *Lee D. Miller*—The Higher Classification, Phylogeny and Zoogeography of the Satyridae (Lepidoptera). 174 pp........$7.00

No. 25. *Michael G. Emsley*—The Schizopteridae (Hemiptera: Heteroptera) with the description of new species from Trinidad. 154 pp. $6.50

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Bonnet: Bibliographia Araneorum. Vol. I of this classic monograph, which is essential to all research on spiders, has been reprinted. 832 pp., bound. $30.00. Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740, U. S. A.

Sharp & Muir: The Comparative Anatomy of the Male Genital Tube in Coleoptera. The classic 1912 monograph and six other papers by the same authors have been reprinted. 304 pp., 43 pls., bound. $10.00. An essential book for all coleopterists. Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740.

Bibliography of New Guinea Entomology (Gressitt and Szent-Ivany). Annotated, 6,140 references, through 1967; all fields of entomology: New Guinea, Bismarcks, Solomons; all subjects indexed. Pacific Insects Monogr. 18, 674 pp., map, 1968. $12.50 bound; $11.50 wrappers. Bishop Museum Press, Box 6037, Honolulu, Hawaii 96818.

For Sale: Goliath beetles, 14 different aberrations, 200 other species of beetles. Russell Dunn, Box 468, Sedona, Ariz. 86336.

Wanted: Live spiders to photograph their eyes. Earl Broderick, 5305 Douglas Dr., Yakima, Washington 98902.

Exchange Spanish Lepidoptera and Coleoptera. Pedro A. Talavera Torralba, Avd. Tirso de Molina, No. 1–4A, Cartagena (Murcia), Spain.

For sale: Books, periodicals, and reprints from private medical entomology library. C. B. Philips, PHS, Hamilton, Montana 59840.

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For sale: Copy of Blatchley's Coleoptera of Indiana, complete, front cover gone; Introduction to Entomology, 1st ed., 1924, poor condition. Send offer to Dr. R. C. Dobson, Dept. Entomology, Purdue University, Lafayette, IN. 47907.

Wanted: Adult Cuterebridae (Diptera) for revision in progress. Prompt return or report. Curtis W. Sabrosky, Systematic Entomology Library, USDA, c/o U. S. National Museum, Washington, D. C. 20560.

Oedemeridae determined promptly from any part of the World. Ross H. Arnett, Jr., Department of Entomology, Purdue University, Lafayette, IN. 47907.

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APRIL 1970

ENTOMOLOGICAL NEWS

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COMING NEXT ISSUE: Preliminary Studies of the Spermatozoa and the Male Reproductive System of some Whirligig Beetles

THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS

Vol. 81 APRIL 1970 No. 4

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MANUSCRIPTS and all communications concerning same should be addressed to: **Prof. R. H. Arnett, Jr., Department of Entomology, Purdue University, Lafayette, Ind. 47907.** The receipt of all papers will be acknowledged and, if accepted, they will be published as soon as possible. Articles longer than eight printed pages may be published in two or more installments, unless the author is willing to pay the cost of a sufficient number of additional pages in any one issue to enable such an article to appear without division.

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EDITORIAL POLICY: Manuscripts on insect life and related terrestrial arthropods are appropriate for submission to Entomological News. Titles, to facilitate computer recording, should be limited, if possible to 80 characters including spaces and punctuation, and should include key words to the contents for indexing. A short informative abstract (not a description of the paper) of about 150 words or less should precede the article. The Editor may reword the abstract for brevity and scope for republication in **Biological Abstracts.** The author's complete mailing address, including zip code number, should be given as a footnote. All papers describing new taxa would be greatly improved by including illustrations of a part or the whole form, and by referring to existing keys, or if none exist, by including an identification key to related taxa. Immediate publication will be given to new distribution records, short field notes, and news in **"The Entomologist's Record"** section; literature notices and books received in **"The Entomological Library,"** and study notices, want items, for sale notices, positions open, and position wanted notices in **"The Entomologist's Market Place."** Articles of wide interest to the general entomologist and non-specialist on the subject of the article are especially desirable. Articles of an archival nature will be recommended for **"Data Documents."** Instructions for the latter will be furnished on request (see vol. 81, pp. 1–11).

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[3.0011]

FURTHER OBSERVATIONS ON "FALSE BROODS" OF *COLIAS EURYTHEME* IN CENTRAL NEW YORK (LEPIDOPTERA: PIERIDAE)[1]

ARTHUR M. SHAPIRO[2,3]

The alfalfa caterpillar or orange sulphur butterfly, *Colias eurytheme* Boisduval, invaded the northeastern United States from the south and west in the late 1920's, establishing itself within a few years (Clark and Clark, 1951; Gerould 1946). In this part of its range it regularly produces "false broods" of fresh butterflies in November and December (Shapiro 1962, 1968). In 1961 alone, such flights were reported from Toronto, Ont. (Nov. 11); Frankfort, Ky. and and Chicago, Ill. (last week of November); Knoxville, Tenn., Baltimore, Md., and Philadelphia, Pa. (first week of December) (Lepidopterists' Society, 1962, and various authors *in litt.*). They probably originate from pupae whose development had been arrested by cold; in the laboratory, such pupae may resume development and eclose rapidly under improved thermal conditions, at least for up to four weeks (Shapiro, 1968). This hypothesis is supported by an emergence at Ithaca, New York, reported below.

November 23, 1968 Record.– Central New York records indicate that *Colias* flight activity usually ends at the beginning of November, roughly four weeks after the first frost. This cutoff probably results from worsening weather which prevents eclosion and gradually kills off the uneclosed pupae. Collecting at Ithaca, J. Keji took or saw his last *C. eurytheme* on the following dates: Nov. 15, 1949; Nov. 7, 1950; Oct. 26, 1951; Oct. 22, 1952. My last dates for 1966-1969 are Oct. 27; Nov. 12; Nov. 23, and Nov. 13 respectively. The 1968

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[1] Accepted for publication February 7, 1970.

[2] Department of Entomology and Limnology, Cornell University, Ithaca, New York 14850.

[3] This research was supported in part by National Science Foundation grant GB 7757 (Environmental Biology).

record seems to be the latest for this region, and the circumstances surrounding it are of considerable interest.

The specimen collected on Nov. 23, 1968 is a very fresh female, and it was taken more than two weeks after the last preceding collection. As shown in fig. 1, a large flight of *C. eurytheme* and *C. philodice* Latrielle was in progress in late October. On Oct. 22, in mostly cloudy weather, only 1 male *C. eurytheme* and 1 female *C. philodice* were found. In sunny, warm conditions on Oct. 27, the catch was: 34 male, 4 female *C. eurytheme*, 15 male, 5 female *C. philodice*, 1 white female. I was unable to collect in good weather Nov. 1-2, but on Nov. 5 I took 30 males, 6 females *C. eurytheme*, 1 male *C. philodice*, and 5 white females. This flight was abruptly terminated by the onset of cold, wet weather Nov. 6. This persisted virtually uninterrupted through Nov. 22; a foot of snow fell on Nov. 17, 19, 20, and 21. Temperatures were rarely below freezing, however; the lowest reading during the period was 26° F.

Persistent overcast and temperatures too low for flight would be expected gradually to eliminate the adults in the fields, if only by starvation. At the

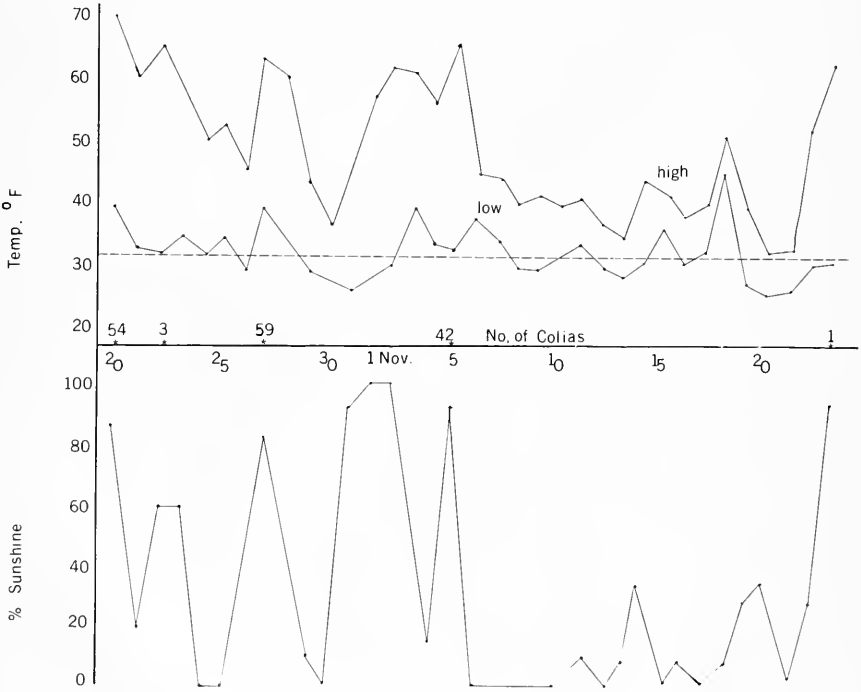

Figure 1. Weather conditions at Ithaca, N. Y. in October and November, 1968, and numbers of *Colias* spp. butterflies collected in two hours on flight days.

same time, the lack of a severe freeze, along with the insulation provided by the snow, suggested the possibility of a late emergence, given suitable weather; at least some arrested pupae would be expected to remain viable in such a regime. The Nov. 23 butterfly emerged after only 36 hours of continuous above-freezing temperatures, and only a few hours of sunshine. This makes it virtually certain that it was fully developed in the pupa and then arrested by cold.

Survival of old butterflies, 1969.– In 1968 some *Colias* taken in late October and early November were not fresh (Shapiro, 1968). Autum, 1969 was generally unfavorable for *Colias*, and the main flight ended early (Fig. 2). Good numbers of both fresh and worn butterflies were flying on Nov. 20th. A cold front passed on Nov. 22nd, with overnight lows of 25, 23, and 25° F. on the next three dates. However, on Nov. 25th it warmed to 60° under clear skies, and a good sample of *Colias* spp. was taken. This consisted of: 15 male, 3 female *C. eurytheme* (6, 2 fresh); 6 male *C. philodice* (1 fresh); 1 white female. This sample thus consisted of 9 fresh individuals (36%) and 16 (64%) which had survived three successive hard freezes. Bad weather then returned. Again, the minimum temperature was reached the morning of a day with strong afternoon warming, Nov. 30th (temperature range 19 to 58°). On this date a sample was taken: 7 male, 4 female typical *C. eurytheme* (6, 2 fresh); 1 fresh female "chrome yellow" *C. eurytheme* (Clark and Clark, 1951); 1 male F_1 hybrid; 5 male *C. philodice* (2 fresh), and 1 fresh white female. Here 7 of 19 butterflies (37%)

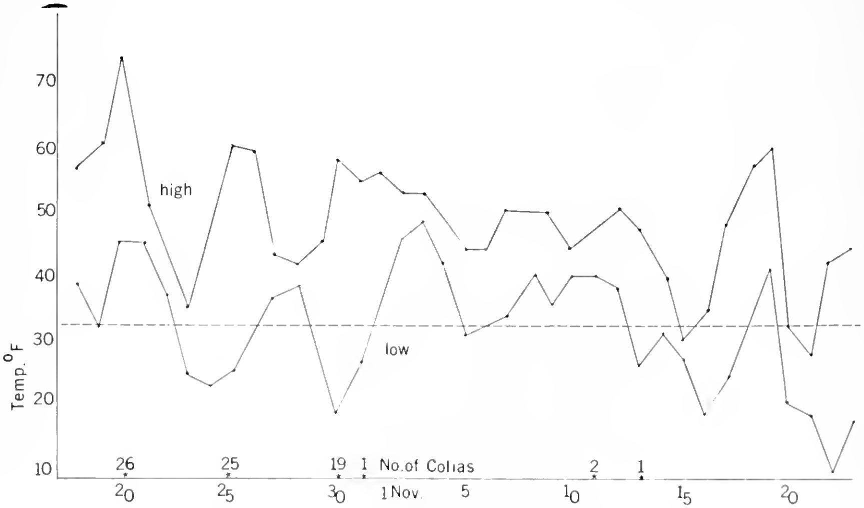

Figure 2. Weather conditions at Ithaca in October and November 1969, with two-hour *Colias* spp. collection totals.

had survived a minimum of one severe and 2 moderate freezes. The next day one old *C. eurytheme* male was taken in a strong wind with high, thin overcast. It was continuously overcast from the night of Oct. 31st through midday Nov. 11th. The temperature was above freezing nearly all of this time, and although some snow fell it did not persist. On Nov. 11th 2 fresh *C. eurytheme*, 1 of each sex, were taken at rest among sweet clover plants in near-overcast with temperature 47°. On Nov. 13th an old hybrid female was taken flying in sunshine at 47°. This butterfly had emerged before Nov. 11th, and perhaps as early as the end of October.

The condition of some of the butterflies taken Oct. 30th suggests they dated from before Oct. 25th, perhaps to Oct. 20th or earlier. This is particularly likely in one female which contained three spermatophores, indicating it had flown and mated on at least three different days. This specimen had lost about 20% of its wing surface, and the wings were badly descaled.

The early onset of cold weather, followed by nearly two weeks of cool, overcast conditions, seems to have prevented the usual late season emergence without being severe enough to kill the older insects quickly. A few days of sunny, mild weather at the end of the cool, cloudy period would probably have resulted in a major emergence. Instead, the weather deteriorated. It was mild on Nov. 18th, but partly cloudy and windy. Some emergence may have occurred, but no flight was observed.

Reproductive potential.– Stern and Smith (1960), studying the reproductive biology of *C. eurytheme* in California, found that newly emerged females showed a preoviposition period whose length was related to temperature and nutrition. At 10° C. (50° F.) the eggs matured slowly enough that the adult might die before ovipositing. Their insects were held at a constant temperature; outdoors late *Colias* sp. are subjected to highly variable temperatures, the biological effects of which may not be equivalent to constant exposure to their mean. The reproductive condition of 14 female *C. eurytheme* collected in good condition in October and November, 1967-1969, was therefore checked. Eleven of these had mated once, and one twice. Five of them contained mature eggs: 10, 11, 14, 35, and 107, the last with a few embryonated. None of these butterflies could have had more than 100 hours above 50° F., and most probably had much less. However, daily maxima may be substantially higher; and on sunny days, soil-surface temperatures may be much higher still. Stern and Smith obtained a mean of 50 mature ova/female after holding 51 hours at 25° C. (77° F.). In general, conditions permitting flight activity (Leigh and Smith, 1959; Watt, 1968, 1969) and mating are also highly favorable for egg maturation, but they must be sustained several days for effective reproduction to take place.

The old female collected Oct. 30, 1969 was ovipositing on red clover in the field. It was caged under continuous light indoors at 75° F. and provided with dandelions. Oviposition on sweet clover cuttings began sometime within 3 hours after caging, and continued until the insect died two days later. Of 118 eggs laid, 98 were fertile. There were less than 12 hours of air temperatures above 50° in the eight days preceding Oct. 30th.

In general, it seems safe to predict that even if eggs are laid, no offspring of "false broods" survive the winter at Ithaca except under very unusual circumstances.

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2.0011 Further observations on "False Broods" of *Colias eurytheme* in Central New York (Lepidoptera: Pieridae).

Abstract.– The age structure of flights of *Colias eurytheme* in late autumn depends on weather conditions. Oviposition is possible even in November, but probably no progeny survive the winter in Central New York.– **A. M. Shapiro**, *Department of Entomology, Cornell University, Ithaca, N. Y.*

Descriptors: Lepidoptera; Pieridae; *Colias eurytheme*; false broods; Central New York.

Data Documents for Systematic Entomology

The following articles are available to specialists in complete form or as abstracts from The Institute for the Study of Natural Species (ISNS), 550 Elston Road, Lafayette, Indiana 47905, U. S. A. Copies are deposited in other Data Document centers as well. These documents are in addition to Data Document numbered articles and abstracts published in other sections of Entomological News.

Notice.– Many readers may be wondering what changes are in progress at the editorial office of the NEWS. Some of these changes are reported below so you will know what to expect.

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In addition to the obvious advantage of immediate publication and space saving aspect, and the early announcement of the results of research, an author will receive as many reprints of the full paper as needed. These reprints will be of the entire article, not just the listing or abstract published in the NEWS, and the article will be in exactly the same format as the NEWS.

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Further information will be available soon.– **Editor.**

1.0038 **Distribution records for *Lutrochus luteus* LeConte (Coleoptera, Dryopoidea, Limnichidae).**– Harley P. Brown, Department of Zoology, University of Oklahoma, 730 Van Vleet Oval, Norman, Oklahoma 73069 and Ralph D. Stoaks, Department of Entomology, Fargo, D. D. 58102. (Data Document Center, ISNS, 2 pp.)

Descriptors: Coleoptera; Dryopoidea; Limnichidae; *Lutrochus luteus*; distribution.

1.0040 ***Loxosceles reclusa* Gertsch and Mulaik (Araneae: Scytodidae) in Pennsylvania.**– George Whitmyre and Williams Wills, Medical Entomologists, Pennsylvania Department of Health, P. O. Box 90, Harrisburg, Pa. 17120. (Data Document Center, ISNS, 1 p.)

Descriptors: *Loxosceles reclusa*; Pennsylvania; Araneae; Scytodidae.

[3.0018]

NEW EXOTIC CRANE-FLIES (TIPULIDAE: DIPTERA)
Part XIX [1]

Charles P. Alexander [2]

The preceding part under this general title was published in *Entomological News*, vol. 80 (10): 259-264. In the present paper I am continuing the studies on the Hexatomine crane-flies of India collected by Dr. Fernand Schmid and have included one further species from Thailand. Types of the species are preserved in the Alexander Collection.

Taiwanomyia inobsepta, NEW SPECIES

Size small (length of female about 4 mm); mesonotum brownish yellow, pleura ventrally light yellow, above with a conspicuous dark brown longitudinal stripe; legs obscure yellow; wings weakly infuscated, costal region more yellowed, veins R_{2+3+4}, R_{2+3} and R_{1+2} subequal, elongate, cell M_1 lacking, M_2 open by atrophy of m; abdominal tergites dark brown, sternites yellowed; valves of ovipositor very long.

Female.– Length about 4 mm; wing 4.2 mm; antenna about 1.4 mm.

Rostrum obscure yellow, palpi yellowish brown, relatively long. Antennae with scape brownish black, pedicel obscure yellow, flagellum medium brown; flagellar segments cylindrical, longer than their verticils on proximal segments, shorter outwardly. Head medium brown.

Pronotum obscure yellow. Mesonotum almost uniformly brownish yellow, without distinct pattern. Pleura ventrally light yellow, above with a conspicuous dark brown longitudinal stripe extending from cervical region to base of abdomen, dorsopleural region obscure yellow. Halteres with stem yellowed, knob infuscated, darker at apex. Legs with all coxae and trochanters clear light yellow; remainder of legs obscure yellow. Wings (Fig. 1) weakly infuscated, prearcular and costal regions more yellowed; veins light brown, slightly paler in costal field. Venation: Sc long, Sc_1 ending about opposite midlength of

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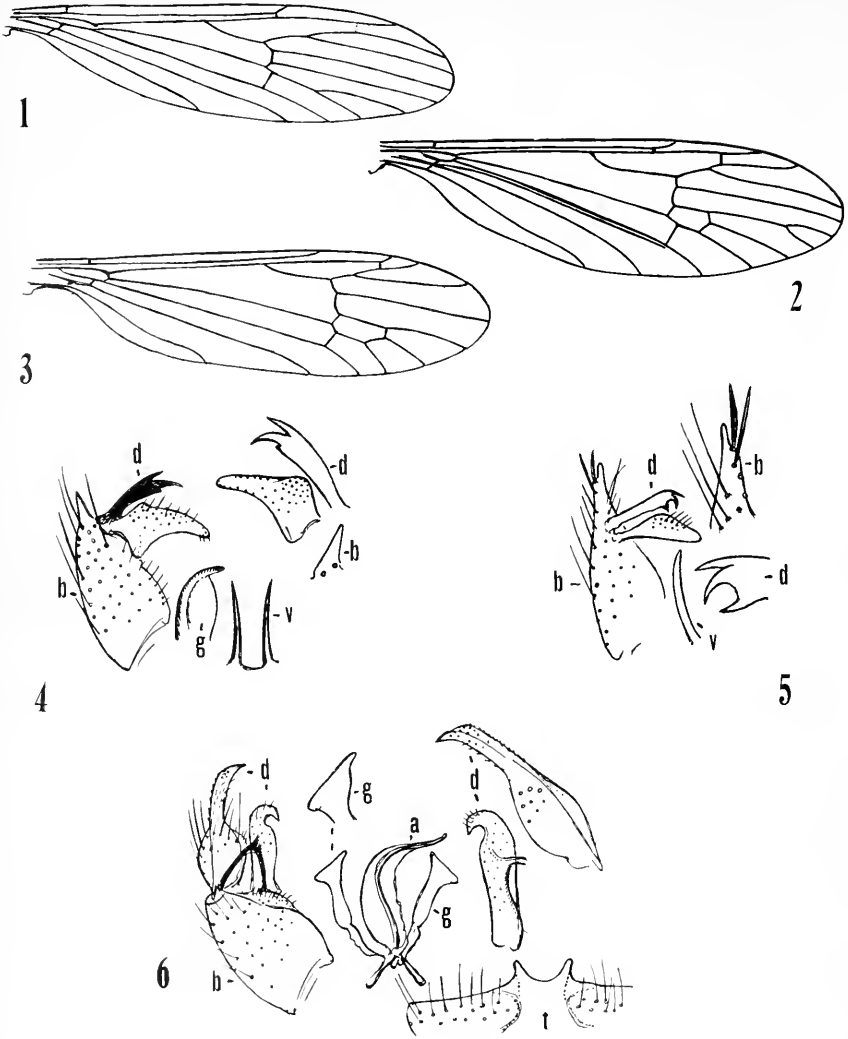
[1] Accepted for publication January 8, 1970.

[2] Contribution from the Entomological Laboratory, University of Massachusetts, Amherst, Mass. 01002.



Figures 1-6.– Fig. 1. *Taiwanomyia inobsepta*, new species; venation. Fig. 2. *Paradelphomyia (Oxyrhiza) angustistyla*, new species; venation. Fig. 3. *Limnophila (Prionolabis) habrosyne* new species; venation. Fig. 4. *Paradelphomyia (Oxyrhiza) angustistyla* , new species; male hypopygium. Fig. 5. *Paradelphomyia (Oxyrhiza) bigladia,* new species; male hypopygium. Fig. 6. *Limnophila (Prionolabis) habrosyne*, new species; male hypopygium.

(Symbols: *a*, aedeagus; *b*, basistyle; *d*, dististyle; *g*, gonopophysis; *t*, 9th tergite; *v*, ventral fork.)

R_{2+3+4}, Sc_2 slightly removed; R_{2+3+4}, R_{2+3} and R_{1+2} long, subequal or the last a little shorter, vein R_2 virtually atrophied, apparently far distad (its position indicated by stippling; *Rs* greatly arcuated, about one-fourth longer than the nearly straight R_{2+3+4}; cell M_1 lacking; cell M_2 open by atrophy of *m*; *m-cu* about one-half its length beyond the fork of *M*; cell *2nd A* moderately broad.

Abdominal tergites dark brown, sternites yellowed. Ovipositor with valves very long, the cerci unusually slender.

Habitat.– Thailand. Holotype: ♀, Chiengmai, at Dr. Buker's cabin, February 4, 1953 (Manop).

The regional *Taiwanomyia perpendicularis* Alexander and *T. perretracta* Alexander differ from the present fly in venation and in coloration details.

Paradelphomyia (Oxyrhiza) angustistyla, NEW SPECIES

Allied to *newar*; general coloration of mesonotum obscure yellow, praescutum with a broad brown median stripe; antennae 16-segmented, dark brown; legs yellow; wings weakly tinted with pale brown, outer cells with abundant macrotrichia; abdominal tergites dark brown, sternites and hypopygium yellow; male hypopygium with dististyles subterminal, outer style with two major outer spines and a further macroscopic denticle, inner style strongly narrowed outwardly.

Male.– Length about 5.5 mm; wing 6 mm; antenna about 1.2 mm.

Rostrum light brown; palpi black. Antennae with scape light brown, remainder dark brown; 16 segmented, proximal four or five flagellar segments short and stout, outer ones elongate, shorter than their verticils. Head light gray; anterior vertex broad.

Pronotum dark brown, sides yellowed. Mesonotum obscure yellow, praescutum with a brown median stripe, centers of scutal lobes less evidently darkened. Pleura yellow. Halteres with stem yellow, knob infuscated. Legs with coxae and trochanters yellow, remainder of legs yellow, outer tarsal segments slightly more darkened. Wings (Fig. 2) weakly tinted with pale brown, prearcular and costal fields more yellowed, stigma only slightly darker; veins light brown. Outer wing cells from R_2 to *1st A* with abundant macrotrichia. Venation: R_{2+3} and R_2 subequal; cell M_1 nearly one-half its petiole; *m-cu* before midlength of M_{3+4}.

Abdominal tergites dark brown, sternites and hypopygium yellow. Male hypopygium (Fig. 4) with basistyle, *b*, produced apically into a small acute pale point. Dististyles, *d*, subterminal, outer style blackened, with two major apical spines, the lower one longer, with a barely indicated microscopic denticle on lower margin at its base; inner style conspicuously narrowed outwardly, apex slender, outer margin beyond base produced into a low lobe. Gonapophysis, *g*, with lateral margins narrowly sclerotized, darker in color than remainder of blade. Spines of ventral fork, *v*, of moderate length, slender.

Habitat.– India. Holotype: ♂, Kulara, Pauri Garhwal, Kumaon, 12,000 feet, August 3, 1958 (Schmid).

The most similar species is *Paradelphomyia (Oxyrhiza) newar* Alexander, of Nepal and Sikkim, which differs evidently in the structure of the hypopygium, including the broad-based apical spine of the basistyle and in both dististyles, the outer style being simply bispinous, the inner one with apex broadly obtuse, its outer margin glabrous, with a low flange.

Paradelphomyia (Oxyrhiza) bigladia, NEW SPECIES

Allied to *discalis*; general coloration uniformly pale yellow; wings subhyaline, with a barely evident darkening over the anterior cord, macrotrichia of wing cells virtually lacking; male hypopygium with basistyle produced beyond bases of dististyles as a narrow hyaline point, outer dististyle narrow, pale, with only the three apical points darkened.

Male.– Length about 5-5.2 mm; wing 5.8-6 mm.

Rostrum light yellow, palpi pale brown. Antennae brownish yellow, flagellar verticils long and conspicuous. Head brownish yellow.

Thorax uniformly pale yellow. Halteres and legs yellow, the terminal tarsal segment darkened. Wings subhyaline, veins pale yellow; a barely indicated darkening over anterior cord including *r-m* and basal section of R_5. Macrotrichia of wing cells virtually lacking, in cases with very few scattered trichia in outer ends of cells R_4 and R_5. Venation: Cell R_3 deep, branches only slightly divergent; cell M_1 present, small; *m-cu* at near midlength of M_{3+4}.

Abdomen, including hypopygium, yellow. Male hypopygium (Fig. 5) much as in *discalis*, differing in details. Basistyle, *b*, produced beyond bases of dististyles as a narrow hyaline point with several long setae, the two outermost shorter, dilated into narrow blades, the outer one at base of a final slight extension of the style. Outer dististyle, *d*, narrow, pale, the three apical spines darker; inner style and ventral fork about as in *discalis*.

Habitat.– Sikkim. Holotype: ♂, Lathong, 6,560 feet, July 26, 1959 (Schmid). Paratopotypes, 2 broken specimens, with type; paratypes, 2 ♂♂, Chateng, 8,000 feet, July 28, 1959 (Schmid).

Most nearly related to *Paradelphomyia (Oxyrhiza) discalis* Alexander, differing in the details of hypopygial structure.

Paradelphomyia (Oxyrhiza) dolonigra, NEW SPECIES

Allied to *dissita;* size large (wing of male 7.5 mm); entire body very dark brown; antennae relatively long, outer flagellar segments elongate with very long verticils; wings weakly tinged with brown, costal border more yellowed, outer wing cells with abundant trichia; male hypopygium with outer dististyle relatively stout beyond base, with two strong terminal spines; points of ventral fork long and straight.

Male.– Length about 6.5 mm; wing 7.5 mm; antennae about 1.5 mm.

Rostrum and palpi brown. Antennae relatively long, brown, flagellum slightly paler; proximal three flagellar segments enlarged, progressively smaller outwardly, succeeding segments elongate with very long verticils, the extreme being about one-half longer than the segment. Head dark brown.

Thorax almost uniformly very dark brown, praescutum, scutal lobes and pleura brownish black. Halteres with stem yellowed, apex of knob weakly darkened. Legs with fore coxae blackened, remaining coxae and all trochanters light yellow, the latter with a blackened mark on posterior face; remainder of legs brownish yellow, outer tarsal segments brownish black. Wings weakly tinged with brown, prearcular and costal fields more yellowed, stigma pale brown; veins brown. Macrotrichia of wing cells unusually abundant, extending from above the stigma in cell C into cell M_4. Venation: Sc_1 ending opposite fork of Rs, Sc_1 long, subequal to R_{2+3+4}, R_2 not apparent; cell M_1 about one-half its petiole; *m-cu* immediately before midlength of M_{3+4}.

Abdomen dark brown, hypopygium very slightly paler brown. Male hypopygium with outer dististyle relatively stout beyond base, with two strong terminal spines and an isolated erect point on inner margin at near two-thirds the length. Gonapophyses very broad, inner margin membranous. Points of ventral fork long and straight.

Habitat.– India. Holotype: ♂, Shergaon, Kameng, North East Frontier Agency, Assam, 6,400 feet, May 8, 1961 (Schmid).

The most similar species is *Paradelphomyia (Oxyrhiza) dissita* Alexander, of Pakistan, which is distinguished by the small size, general coloration, and in the details of the male hypopygium.

Limnophila (Prionolabis) habrosyne, NEW SPECIES

Size medium (wing of male about 6 mm); general coloration of body polished black; antennae short, only slightly longer than the head; legs with femoral bases yellow, tips broadly black; wings before cord light yellow, outer fifth weakly darkened, stigma and a seam over cord still darker, cell M_1 lacking; male hypopygium with posterior border of tergite produced into two slender lobes; outer fourth of inner dististyle curved to form a crook-shaped structure.

Male.– Length about 4.2-4.5 mm; wing 5.8-6 mm; antenna about 1.2-1.3 mm.

Female.– Length about 6 mm; wing 7 mm.

Rostrum and palpi black. Antennae 15 segmented, black, short, only slightly longer than the head; flagellar segments short-oval, crowded, the more proximal ones about as long as broad, the outer segments smaller and very slightly longer, terminal segment more elongate. Head polished black.

Thorax polished black, very restrictedly gray pruinose on posterior praescutal interspaces and less evidently elsewhere. Halteres pale yellow. Legs with coxae black, trochanters brownish yellow; femora yellow, tips broadly black, on fore and middle pairs including about the outer two-thirds, on posterior legs about the outer third; tibiae obscure yellow, tips narrowly brownish black; tarsi pale brown, outer segments darker. Wings (Fig. 3) with cells before cord light yellow, outer fifth weakly more darkened; stigma and seams over cord and outer end of cell *1st* M_2 slightly darker brown; veins clear light yellow in the ground, yellowish brown in the patterned areas. Venation: *Rs* from three to four times R_{2+3+4}; cell M_1 lacking; *m-cu* at near one-third M_{3+4}.

Abdomen uniformly polished black. Male hypopygium (Fig. 6) with central region of posterior border of tergite, *t*, produced into two slender lobes that are separated by a U-shaped emargination. Outer dististyle, *d*, with base enlarged, suboval, outer half a straight black rod, its tip suddenly narrowed into an acute point, outer surface with setae and microscopic roughened points; inner style about two-thirds as long, straight, outer fourth more narrowed and arcuated, crook-shaped. Gonapophysis, *g*, expanded at apex into an irregularly triangular blade. Aedeagus, *a*, narrow, apical third narrowed.

Habitat.– India. Holotype: ♂, Nyukmadong, Kameng, North East Frontier Agency, Assam, 6,800 feet, April 19, 1961 (Schmid). Allotype: ♀, Rahung, Kameng, 7,000 feet, April 25, 1961. Paratopotypes, 3 ♂♂, 6,600-8,000 feet, April 18-20, 1961. Paratypes, 1 ♂, 1 ♀, Jhum La, Kameng, 7,800 feet, May 13, 1961 (Schmid).

Limnophila (Prionolabis) habrosyne is quite distinct from other regional members of the subgenus having cell M_1 of the wings lacking, including *L. (P.) coracina* Alexander, *L. (P.) fletcheri* Senior-White, and *L. (P.) mecocera* Alexander. It differs most evidently in the short antennae, wing pattern and in the details of the hypopygium, particularly the tergite and inner dististyle.

2.0018 New exotic crane-flies (Tipulidae: Diptera), part XIX. Abstract.– Continued studies on the Hexatomine crane-flies of India and one species from Thailand; five new species are described.– **C. P. Alexander,** *Entomological Laboratory, University of Massachusetts, Amherst, Mass. 01002.*

Descriptors: Diptera; Tipulidae; Hexatominae; *Taiwanomyia inobsepta; Paradelphomyia (Oxyrhiza) angustistyla; Paradelphomyia (Oxyrhiza) bigladia; Paradelphomyia (Oxyrhiza) dolonigra; Limnophila (Prionolabis) habrosyne*; India; Thailand; Sikkim.

[3.0019]

BIONOMICS OF THE BARK BEETLE PREDATOR, *Temnochila virescens* Mann. (Coleoptera: Ostomidae) [1]

Edward C. Mignot[2] and Roger F. Anderson[3]

Many species of Ostomid and Clerid beetles are well known predators of bark beetles; consequently, the adults of these insects are commonly observed on the outside bark whereas the larvae inhabit the inner-bark of trees infested with bark beetles. Inasmuch as Ostomid and Clerid beetles are usually the most abundant insect predators of bark beetles and because only a few intensive studies have been made on these insects it was thought desirable to evaluate the effectiveness of two species of these common predators, *Temnochila virescens* Mann. and *Thanasimus dubius* (Fab.). Therefore, a study of these relationships was undertaken in 1964 and conducted over the following two year period, 1964-1966.

Part of these studies entailed collecting a considerable amount of information on the life history and ecology of these predators and for one of these, the Ostomid beetle, *Temnochila virescens*, the results are presented in this paper. Another paper (Mignot and Anderson, 1969) deals with the Clerid beetle, *Thanasimus dubius.*

The only intensive past studies of Ostomid beetles as predators of bark beetles were those of Struble (1942a and 1942b). These also dealt with *T. virescens* but the host prey was the mountain pine beetle, *Dendroctonus monticola* Hopk. The result of these studies were somewhat similar to those presented here.

In a third paper, which is scheduled for future publication, the potential effectiveness of both *Temnochila virescens* and *Thanasimus dubius* in regulating bark beetle populations will be discussed.

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[1] This study was supported jointly by the Southern Forest Disease and Insect Research Council and Duke University. Accepted for publication January 9, 1970.

[2] Present address: Department of Entomology, Purdue University, Lafayette, Indiana 47907.

[3] School of Forestry, Duke University, Durham, N. C. 27706.

Methods of study

Both field and laboratory studies were used. Ten pines (*Pinus taeda* L.) were felled in each of twelve different areas of the Duke University Forest which is located near Durham, North Carolina. These trees were cut at four different times during the year–spring (April), early summer (June), late summer (August), and fall (Spetember). This experimental design resulted in infestations by bark beetles, mostly the pine engraver, *Ips grandicollis* (Eichh.) and to a lesser extent *I. avulsus* (Eichh.) and *I. calligraphus* (Germ.), at various times during the warmer seasons so that activities of the predators could be followed in the field. These felled trees were observed periodically to determine the presence of infestations by the pine engravers and the associated predators. Starting three weeks after each group of trees had been cut, and continuing thereafter at weekly intervals for a period of twelve weeks, bolts two feet long were cut from the boles of the felled trees. The bark was removed from these samples so that the *Ips* and predators present in the inner-bark could be identified, counted, and their developmental stage determined.

In the laboratory the predators were reared in Petri dishes. The inside of the bottom plates were usually covered with moistened filter paper so as to produce moisture conditions similar to those in the inner-bark where the immature stages of the predators normally live. The larval stages of the predators were fed with larvae and pupae of the pine engraver beetles (*Ips* spp.) while the adult predators were fed with adult engraver beetles. Various constant temperatures were

Table 1. Length of the developmental periods for the predator *Temnochila virescens* and its host, the pine engraver, *Ips* spp.

Insect Species	Time of Year			
	Spring	Early Summer	Late Summer	Fall
		Days		
Ips spp.	34-37	31-35	33-35	32-34
T. virescens	absent[1]	89-91	254-258[2]	absent[3]

[1] Only adults were observed on the outside bar, larvae and pupae were not found.

[1] Only adults were observed on the outside bark, larvae and pupae were not found.

[2] The long developmental period was because the larvae passed the winter in this stage.

[3] Neither adults nor larvae and pupae were found.

used for the laboratory studies. A small piece of pine bark had to be placed with each pair of reproducing beetles. This material provided a suitable place for egg deposition.

Results

The field data collected on the life cycle of the Ostomid beetle, *T. virescens*, are summarized in Tables 1 and 2, whereas similar data collected in the laboratory are presented in Table 3. Mortality data for the developmental stages at the various temperatures are presented in Table 4.

Longevity of the adults when kept separately in Petri dishes varied from 115 to 194 days. Longest survival occurred at 30° C and the shortest at 20° C. The averages and standard errors for the five replicates used for each of the five temperatures were as follows: 20° C, 131± 4.7 days; 25° C, 165± 6.8 days; 30 ° C, 179± 5.4 days; 35°C, 176± 3.7 days; 37½° C, 153± 3.4 days.

The average preoviposition period from the time of beetle emergence to when the first egg was laid varied from 31 days at 30° C to 48 days at 20° C. The length of time was 34 days at 25° C, 35 days at 35° C, and 43 days at 37½° C. Five replicates were used at each temperature studied with the range for each varying from 29 to 34 days at 30° C to 42 to 56 days at 20° C. Subsequently, the oviposition period continued for 83 days at 20° C to 148 days at 30° C.

Total egg production for pairs of these predators varied from 81 to 216. The average number of eggs per female for the various temperatures were as follows: 20° C, 81 eggs; 25° C, 157 eggs; 30° C, 216 eggs; 35° C, 184 eggs; 37½° C, 118 eggs. These were produced at an average rate of 6.8 to 10.2 eggs per week.

Moist conditions appeared to be better than a dry environment for larval development. The total mortality was 58.4 percent when the insects were reared on dry filter paper, but was only 36.9 percent when the paper was kept moist. A total of 100 larvae were used in this study.

Whenever two *T. virescens* larvae were enclosed together in a Petri dish, one commonly killed and ate the other. Even when other food (bark beetle larvae or pupae) was present, cannibalism was still rather high (80 percent) during the test period of one to two days. When bark beetle larvae or pupae were lacking one larva always destroyed the other. The adult beetles, on the other hand, were cannibalistic about two-thirds of the time but only in the absence of their usual food.

In the field, the density of the *T. virescens* populations, on the outside of logs infested with pine engravers was constant during the spring, early summer, and late summer (averaging 1 beetle per 3 square feet of bark). In the fall, this species of predator was absent from the outside of infested logs. Larval populations of the earlier instars of this predator averaged 1 per 2 square feet of inner-bark surface during both the early summer and late summer seasons. However, this density decreased as the larvae matured so that for the last (6th) larval instar and the following pupal stage there averaged only 1 insect per 3 square feet of inner-bark. As can be seen from the data in Table 1, there were no immature stages of *T. virescens* present in the logs infested with *Ips* spp. during the cool spring months of April and May. Throughout the autumn this predator was also absent in those logs that had been cut in September and only recently attacked by *Ips*. Older *T. virescens* larvae, however, were present throughout the fall in the inner-bark of logs that had been cut and infested earlier in the summer (June and August).

Table 2. Development of *Temnochila virescens* in the field

Time of Year	Instar[1]							
	1	2	3	4	5	6	Pupal	Total
	Days							
Early Summer	3	6	13	37	5	6	16	86
Late Summer	3	7	13	196[2]	5	5	16	245

[1] Development of the egg stage was not followed in the field.

[2] Extended length of time for fourth stadium was because the insects passed the winter in this instar.

Discussion

The data presented in Tables 1 to 4 show that the bark beetle predator, *T. virescens*, developed fastest and survived better at the warmer temperatures that occur during the summer season. This species apparently was unsuccessful in establishing broods during the cooler periods of spring and fall. Immature stages were absent in logs exposed in the field and initially infested with bark beetles in April and September even though the adult predators were present during the spring. During the cooler months this ecological niche in the inner-bark was consistently occupied by another common predator, *Thanasimus dubius* (Mignot and Anderson, 1969).

As with most preliminary types of studies, the present one suggests several relationships that should be investigated more thoroughly. One aspect that needs clarification is to determine why the immature stages were absent during the cool spring and fall months. As stated previously, the inner-bark of logs infested with bark beetles during both spring and fall was occupied by another predator, *Thanasimus dubius.*

From the data presented it is obvious that *T. virescens* has only one generation per year in North Carolina. Winter was passed in both the larval and imago stages.

It also should be noted that the rate of development decreased greatly at temperatures below 30° C. At 30° C the rate of development from time of oviposition to the imago was 38 and 63 percent faster than it was at 25° C and 20° C respectively. This adverse effect of cooler temperatures agrees with the other results indicating that this predator succeeds better at higher temperatures. However, as can be seen from the results in Table 3, extremely high temperatures also repressed the speed of development. At 37½° C and 35° C the rate of development was 42 and 22 percent slower for the two respective temperatures than at 30° C.

And, lastly, the interspecific relationship between the two predators, *Temnochila virescens* and *Thanasimus dubius*, should be investigated more thor-

Table 3. Development of *Temnochila virescens* at various constant temperatures

Stage of Development	Temperature °C				
	20°	25°	30°	35°	37½°
			Days		
Egg	18(1.3)[1]	14(1.4)	9(0.5)	7(0.2)	10(0.9)
Larval Instars					
1	17(0.8)	9.5(0.8)	6.5(0.2)	4(0.3)	10(0.7)
2	21.5(1.2)	15.5(1.2)	6.5(0.4)	7.5(0.2)	8.5(0.5)
3	61(4.6)	54.5(6.1)	16.5(1.7)	10(0.9)	25(1.5)
4	118(4.7)	50(3.1)	55(4.3)	51(3.0)	65.5(4.8)
5	22(1.3)	11(1.5)	4.5(0.5)	14(1.8)	20(3.3)
6	10(0.7)	7(0.3)	[2]	21(1.0)	23(1.1)
7	[2]	[2]	[2]	17(2.1)	20.5(1.8)
Pupa	24(1.8)	13(0.3)	11(0.7)	6(0.2)	5(0.6)
Total	291.5	174.5	109.0	137.5	187.5

[1] Values in parentheses are standard errors. Five replicates were used for each temperature.

[2] No instars occurred at these temperatures.

oughly especially at cooler temperatures. This type of study may help to explain the fate of the Ostomid larvae in the spring and the Clerid larvae in the summer.

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Table 4. Mortality suffered by *Temnochila virescens* during the developmental period

Stage of Development	Temperature °C 20°	25°	30°	35°	37½°
	Percent Mortality[1]				
Egg	44.0	42.0	33.0	47.0	50.0
Larval Instar					
1	10.6	10.4	9.4	11.1	19.5
2	5.9	4.8	4.0	3.8	3.7
3	3.2	2.2	2.7	1.9	1.9
4	6.9	3.7	1.0	1.8	2.0
5	7.1	4.8	1.0	1.4	1.8
6	6.5	4.2	[2]	3.0	2.7
7	[2]	[2]	[2]	4.8	3.3
Pupa	4.5	6.7	5.9	5.0	5.4
Total	88.7	78.8	57.0	79.8	90.3

[1] Mortality values for each stage are based on the total population at the beginning (e.g. number of eggs). The number of insects used for each stage at each temperature varied from 19 to 51 with the average being 35.1.

[2] No instars occurred at these temperatures.

2.0019 Bionomics of the bark beetle predator, *Temnochila virescens* Mann. (Coleoptera: Ostomidae).

Abstract.– The Ostomid, *Temnochila virescens* Mann., a predator of *Ips* spp. bark beetles in the Southeastern United States, develops and survives best during the summer months. In this area this predator has one generation per year, overwintering in both the larval and imago stages. Longevity and egg production are at a maximum while mortality and preoviposition period are at a minimum at 30° C. Both adults and larvae exhibit canni-

balism.– Edward C. Mignot and Roger F. Anderson, *Department of Entomology, Purdue University, Lafayette, Indiana 47907,* and *School of Forestry, Duke University, Durham, N. C. 27706.*

Descriptors: Ips spp.; *Temnochila virescens*; bark beetles; predator; Ostomidae; Coleoptera.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

3.0033 Neoaplectanid nematodes as parasites of the pales weevil larva, *Hylobius pales.*– The purpose of this note is to report what is believed to be the first known instance of Neoaplectanid nematodes attacking the pales weevil, *Hylobius pales* (Herbst).

In August 1965, during an ecological study of immature stages of the pales weevil in a stand of lobolly pine (*Pinus taeda* L.) near Raleigh, N. C., 14 sixth-instars and 1 pupa, all apparently diseased, were removed from the roots of one stump. The specimens were turgid but yellowish-brown, as compared with the near-white of normal individuals, and made up about 30% of the weevil population in that stump. All were adjacent to one another on the same root about 5 cm below the soil surface. Approximately 125 additional weevil larvae and pupae were collected from 8 stumps in the same area, but no other abnormal specimens were found. Microscopic examination showed the specimens to be heavily infected with large numbers of an immobile nematode which was identified as *Neoaplectana* sp. by Dr. C. W. Massey, USDA Forest Service, Albuquerque, N. M.

Recent work by Jackson and Moore (1969. J. Invertebrate Pathl. 14: 194-198) showed that infestation of pales weevil larvae under laboratory conditions is feasible, and the discovery of a natural infestation in the field points to the possibility of using *Neoaplectana* sp. against the weevil as a control practice.– H. A. Thomas, *Southeastern Forest Experiment Station, Research Triangle Park, N. C. 27709.*

Descriptors: Coleoptera; Curculionidae; pales weevil; *Hylobius pales*; neoaplectanid nematodes; parasites.

USDA announces insect and disease slide sets.– A set of 400 35 mm color slides has been prepared to help identify plant disease and insect injury and symptoms which cause problems on crops, livestock, timber, garden, and man. The slides are useful for accurate diagnosis of pests and injury symptoms. The complete set, which contains 225 insect and 175 plant disease slides, was prepared by the Extension Service of the USDA in cooperation with Clemson University, Clemson, S.C. These slides are especially suited for use of individuals and groups interested in pests and pest control. The full set, selling for $ 50, is Set A-52, "400 Insects and Plant Diseases." This large set is divided into several categories which may be purchased separately.– *Photography Division, Office of Information, U. S. Department of Agriculture, Washington, D. C. 20250.*

3.0039 **A unique larval habitat of *Tabanus atratus* Fab.**[1] – The typical semiaquatic habitat of the immature stages of *Tabanus atratus* Fab. has been well-documented. However, a few reports exist of larvae found in unexpected locations such as floating logs and other debris, under submerged stones in a brook, and under a log on dry land that had been submerged 2 or 3 weeks earlier (Marchand, 1920). The development of larvae in the effluent from a dairy barn (Gingrich and Hoffman, 1967) is perhaps especially unexpected. This present note reports the occurrence of larvae in an artificial container.

Every spring one of the maintenance jobs at the Mississippi State University Agricultural Experiment Station at Stoneville, Mississippi, involves cleaning and repairing the concrete watering troughs in the pastures. On April 12, 1966, while the accumulated algae and other debris were being removed from one trough, tabanid larvae floated to the surface. A total of nine larvae ranging in size from 20 to 25 mm was found and identified as *T. atratus*. This trough (Figure 1) measured 12 x 1 x 1 ft. internally and had 4-in. thick walls and bottom. At the time the larvae were found, the water was about 8 in. deep, and the algae on the sides and bottom was from 2 to 4 in. deep. Other unidentified organisms also living in the algae probably served as food for the larvae.

Since the date of collection was well before the adults of this species appear in the field, the larvae were obviously from eggs oviposited sometime in 1965. The most likely site of oviposition was the fence cross-bar shown in Figure 1.

Because the larvae were present in the trough instead of the ground through the winter, they were exposed to greater extremes of temperature. According to John Hursh, Environmental Science Service, U. S. Department of Commerce, at the station, January 1966 was unusually cold; the mean monthly temperature was 37.6° F, the fourth coldest average temperature recorded for January since 1931. From January 16 to February 7, early morning temperatures were 32° F or less, and the lowest temperatures were 12° F (January 29), 5° F (January 30), and 7° F (January 31). Moreover, during this 3-day period, the daytime temperatures did not exceed 32° F. During this period, the surface of the water in the trough was frozen, so the larvae could not reach the surface for respiration. Undoubtedly, the sides and bottom were coated also with ice, so there is a good possibility that these larvae were imbedded in ice.

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[1] In cooperation with the Delta Branch of the Mississippi State University Agricultural Experiment Station, State College, Mississippi 39762.

Figure 1. Water trough where larval *T. atratus* were found.

Larvae have not been found in this or any other trough on the station in the 3 years subsequent to 1966.

Literature cited.– Marchand, W. 1920. The early stages of Tabanidae (Horse flies). Monograph of the Rockefeller Institute for Medical Research, no. 13, 203 pp. Gingrich, R. E. and R. A. Hoffman. 1967. Abundance and survival of tabanid larvae in effluent from a dairy barn. Ann. Ent. Soc. America, 60: 72-74.– **R. H. Roberts,** *Entomology Research Division, Agr. Res. Ser., U. S. Department of Agriculture, Stoneville, Mississippi 38776.*

Accepted for publication April 14, 1970.

Descriptors: Diptera; Tabanidae; *Tabanus atratus*; larval habitat; Mississippi.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

Publications received.– The following annotated list of publications and short reviews have been received for notation in this section.

Butterflies

Cowan, Charles F. 1970. Annotationes Rhopalocerologicae 1970. Clunbury Press, Berkhamsted, Herts, England, 70 pp. $ 3.00.

This is Cowan's second and last installment of addenda and corrigenda to the late Francis Hemming's "Generic names of the butterflies and their type-species." The booklet is divided into seven sections, A-G. Seventy-nine generic names are treated, a number of these for North American genera. An interesting discussion about emendation and incorrect spellings and an analysis of emended generic names constitutes section E and should be read by every nomenclaturist. Section B establishes the dates of publication of important nomenclatorial works of seventeen authors, including S. H. Scudder.

This little booklet and its earlier companion should be in the possession of every active taxonomist and nomenclaturist working with North American butterflies. Principles used by Cowan will be of interest and use to all such workers in zoological areas. The two booklets can be purchased from the author at Little Gaddesden House, Berkhamsted, Herts, England.– **F. M. Brown,** *Fountain Valley School, Colorado Springs, Colo. 80911.*

Mosquitoes

Gerberg, Eugene J. 1970. Manual for mosquito rearing and experimental techniques. American Mosquito Control Assoc., Inc. Bull. no. 5, viii + 109 pp.

Bringing together in a meaningful way the voluminous literature relating to procedures developed for the colonization of mosquitoes is a tremendous task. Yet, the values that can be derived from the accomplishment of this task are great. Therefore, all who work with mosquitoes owe a very large debt to the American Mosquito Control Association for organizing and supporting the endeavor. An even larger debt is owed to the individual who accomplished it.

The choice of Dr. Eugene J. Gerberg for the task of revising and updating the former publication (Bulletin 3) is a particularly fortunate one. For a number of years he has been engaged in the development of mass rearing methods for mosquitoes and has probably become more knowledgeable in this area than anyone else.

The acquisition of knowledge of the taxonomy, biology, and control of mosquitoes and of their relationship to the transmission of animal disease has been tremendously aided by the ability to colonize them in the laboratory. Yearly, new species are added to the list of those that can be continuously maintained in cages, and the acquisition of useful biological information results in each case. I am confident that the availability of this most useful compendium of information on rearing techniques for mosquitoes will provide new stimulation for this.— **Kenneth L. Knight** *(from the Foreword).*

Information Retrieval

Arnett, R. H., Jr. and **G. Allan Samuelson,** *et al.* Directory of Coleoptera Collections of North America. Agricultural Information Department, Purdue University, Lafayette, Indiana, vii + 123 pp. Cloth $ 3.95.

The 286 collections of beetles known to be housed in North America are described in this directory. The 174 institutional collections represent all of the research collections of insects in the area covered, thus providing a valuable source of information for groups in addition to the Coleoptera. Introductory chapters describe the nature of insect specimen information storage and retrieval and the use of the collections listed.— *From flyer.*

Pest Management

Hassal, H. K. 1969. World Crop Protection, vol. 2. Chemical Rubber Co. Press, Cleveland, Ohio 44128, 249 p. Cloth $ 16.60.

For student, scientific farmer or agricultural advisor who would like basic information on pesticides, this volume should prove invaluable. The contents include some general considerations; physico-chemical factors; barriers and targets in insects; organochlorine insecticides; other insecticides and related compounds; inorganic fungicides; organic fungicides; and herbicides. The author discusses the scientific principles which relate to the formulation, persistance, degradation, synergism, toxocology, and side effects of pesticides. This volume is not a catalogue of pesticides, it is a treatise on the principles, beneficial aspects and hazards of pesticides.— **Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, Md. 21228.*

Desert Locust Project, FAO, Rome 1968, 142 p. UNIPUB Inc., 650 First Ave., N. Y., N'Y' 10016.

The United Nations Development Program Desert Locust project was planned to operate for six years (1960-1965) with the Food and Agriculture Organization of the United Nations (FAO) as executing agency. Forty territories were involved, from Senegal in the west and Tanzania in the south to India and Pakistan in the east and Turkey in the north.

The project was organized and executed in five main sections: ecological survey; strengthening and coordination of research; reporting and forecasting; training, and operational research.

This is the final report of the project and provides an excellent summary of the organization, contributions and recommendations of an international pest control program.— **Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, Md. 21228.*

[3.0035]

THE TYPE LOCALITY AND THE STUDY OF NATURAL POPULATIONS[1]

Ross H. Arnett, Jr.[2]

The greatest drain on the modern systematic entomologist's time is the burden of the original literature. The law of priority, because it requires that every taxon be accounted for, leaves no alternative for the systematist except to deal with all described genera, species, and infraspecies whether or not they are based on sound evolutionary theory. However, a systematist can study natural populations without involving himself in nomenclatural problems, and for one to insist on a complete accounting of all past taxonomic literature often delays work that may lead to the discovery of important biological phenomena. A procedure to circumvent this problem, which at the same time permits thorough work within the requirements of the rules of the International Code of Zoological Nomenclature, is proposed below. This is done by fitting previous taxonomic work into the population concepts of species resulting from field studies, without the necessity of solving useless nomenclatural puzzles.

The natural species is defined after the results of the data on the component natural populations have been analyzed, in contrast to the non-dimensional species concept of the old-time naturalist (ref. Mayr, 1963: 17), or the museum taxonomist's concept based on mechanical differientation. In groups that are poorly known and poorly studied, it cannot help but be true that natural species are really unknown, and the methods of the taxonomist are no different than those of the field biologist. But once a significant number of populations have been observed, there is a chance that isolating mechanisms and the evolutionary potential of the populations leads to an understanding and appreciation of our living environment and justifies systematics.

A study of populations requires almost exactly the same procedure as studies at the species level. The systematist estimates by sampling the most useful para-

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[1] Approved by the Agriculture Experiment Station, Purdue University, as Journal Paper no. 2957. Accepted for publication March 9, 1970.

[2] Professor of Entomology, Purdue University, Lafayette, Indiana 47907.

meters, including variance, of the populations of a species. Until the systematist learns this, he is unable to procede further with his work because he lacks a foundation upon which he can build. Unless the data on populations are organized and used, future generations of systematists will be forced to continue to deal with the past taxonomic literature.

The use of the phenogram[3] (Arnett, 1963) is one way to synthesize population data and is an approach toward the solution of a systematic problem by a field biologist. The phenogram provides a graphic means of assigning the holotype or neotype specimen to the exact population of which it may have been a member. This is done by making a list of all of the major distinguishing features to be found in a single genus, with all of the known variations, distributed in a series of from two to ten states. *This includes all known intraspecific variations* as well as interspecific differences. Many systems already purport to do this in a sophisticated manner but are very tedious, may include expensive computer time, and many really are faulty systems. So far, these procedures have been done to demonstrate a particular phenomenon and as yet have not achieved the status of a routine, as have, for example, genitalia preparations in insects. As a working hypothesis, the features listed for the phenogram are assumed to be influenced either by a single gene or by a gene complex. The proof or disproof of this hypothesis may be one of the chores of the gamma taxonomist, and, of course, can not be done in most groups. The connection between the various descriptions and nomenclature is apparent when it is understood that the contents of a description is the postualtion of the natural species, while the publication of the name is the process of nomenclature.

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[3] Although the term *phenogram* has priority and is etymologically more appropriate as I have used it (Arnett, 1963), it is necessary that I redefine it here because, like the term genotype taken over by the geneticists, this term has been assumed for another use. My 1963 definition of a phenogram still holds as a modified histogram showing the pattern of phenotypic characters of an individual, a sample, a population, or a species by plotting the the position of many characters and their states in graphic form. In 1965 the phenogram was redefined (Camin and Sokal) as a phenetic dendrogram (*sic*; **graph** means connecting lines, while **gram** means a drawing or a picture, hence *histogram*) as opposed to a cladogram (*sic*), a cladistic (=phylogenetic) dendrogram (*sic*) and even though my 1963 paper was referred to, the term was used instead of the more appropriate term, *phenograph.* More recently Sokal (1966) has again used phenogram incorrectly as a phenetic dendrograph without regard to priority or etymology which is even more important.

NOTE: This paper, written several years ago, was refused publication in two national journals with the comment that the author "is listening to a different drummer." This may not be the right "drum", but considering the slow progress being made by taxonomists, and the low regard for taxonomy held by many scientists, it seems that a"different drummer" is needed.

To avoid *a priori* thinking, the systematist compares the holotype specimen with the natural populations rather than the converse. The phenogram treats the existing nomenclature with a maximium of objectivity and tests are readily available enabling the fitting of a single specimen (e.g., a holotype) into a population, once sufficient samples have been gathered (ref. Simpson, *et al.*: 182). For well known species, which in some cases have no existing holotype, and no designated neotype, the problem for the student of natural species is simple since he accepts species as he recognizes them from his field studies. His problem is to determine the homogeneity or heterogeneity of the aggregate populations. Then by the restriction of the type locality to the area of a single population, even in the cases of sympatric sibling species, the need for a neotype becomes less important, and may even be eliminated. This does not apply to those relatively few cases where the exact type locality has been destroyed. By a designation of the population from which the holotype was selected, a very useful purpose is served, for it fixes a unit population from which genetic and/or phenetic change can be measured. The successful application of this theory may lead to a considerable revision of our thoughts about holotypes. Even if a neotype has been selected and doesn't conform with the description of the population to which the lost holotype probably belonged, as might be shown by an examination of the work of a second revisor, it too may be fitted into a population. The names may then be correctly applied, and any nomenclatural adjustments may be made. This method would go a long way toward eliminating the need for complex rules of nomenclature and permit easy handling of these procedural matters by the systematist.

The phenogram procedure may be compared with the keying of a specimen for identification. The major difference is that all decisions are based on a study of the various natural populations, independent of any previous treatment by taxonomists. Here is an example of how I used this system to revise the genus *Oxacis*. There was no comprehensive monograph of the genus for any area, thus necessitating an examination of all of the literature, available types, and museum specimens, as well as all of the other normal procedures required of alpha taxonomic work. I then ignored the species-group names where type specimens were non-existent and the descriptions were so poor that the species couldn't be recognized. These names were listed, but no further consideration was given to them at that time. Next, I was concerned with two things: the species that were discovered by studying as many populations as possible, and the probable species known only from a few samples. As a speciationist, I was concerned with the variants and isolates. An interest in the classification of the entire family as well, required me to make use of this revision as a part of the classification of the higher groups. In other words, a genetic concept was formed also. This completed, it became necessary to assign holotypes to populations enabling the proper application of species-group names. In the case of species based on a knowledge of only one or a few population samples, the species were either referred to as typological species if a holotype were available, or if not, then these were described as unassigned populations (and remain unnamed). Once this was done there was no longer a need to refer to systematic work published prior to the date of my revision (Arnett, mss.) unless I desire to and have the opportunity to do so. I, however, may find it necessary at a later date to rearrange taxa using newly available data.

There is no need to "pass judgement on" previous work with the view of discarding the work of the taxonomist. The individual always makes the decision on what work is acceptable and what is rejected. The acceptance is indicated by the use of the work in question. The rejection is signified by the publication of a subsequent revision or monograph. The procedure described here for the treatment of all taxonomic literature enables the placing of all work but does not oblige the population systematist to do so. He is not required, when his primary concern is populations, to search out and insert every old "species" into his treatment of natural species. However, by using this system, he may, at any time, add old, overlooked, or subsequent species descriptions to the work. This is the system used by most field biologists, including those concerned with pest management; they do not delay their research waiting for the snail-paced taxonomist to untangle 200 years of archaic literature.

The following is a summary of the proposals made above. To follow these, I believe, will not only enable the modern population systematist to carry on his work without the long standing impediments of nomenclature but will speed up the process of alpha taxonomy for the systematist interested in faunistics.

1) Study populations of animals using every available technique to delimit the natural breeding populations. Do this first with the minimum use of previous literature. By doing so, one can form unprejudiced concepts of species. Many workers advocate starting without reference to literature, but few have actually done so. As far as possible the populations should be analyzed and compared species by species throughout the genus and from genus to genus throughout the family.
2) By means of the phenogram method, or similar procedure, describe the species of a genus using as the basis for the description an analysis of the characters and their variation as found in the populations studied. The isolates, if any, should be carefully and fully described in terms inclusive enough so that they can be recognized when additional specimens need to be identified. Scatter diagrams, comparative tables, and refined statistical treatment of the data should be used wherever there are available data.

3) If there is a comprehensive work available then the results of 1) and 2) can be collated with such works. For example, the exhaustive monograph of the Onychophora by Bouvier (1905-1907) makes all reference to earlier literature unnecessary. No doubt a thorough restudy of all previous work would reveal nomenclatural errors in Bouvier's work, but what possible useful purpose would be served? If such a work is not available then step 4) must be followed.
4) The use of copying machines makes the World's literature readily available to any worker. To prepare a catalog and to determine type localities is time consuming, but eventually necessary. The assigning of available names to the material at hand should now be so simple as to be almost routine. Holotype specimens that are readily available can be placed in the proper variational spectrum of the species by following the procedure discussed previously. As emphasized before, obscure descriptions, unrecognizable species and unavailable holotypes need not be considered further at this time.
5) Some groups have been particularly overworked by taxonomists or, even worse, by incompetent amateurs. In exceptional cases, the majority of the available names in a group for major areas have been validated by such workers, and many of the holotypes destroyed through lack of proper care or by accident. After a reasonable attempt is made to place the names involved, they should receive little further consideration, thus saving vast amounts of time and money. This will not be difficult to do except for the systematist who persists in following the outmoded taxonomy of pre-Darwinian days. Those who follow the recommendations of 1) will find this the easiest step in these procedures. As long as it is kept in mind that the proposed system is an open ended one and any of these difficult names can be placed at any time if new data become available, then the chance of evoking anarchy in our science by such a procedure is non-existent.

Currently, it seems, the twentieth century systematist is still chained to a nineteenth century methodology which does not fit the new concepts of species. Great strides have been made to develop a suitable methodology, e.g., biometry, refined collecting methods, field experimentation, and laboratory study of living material. A better system for filtering and treating current and past literature is badly needed. The "new systematics" has gotten old and is increasingly haunted by its stilted ancestor—nomenclature.

Acknowledgments.— A preliminary draft of this paper was circulated among my graduate students which resulted in many useful suggestions, especially by Thomas F. Hlavac and Gerald Noonan, then at Purdue University, Dr. Leland Chandler of the Purdue University faculty offered several constructive comments. The greatest help came from discussions with Dr. John N. Belkin of the University of California at Los Angeles and Dr. Eugene J. Gerberg of BioRand, Inc., Baltimore, Maryland during our trip to Ecuador and the Galápagos Islands. This resulted in essentially a rewriting of the entire manuscript. I do not mean to imply that any of these readers agree with my views or endorse them; I cannot deny that they influenced me greatly. To them I extend my thanks.

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2.0035 **The type locality and the study of natural populations.** Abstract.– The use of topotypic material and the study of the holotype population provides an objective means of relating the name of an organism to the living insect, leaving the study of the polymorphism of contemporary populations unhampered by nomenclatural legalities.– **Ross H. Arnett, Jr.,** *Department of Entomology, Purdue University, Lafayette, Indiana 47907.*

Descriptors: Type locality; topotypes; populations; phenogram; International Code of Zoological Nomenclature.

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ENTOMOLOGICAL NEWS

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[3.0028]

PRELIMINARY STUDIES OF THE SPERMATOZOA AND THE MALE REPRODUCTIVE SYSTEM OF SOME WHIRLIGIG BEETLES (COLEOPTERA: GYRINIDAE) [1]

OSMOND P. BRELAND and EVERETT SIMMONS [2]

For some months several of us have been studying the developmental stages and the mature spermatozoa of various kinds of insects. During the course of this work, we have encountered an unusual situation in two species of whirligig beetles. This situation is described below.

As the spermatozoa of these gyrinid beetles pass through the vasa deferentia, they become attached by their heads to rodlike objects which we have termed spermatostyles. These spermatostyles, each with more than 100 attached spermatozoa, also occur in the reproductive tract of the female. As yet we do not know the details relative to the formation of the spermatostyles and the association of the spermatozoa. However, because of the occurrence of cold weather which will limit our work for some months, and because the situation is so unusual, we feel that a report at this time is justified.

So far as could be determined, little work has been published on the reproductive systems of gyrinid beetles. For this reason, a diagram of the male reproductive system is included, and a brief comparison is made between the reproductive systems of those beetles and those of a few related species.

Materials and Methods

The results reported here are based upon a study of two closely related species of gyrinid beetles, *Dineutus assimilis* Kirby and *Dineutus carolinus* LeConte. These two species are very similar, and much of the work was done before we were able to distinguish between the two. So far no important differences in the reproductive system or in sperm development have been noted be-

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[1] Accepted for publication February 9, 1970.

[2] The University of Texas at Austin, Texas 78712.

Ent. News, 81: 101-110, 1970

tween the two species. However, since both species were involved in the studies, the insects will be referred to as *Dineutus* or *Dineutus* sp. in the description and discussion to follow.

All specimens used were collected from ponds near Austin and San Marcos, Texas. Collections began near the first of July, 1969 and continued intermittantly until low temperatures the middle of October presumably caused the beetles to disappear. During this period we collected and dissected several dozen beetles, and although no effort was made to collect males only, less than half a dozen females were found. The reason for the paucity of females is not apparent. In the laboratory, the insects were kept in plastic containers or aquaria containing pound water until they were dissected.

Sexes of the two species of *Dineutus* can be easily distinguished by grasping the beetles with blunt forceps, and examining the posterior abdominal sterna with a low power (e.g. 10X) dissecting microscope. The terminal sterna are somewhat transparent in strong direct light, and the external genitalia can be seen through them. The genitalia of males have three projections, whereas, those of females have only two.

The beetles were pinned to paraffin in a small dissecting dish, and dissected in Balar's saline using small scissors, fine needles and forceps. Portions of the reproductive system were placed in saline on a microscope slide and dissected further; a cover slip was applied and the material examined with a phase contrast microscope.

Observations

A diagram of the male reproductive system of *Dineutus* sp. is shown in figure 1. This system is similar in many respects to that of *Dytiscus marginalis* (L.) (Dytiscidae) described by Blunck (1912) and Damandt (1912); and to two species of Dytiscidae examined by us, *Cybister* sp. and *Thermonectus* sp. There are, however, some differences. For example, in all the dytiscids the vasa deferentia join the ducts of the accessory glands very near the point of fusion of the accessory gland ducts into a single one. In *Dineutus* these connections occur considerably anterior to the fusion of the accessory gland ducts into a single duct. Also, in *D. marginalis* and *Cybister* sp. each vas deferens forms a separate epididymis, whereas, in *Dineutus* the two epididymides are entangled into a single mass. Only a single mass of epididymides occurs in *Thermonectus.*

The testes of *Dineutus* are single coiled tubes, not divided into follicles. The testes are thus similar to certain other species of Coleoptera, suborder Adephaga, that have been studied. In many insects, including some Coleoptera, suborder Polyphaga, the testes are composed of small divisions or follicles; the

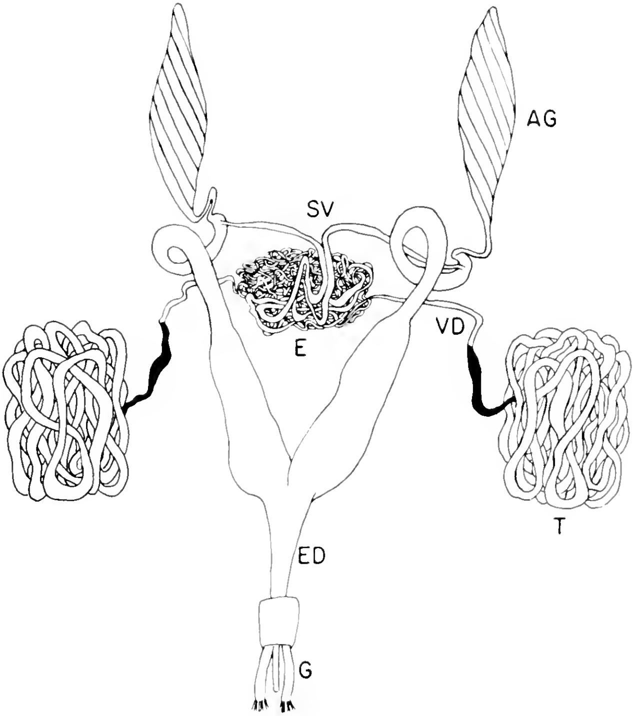

Figure 1. Diagram of male reproductive system of *Dineutus* sp. AG, accessory gland; E, epididymides; ED, ejaculatory duct; G. external genitalia; SV, seminal vesicles; VD, vas deferens.

spermatozoa develop within these follicles and are often in cysts formed by testicular cyst cells (Blunck, 1912; Davey, 1965; Imms, 1960; Krause, 1946; Snodgrass, 1935; Williams, 1945).

Preliminary studies indicate that in *Dineutus* the spermatozoa do not pass through most of their development stages in cysts as often occurs in insects with testicular follicles. Single spermatozoa of varying lengths, with cytoplasmic blobs indicating immaturity, occur at the anterior ends of the uncoiled testes. As one proceeds posteriorly along the testes, the spermatozoa lose their blobs, become longer, and groups of spermatozoa become surrounded by cells which form cysts about each group. Near the posterior end of the testes, the walls of the cysts break and become dissipated. However, most of the sperm remain in groups, held together by masses of material at their anterior ends. These adhesive masses may be composed of cyst cells, or derived from these cells, as found by Anderson (1950) in the Japanese beetle.

Within the vasa deferentia the groups of spermatozoa with the adhesive material became associated together into larger groups. Often chains of groups, considerably longer than individual sperm were seen, and the tails of the sperm were often twisted into tight spirals.

Each vas deferens passes from a testis toward the midline of the body, becomes very small and convoluted, and is entangled with the other to form a tightly coiled mass. The term epididymis (E, Fig. 1) is often used for a coiled or convoluted part of a vas deferens (Snodgrass, 1935; Tuxen, 1956). Because of the small diameter of the epididymides, and the compact tortuous coils, we have not been able to maintain complete orientation within this mass with conventional dissection methods. However, within the epididymides, groups of spermatozoa of varying lengths and spermatostyles have been encountered. Sometimes the spermatostyles had their complete complement of spermatozoa; sometimes only a few sperm were attached; and sometimes the rods were bare.

As indicated in the diagram, the very small tubes of the epididymides enlarge near their posterior ends forming what might be called seminal vesicles (SV, Fig. 1). These larger tubes are relatively easy to dissect. The formation of the spermatostyles and the attachment of the spermatozoa are essentially complete, so far as phase contrast microscopy reveals, by the time the seminal vesicles are attained. Well formed spermatostyles with attached spermatozoa also occur in the common ducts of the vasa deferentia and accessory glands, and they are also found routinely within the spermathecae of females. Spermatozoa, attached to spermatostyles, when removed from seminal vesicles, common ducts, or spermathecae, often became quite active in saline. In fact, on several occasions, the beating of the sperm tails has caused the spermatostyles to move rather rapidly through the saline. Detached spermatozoa were also often active and sometimes swam across the microscope field.

The rods or spermatostyles with their attached spermatozoa vary in length, diameter and conformation (Fig. 2 and 3) although it is probable that some of the variation may represent different developmental stages. We have tentatively assumed that most of the spermatostyles in the posterior part of the male reproductive system, and those in the female reproductive tract are fully developed. In these regions, most of the spermatostyles have been 800 to 1,000 micra in length, and the spermatostyles were apparently rigid (Fig. 3). In the epididymides, however, where formation of the rods and the association of the spermatozoa occur, much shorter spermatostyles have been found and some of the rods have been apparently flexible (Fig. 2). Individual spermatozoa are approximately 150 micra in length.

The development of the spermatozoa and the spermatostyles in these whirligig beetles is apparently continuous during the summer in this area. From the first of July until the middle of October we averaged several dissections per week, and in practically all specimens we found similar stages in comparable parts of the male reproductive system.

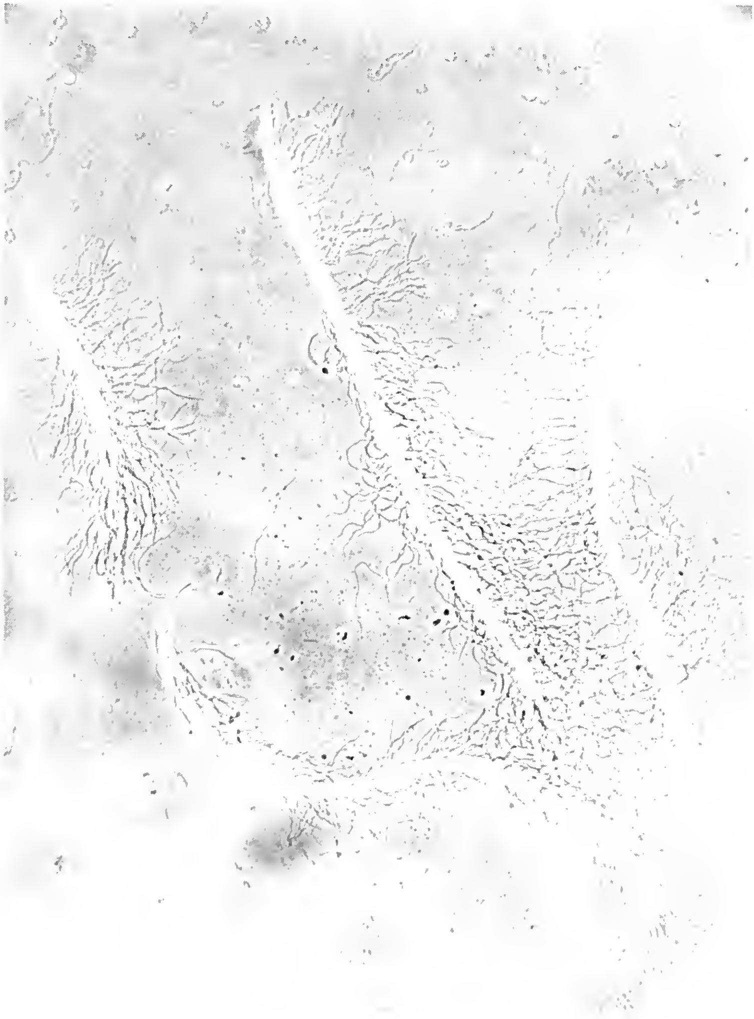

Figure 2. Spermatostyles with attached spermatozoa, from epididymis of *Dineutus* sp. The curved, apparently flexible, spermatostyles suggest that they are not completely developed. Phase contrast, ca. 190X.

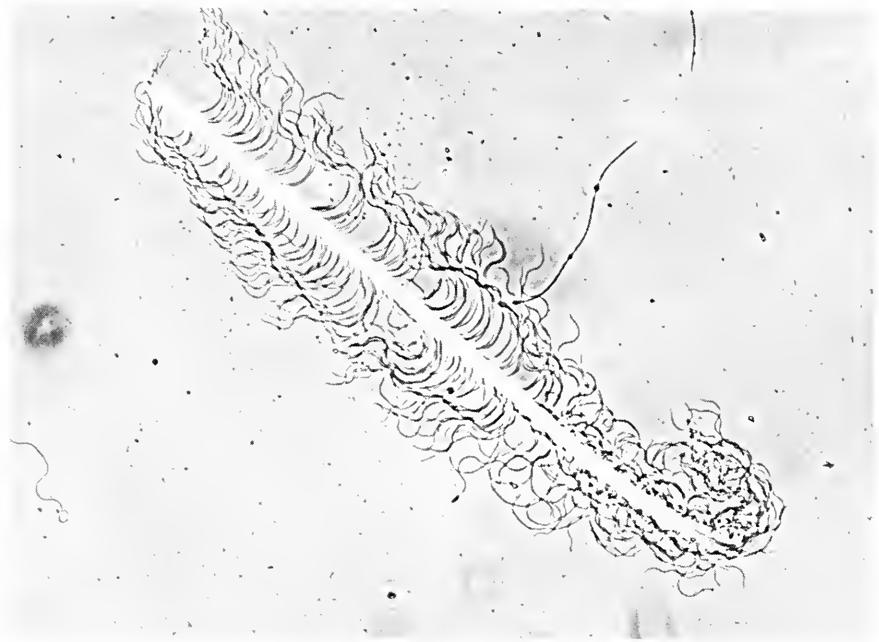

Figure 3. Spermatostyles with attached spermatozoa, from seminal vesicle of *Dineutus* sp. The relatively straight, apparently rigid, spermatostyle suggests that it is more completely developed than those in Fig. 2. Phase contrast, ca. 225X.

Discussion

The observations we have made to date suggest two possibilities with respect to the formation of the rods or spermatostyles, and the attachment of the spermatozoa. One possibility is that the rods are formed first, and the spermatozoa attach to the spermatostyles after they have formed. We have seen rods free of spermatozoa in various parts of the vasa deferentia, but we have not seen anything free of spermatozoa that could be considered as developmental stages of the rods. All spermatostyles free of spermatozoa we have seen have been fully developed. There has not been any indication that individual motile sperm are attracted to the spermatostyles, nor can we suggest a method by which the spermatozoa could attach to a fully formed rod. For these reasons, and for other reasons to be mentioned, we are at present inclined to support the second suggested sequence of events noted below.

We have mentioned that groups of spermatozoa with their anterior ends embedded in masses of material (possibly cyst cells) occur near the anterior ends of the vasa deferentia. It has been noted also that these groups occur attached to each other in chains of varying lengths. Shiny material, similar in appearance to that at the anterior ends of the individual bundles can often be seen along these chains, and each bundle is probably attached to the chain by this material. It is suggested that as development proceeds that the adhesive material becomes transformed into the rods or spermatostyles (possibly with some contribution from the epididymides) with the heads of the spermatozoa embedded within them. What might cause this transformation has not been established, although certain things are suggestive. Anderson (1950) found evidence that cyst cells are capable of active synthesis, and the material in which the groups of sperm heads of the gyrinid beetles are embedded is probably composed of cyst cells or is derived from the cells. Since the sperm tails within the groups of sperm often occur in tight spirals, it seems possible that the tails could help in compressing the material into the rods.

It is possible that the spermatostyles with their attached spermatozoa could be considered as modified spermatophores, but so far as could be determined, nothing comparable to the present situation has ever been reported in insects. Spermatophores that have been described vary considerably in structure, method of formation, and time of formation (cf. Alexander, 1963; Davey, 1960; Hinton, 1963; Khalifia, 1949; Wilde, 1964). In some cases they are elaborate structures consisting of sperm sacs in a gelatinous matrix; in other instances either the matrix or the sperm sacs are lacking. Hyaline threads or rods supporting droplets containing sperm (some Collembola and Thysanura) are considered by some to be modified spermatophores (e.g. Alexander, 1963). In some insects the spermatophores are completely formed in the male before copulation; in others they are formed during copulation, and partly within the body of the female. The origin of the gelatinous matrix is not known in all cases, but sometimes it is formed by the male accessory glands and/or cells in the vasa deferentia. The hyline rods in the Collembola and Thysanura mentioned above may be similar to the spermatostyles, but in these cases the spermatozoa are apparently not tightly attached to the rods as in the gyrinids, and the methods of transfer from male to female are presumably different in the two groups.

Although it cannot at present be determined whether or not the spermatostyles and their attached sperm are homologous with spermatophores, one similarity between the two is obvious. The combination of spermatostyles and spermatozoa makes it possible for large numbers of sperm to be transferred to the female at one time, an occurrance which might be considered as one function of a spermatophore. Indications are that within the spermatheca of the female the spermatozoa become detached and the spermatostyles eventually disintegrate. Broken and partially disintegrated spermatostyles, free of spermatozoa, have been recovered from spermathecae on two occasions.

It seems possible that certain phenomena reported in the Dytiscidae may have some significance with respect to the present situation. It has been known for a long time that in some Dytiscidae the spermatozoa occur in pairs with the heads fused together forming what have been called double sperm. During development in these insects, masses of tightly wound spermatozoa occur with their heads bound together by an attachment mass (the socalled *Klebemasse*); in some species, chains of spermatozoa are formed and small rodlets may develop from the attachment mass (Ballowitz, 1895). According to Ballowitz, the heads of double sperm and the chains of sperm are held together by material from the attachment mass. Several of the illustrations published by this author are very similar to certain developmental stages we have seen in *Dineutus*.

Sharp and Muir (1912) found that the genitalia of the Gyrinidae are more similar to the Hydrophilidae than to the Dytiscidae, but most modern workers believe that the Gyrinidae and Dytiscidae are closely related (e.g. Arnett, 1963; Crowson, 1960; Leech and Chandler, 1956). It has been suggested also that modern gyrinids and dytiscids are descended from dytiscid stock (Crowson, loc. cit.). The similarities in the male reproductive systems of *Dineutus* and several species of dytiscids mentioned previously, as well as, the similarities of sperm developmental stages, could be considered as additional evidence that gyrinids and dytiscids are closely related. Perhaps both modern gyrinids and dytiscids inherited a rudimentary pattern of unusual sperm association and some gyrinids further elaborated this pattern to form the rods or spermatostyles.

One additional point should be mentioned. The large size and apparent complexity of the accessory glands in *Dineutus* suggest that these glands have an important function in reproductive processes. In fact our first thought when the spermatostyles were discovered was that the spermatostyles were formed by the accessory glands. However, we have stated previously that the spermatostyles are apparently completely formed, and the spermatozoa are associated with them before the vasa deferentia join the ducts of the accessory glands. This situation suggests that the accessory glands do not have a major role in the formation of the spermatostyles. It seems possible, however, that the accessory glands may contribute additional material to the spermatostyles after they attain the common duct of the vasa deferentia and the accessory glands. It also seems probable that the accessory glands secrete material which could help in the transfer of the spermatostyles to the female.

Additional studies of this unusual situation, including electron microscopy, are now in progress.

Acknowledgements

The writers greatly appreciate the help of the following who assisted in this project: Drs. Horace Burke and Paul Spangler, who identified the gyrinid beetles, and Dr. John Biesele, Mrs. Pauline West, Robert Riess, Jon Flores, and William Records who gave other assistance. This work was supported in part by Grant No. 5262, Penrose Fund, from the American Philosophical Society, Biomedical Science Support Grant 5 So5 FR 07071-04, NIH, and by the University of Texas Research Institute.

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2.0028 Preliminary studies of the spermatozoa and the male reproductive system of some whirligig beetles (Coleoptera: Gyrinidae).

Abstract.– Studies have been made of the developing spermatozoa and the male reproductive systems of two species of whirligig beetles, genus *Dineutus.* As the spermatozoa of these beetles pass through the vasa deferentia, they become attached by their heads to long rods (as much as 1,000 micra in length) which have been termed spermatostyles. These spermatostyles with the attached spermatozoa also occur in the female reproductive tract. Two possible methods of formation of this unusual sperm association are discussed. Brief comparisons are made between the reproductive systems of *Dineutus* and some Dytiscidae, as well as, comparisons of sperm associations in the two groups.–
Osmond P. Breland and **Everett Simmons,** *Department of Zoology, University of Texas, Austin, Texas 78712.*

Descriptors: Coleoptera; Gyrinidae; spermatozoa; male reproductive system; *Dineutus* spp.; spermatostyles; Dytiscidae.

[3.0013]

ACCESSORY PULSATING ORGANS IN THE LEGS OF *Gelastocoris oculatus* (Fabricius) (Heteroptera: Gelastocoridae) [1]

Halkard E. Mackey, Jr. [2]

During a survey of the morphology of *Gelastocoris oculatus*, pulsating organs used for blood circulation were found in each leg of the adult and the fifth instar nymph. Earlier nymphs were not examined. These organs were seen in the tibia near the point of its articulation with the femur (Fig. 1).

Pulsating organs are apparently widespread in Heteroptera especially in Pyrrhocoridae and Hydrocorisae (Poisson, 1951). Locy (1884a) made numerous observations of their presence in species of *Gerris, Corixa, Notonecta, Belostoma, Perthostoma* (Nepidae), and *Ranatra* (Nepidae). Wigglesworth (1965) described a variety of pulsating organs in insects and included a figure of the pulsating organ in the leg of *Notonecta* sp. For those insects studied by Locy (1884a and 1884b), except for *Ranatra* sp., the pulsating organ of the prothoracic leg occurs near the articulation of the tibia and tarsus, while in the other legs its location is near the articulation of the femur and tibia. Brocher (1909), in studies of species of *Ranatra, Nepa, Corixa, Notonecta,* and *Naucoris*, noted the presence of pulsating organs in similar positions. Wigglesworth (1965) also figured the pulsating organ in the prothoracic leg of *Notonecta* sp. as near the articulation of the tibia with the tarsus. Locy (1884a) gave the location of the pulsating organs in *Ranatra* sp. as near the articulation of the tibia and femur in all legs, as did Hamilton (1931) in *Nepa cinerea.* Presswalla and George (1936) stated that the accessory pulsating organs occur in the tibia of all the legs of *Sphaerodema rusticum* (Belostomidae). Brocher (1909) noted that in the nymphs of *Notonecta* sp., Locy (1884a) in the nymph of *Belostoma* sp., and Rawat (1939) in the last instar nymph of *Ilycoris cimicoides* (Naucoridae) that the pulsating

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[1] Portion of a dissertation for the University of Tennessee, Knoxville, Tennessee. Accepted for publication February 9, 1970.

[2] Department of Zoology and Entomology, The University of Tennessee, Knoxville, Tennessee 37916.

organs are situated in all legs near the articulation of the tibia and femur.

Pulsating organs in the legs of Heteroptera apparently are characteristic of Hydrocorisae and Pyrrhocoridae. Even though there appears to be some variation as to the location of these organs in Hydrocorisae, accessory pulsating organs in *Gelastocoris oculatus* may serve as further evidence linking Gelastocoridae with Hydrocorisae. Accessory pulsating organs also occur in at least one genus, *Gerris*, of Amphibicorisae (Locy, 1884a) and in one family, Pyrrhocoridae, of Geocorisae.

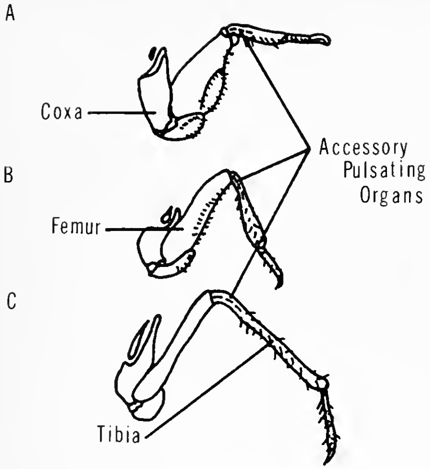

Figure 1. Legs of *Gelastocoris oculatus* showing the location of the accessory pulsating organs. A. Prothoracic leg; B.Mesothoracic leg; C. Metathoracic leg.

Acknowledgements

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2.0013 Accessory pulsating organs in the legs of *Gelastocoris oculatus* (Fabricus) (Heteroptera: Gelastocoridae).

Abstract.– The presence of accessory pulsating organs in the legs of *Gelastocoris oculatus* may serve as further evidence linking Gelastocoridae with Hydrocorisae.– **Halkard E. Mackey, Jr.**, *Department of Zoology and Entomology, University of Tennessee, Knoxville, Tennessee 37916.*

Descriptors: Heteroptera; Gelastocoridae; *Gelastocoris oculatus*; pulsating organs.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

Publications received.–The following annotated list of publications and short reviews have been received for notation in this section.

Natural History

Woodcock, George 1969. Henry Walter Bates, Naturalist of the Amazons. Barnes and Noble, N. Y. 269 p. Cloth, $ 5.50.

A brief, but well written and readable account of the life of Henry Bates. Bates relationships with the other great naturalists of his day, Wallace, Darwin, and Hooker, are well brought out.–**S. S. Roback.**

Medical Entomology

James, Maurice T. and **Robert F. Harwood** 1969. Herm's Medical Entomology, 6th ed. The MacMillan Co., N. Y. ix + 484 p. Cloth, $ 15.00.

An up-to-date, extensively rewritten book on the biology and control of medically important arthropods. With increased travel spread of arthropod disease vectors, a broad approach to medical entomology problems is stressed. Principles of control are emphasized and the purely taxonomic data has been reduced.–**S. S. Roback.**

Morphology

Chapman, R. F. 1969. American Elsevier Publishing Co., Inc., N. Y. xii + 819 p. Cloth, $ 13.75.

This deceptively simple book is one of the most valuable reference books on insect morphology and physiology to appear in many years. The thrust of the volume is the integration of structure, function and behavior. There are 6 major sections in the book, starting with the head and including subsections on the appendages, feeding, the alimentary canal, digestion and absorption, nutrition, the fat body and general metabolism and color. The succeeding sections are on the thorax, the abdomen, the cuticle, the nervous and sensory systems and the blood, hormones and pheromones. Each of these sections is also subdivided as is the section on the head. The discussions of each topic are very lucid and references are given to sources and to more comprehensive treatments of the subject. The illustrative material consists of line drawings of excellent clarity and quality which complement the text. There is an extensive bibliography as well as both subject and taxonomic indices.

In all, this is an extremely useful book not only to students but to practicing entomologists who require information on subjects impinging on their prime field of study. In addition to its other merits, compared to other current literature, the price is very reasonable.–**S. S. Roback.**

Regional Guides

Horning, Donald S., Jr. and **William F. Barr.** 1970. Insects of craters of the Moon National Monument, Idaho. University of Idaho, College of Agric., Misc. Ser. no. 8, [ii] + 118 p.

Regional Lists

Kirk, Vernon M. 1970. A list of beetles of South Carolina. Part 1–Northern Coastal Plain. South Carolina Agric. Exp. Sta., Tech. Bull. 1033 (Dec. 1969). 124 p.

Pest Management

Sterile male technique for eradication or control. Proc. Panel FAO/IAEA Div. Atomic Energy in Food and Agriculture, 1968, Vienna. 1969, 142 pp. UNIPUB, Inc., P.O. Box 433, N. Y., N. Y. 10016. Cloth $ 4.00.

This is another of the excellent panel proceedings series (PPS) of the International Atomic Energy Agency. The publication contains the summary of the meeting and the recommendations of the Panel. The summary includes data on insects which research information is available and which are ready for field testing; list of insects on which basic and applied research is needed; reduction of populations prior to release of sterile insects; increased studies of genetic mechanisms, biology and field ecology; prevention of diseases in mass rearings. The papers presented at the Panel include a number of articles on sterile male techniques in the U.S., USSR, Europe, Asia, and South America. There is also an interesting article on the possibility of a new method for the control of insect pests by means of genetic translocations.– **Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, Md. 21228.*

Radioisotopes and ionizing radiations in entomology, vol. IV, Biographical series no. 36. International Atomic Energy Agency, Vienna, 1969. 805 p. UNIPUB, Inc., P.O. Box 433, N. Y., N.Y. 10016. Cloth $ 22.00.

This annotated bibliography is the fourth of a series which cover the years 1950 to 1967. This particular volume covers the year 1966-1967. Abstracts have been included whenever possible. The bibliography is organized in such a way as to permit several different approaches to the individual references. The documentation will be of practical use to the specialist requiring a rapid survey of relevent publications in related disciplines, to someone in search of detailed documentation on a particular aspect of the field and to the scientist in developing countries or elsewhere whose access to the world literature might be somewhat limited. It should be in all scientific institutional libraries.– **Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, Md. 21228.*

[3.0023]

DISTRIBUTION RECORDS OF THE LOCUST LEAF MINER, *Odontota dorsalis* (Thun.), [1] IN THE UNITED STATES [2]

William N. Cannon, Jr. [3]

The records and reports of the distribution of the locust leaf miner, *Odontota dorsalis* (Thun.) (Butte, 1968), in the United States have been assembled in this paper.

The locust leaf miner is native to North America. The primary host of this species is the black locust tree, *Robinia pseudoacacia* L. According to Newhall (1890), the native range of the black locust was the Allegheny Mountains from Pennsylvania to Georgia, but by at least 1890 it was very generally naturalized throughout the United States east of the Rocky Mountains.

An account of the natural history of the locust leaf miner was first published by T. H. Harris in 1835 (Chittenden, 1902). In 1859, Fitch reported observing this species in New York (Lintner, 1898) and in 1865 he discussed the damage it caused to black locust on Long Island (Fitch, 1865). Horn (1883) wrote that the beetle occurred in the "middle and southern states". It was observed in Harrison Co., West Virginia, about 1885 by Hopkins (1891). Schwarz (1891) reported that this beetle had defoliated black locust in the vicinity of Washington, D. C. These early reports were reviewed by Lintner (1898) in his bibliography of this species. Chittenden (1902) consolidated the information then available concerning its distribution. By this time its reported range extended from Massachusetts, Connecticut, and southern New York; south through Virginia; and westward through Indiana to Missouri.

At present this species has been reported from all states east of the Mississippi River, with the exception of Vermont. In addition, it has been found west

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[1] Coleoptera: Chrysomelidae.

[2] Accepted for publication February 9, 1970.

[3] USDA Research Laboratory, Northeastern Forest Experiment Station, Forest Service, USDA, Delaware, Ohio 43015.

of the Mississippi River in Missouri, Arkansas, and Louisiana. The known distribution is illustrated in Fig. 1. The source of this information is listed by state and county in the list given below.[4] It is recognized that the absence of records or reports of this species from any area, particularly from within the general range shown in Fig. 1, may reflect only the location of collectors or areas inspected by state survey entomologists.

Distribution records by county of the locust leaf miner in the United States

Alabama: Loding (1945), CEIR[5] '66; Colbert: APIC, CEIR '63; Cullman: CEIR '63; Franklin: CEIR '63; Jefferson: CEIR '63; Lee: APIC, CEIR '63; Mobile: APIC; Perry: APIC; Walker: Hays (1966)[6].

Arkansas: Benton: Warren (1966)[6]; Crawford: Warren (1966); Faulkner: CEIR '63; Hempstead: CEIR '63, Warren (1966); Nevada: CEIR '62, Warren (1966); Scott: Warren (1966); Sebastian: Warren (1966); Washington: UADE, NYSM.

Connecticut: UMDE, USNM, Chittenden (1902), CEIR '53; Fairfield: AMNH, CUIC; Hartford: KSUC; New Haven: CUIC, CEIR '53.

Delaware: Kent: RUIC, UDCC, CEIR '58; New Castle: Milliron (1958), CEIR '66; Sussex: UDCC.

District of Columbia: ISUI, MCZC, Chittenden (1902), Butte (1968).

Florida: DEFW; Key Largo: AMNH.

Georgia: MSUC; Fulton: CUIC.

Illinois: MCZ; Adams, Alexander, Calhoun, Carroll, Champaign, Coles, Cook, Dupage, Fayette: Sanderson (1966)[6]; Franklin: CEIR '63; Fulton: CEIR '62; Hancock, CEIR '63; Hardin: CEIR '64; Iroquois: CEIR '63; Jackson, Jo Daviess: Sanderson (1966); Johnson: CEIR '63; Lake: CEIR '63; Logan, Madison: Sanderson (1966); Mason: CEIR '62, Butte (1968); McLean: CEIR '62; McHenry: CEIR '63; Piatt: Sanderson (1966); Pike: CEIR '64; Pope: CEIR '63; Putnam, Rock Island: Sanderson (1966); Sangamon: CEIR '63; Union, Vermilion, Washington, White, Winnebago: Sanderson (1966).

Indiana: MCZC, Blatchley (1910), CEIR '57; Clark: PUIC; Dearborn: CEIR '60; Decatur: CEIR '60; Floyd: CEIR '66; Greene: CEIR '61; Harrison: PUIC, CEIR '66; Hendricks: USNM; Jefferson: CEIR '61; Jennings: CEIR '61; Knox: USNM, CEIR '61; Kosciuscko: PUIC; Lagrange: PUIC; Marion: PUIC; Marshall: CUIC; Monroe: PUIC; Morgan: PUIC; Perry: PUIC; Pike: PUIC; Posey: PUIC, RUIC; Pulaski: CEIR '59; Putnam: PUIC, TAMU; Rush: CEIR '59; Tippecanoe: PUIC; Vigo: PUIC, USNM; Wayne: PUIC.

Kansas: MCZC.

Kentucky: MCZC; Fayette: USNM; Floyd: MSUC; Franklin: Chittenden (1902); Jefferson: USNM; Nelson: Chittenden (1902).

Louisiana: East Baton Rouge: LSUC.

Maine: Kennebec: Brower (1966)[6]; Hancock: Procter (1938); Oxford: Brower (1966).

Maryland: MSUC, DEFW, CEIR '66; Allegheny: UMDC, CEIR '54; Anne Arundel: CUIC, UMDC, CEIR '63; Baltimore: UMDC, Butte (1968); Calvert: UMDC, USNM, CEIR '62; Carroll: UMDC, CEIR '61; Charles: UMDC; Cecil: UMDC; Frederick: MCZC, UMDC,

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[4] The meaning of the letter abbreviations for each collection cited is given in the acknowledgments at the end of this paper.

[5] Cooperative Economic Insect Report, Plant Pest Control Div., ARS, USDA.

[6] Personal communication.

USNM, CEIR '54; Garrett: USNM, Chittenden (1902); Howard: UMDC, USNM; Montegomery: UMDC, USNM, Chittenden (1902), CEIR '54; Plummers Island: USNM; Prince Georges: RUIC, UMDC, USNM, Chittenden (1902), CEIR '63; Queen Annes: UMDC; St. Marys: UMDC, CEIR '62; Summerset: CEIR '63; Washington: UDCC, UMDC, USNM, CEIR '64.

Figure 1.– Recorded distribution of *Odontota dorsalis* (Thun.) in the United States, by county.

Massachusetts: MSUC, UMDE, Chittenden (1902); Bristol: MCZC, UMDE; Essex: AMNH, CUIC, MCZC, UMDE; Hampden: MCZC, USNM; Hampshire: MCZC, UMEC; Middlesex: ISUI, MCZC; Norfolk: Butte (1968); Plymouth: MCZC; Suffolk: MCZC, MSUC, RUIC, USNM.

Michigan: Berrien: MSUC; Ingham: KSUC, MSUC; Kalamazoo: MSUC; Oakland: MSUC; Saint Joseph: MSUC; Washtenaw: Butte (1968); Wayne: MSUC.

Mississippi: Chickasaw: CEIR '51; Lee: CEIR '51; Grenada: NYSM; Monroe: CEIR '51; Pototoc: CEIR '51.

Missouri: Boone: Brown (1966)[6]; Grundy: Brown (1966); Pike: Chittenden (1902); St. Louis: ISUI, UMTM; Washington: Chittenden (1902).

Nebraska: MCZC.

New Hampshire: Cheshire: DENH; Grafton: AMNH; Rockingham: Brower (1966)[6]; Strafford: DENH.

New Jersey: OSUC, PSUC, Smith (1910); Atlantic: MCZC; Bergen: AMNH, CUIC, MCZC; Burlington: AMNH, CUIC, PUIC, USNM; Camden: RUIC; Cape May: RUIC; Essex: AMNH, RUIC; Gloucester: PSUC, RUIC; Mercer: AMNH; Middlesex: AMNH, RUIC; Monmouth: AMNH, USNM, Butte (1968); Morris: CEIR '53; Ocean: AMNH, RUIC; Union: AMNH, USNM; Warren: USNM, Butte (1968).

New York: PSUC, PUIC; Albany: NYSM; Cattaraugus: CUIC, USNM; Cayuga: Leonard (1926); Dutchess: Leonard (1926); Kings: Chittenden (1902), Butte (1968); Monroe: NYSM; Steuben: CUIC; Nassau: CUIC, Fitch (1865), Leonard (1926); New York: AMNH, Leonard (1926); Niagara: CUIC; Orange: Leonard (1926); Otsego: AMNH; Queens: AMNH, Chittenden (1902), Leonard (1926); Rensselaer: Leonard (1926); Richmond: AMNH; Suffolk: AMNH, CUIC, NYSM, Chittenden (1902), Leonard (1926); Tompkins: CUIC, UDCC, Leonard (1926); Westchester: AMNH; Yates: CEIR '60.

North Carolina: UMEC; Allegheny: NCSU, Butte (1968); Buncombe: MCZC; Haywood: NCSU, MCZC, Butte (1968); Macon: MCZC; Montgomery: NCSU; Moore: RUIC; Polk: USNM; Surry: NCSU; Swain: MCZC; Wake: AMNH, NCSU, Butte (1968); Yancey: UMEC, USNM.

Ohio: MCZC; Adams: CEIR '63; Ashtabula: USNM; Athens: CEIR '62; Belmont: CEIR '60; Brown: MSUC, Chittenden (1902), CEIR '63; Clermont: Chittenden (1902); Clinton: CEIR '61; Coshocton: CEIR '65; Cuyahoga: UMEC; Delaware: OSUC; Eire: USNM; Franklin: NYSM, CEIR '64; Green: OSUC; Guernsey: CEIR '63; Hamilton: NYSM, Chittenden (1902); Highland: CEIR '63; Hocking: NYSM; Holmes: NYSM, CEIR '66; Jefferson: OSUC; Lawrence: NYSM; Lorain: NYSM; Madison: CEIR '63; Meigs: Cannon (1966)[7]; Montgomery: CEIR '60; Pike: CEIR '63; Ross: CEIR '63; Scotia: NYSM, OSUC; Vinton: OSUC; Washington: CEIR '63; Wayne: CEIR '64.

Pennsylvania: KSUC, MSUC, NYSM, RUIC; Adams: CUIC, PSUC, CEIR '57; Allegheny: CUIC, TAMU, USNM, Chittenden (1902), CEIR '62; Armstrong: USNM; Beaver: PSUC, CEIR '59; Bedford: AMNH; Blair: CEIR '61; Bucks: AMNH. RUIC; Butler: CEIR '62; Centre: PSUC; Chester: Gesell (1966)[6]; Cumberland: PSUC; Dauphin: PSUC, USNM; Delaware: USNM; Erie: PSUC, USNM; Fayette: PSUC, USNM, CEIR '63, Butte (1968); Franklin: AMNH, USNM, CEIR '55; Fulton: AMNH; Green: Guyton (1926); Huntington: CEIR '61; Indiana: PSUC; Lackawanna: Gesell (1966); Lancaster: AMNH, PSUC; Lycoming: PSUC; Monroe: AMNH, PSUC, Butte (1968); Montgomery: PSUC; Perry: CEIR '59; Philadelphia: CUIC, OSUC, Butte (1968); Pike: AMNH; Somerset: Gesell (1966); Washington: CEIR '59; Westmoreland: CEIR '62; York: OSUC, Chittenden (1902), CEIR '57.

Rhode Island: Providence: USNM.

South Carolina: MCZC; Florence: Cochran (1966)[6]; Greenville: Cochran (1966); Pickens: Cochran (1966).

Tennessee: CEIR '55; Clairborne: CEIR '66; Cocke: CEIR '65; Davidson: USNM; Humphreys: USNM; Knox: CEIR '66; Polk: USNM; Robertson: Butte (1968); Sevier: CUIC; MSUC, UMEC; Union: CEIR '66; Wilson: MSUC.

Virginia: MSUC, UMEC, DEFW; Amherst: CEIR '65; Arlington: USNM, Chittenden (1902); Augusta: USNM, CEIR '62; Botetourt: USNM, CEIR '66; Brunswick: CEIR '56; Charlotte: CEIR '56; Culpepper: CEIR '56; Fairfax: CUIC, ISUC, MCZC, UMEC, USNM; Fauquier: CEIR '59, Butte (1968); Floyd: MSUC; Frederick: MCZC; Greene: CEIR '62; Lee: CEIR '65; Loudoun: UDCC, USNM, CEIR '62; Madison: ISUI; Nelson: USNM, CEIR

[7] Author's collection.

'65, Butte (1968); Norfolk: Butte (1968); Page: USNM, CEIR '56; Rappahanock: CEIR '59; Richmond: RUIC; Roanoke: CEIR '63; Tazewell: USNM; Warren: USNM; Wise: CEIR '65.

West Virginia: Hopkins (1896), CEIR '58; Braxton: CEIR '54; Cabell: CEIR '55; Hancock: Chittenden (1902); Harrison: Chittenden (1902), CEIR '54, Hopkins (1891), Butte (1968); Kanawha: CUIC; Monongalia: ISUI, USNM, Chittenden (1902); Preston, Tucker, Tyler, Upshur, Wood: Chittenden (1902).

Wisconsin: USNM; Grant: Conrad (1966)[6]; Trempealeau: CEIR '63; Walworth: CEIR '63.

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I wish to express my appreciation to the following individuals for sharing their personal observations of this species and for providing information on material in the collections of their respective institutions:

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2.0023 Distribution records of the Locust Leaf Miner, *Odontota dorsalis* (Thun.), in the United States.

Abstract.– The locust leaf miner, *Odontota dorsalis* (Thun.) (Coleoptera: Chrysomelidae), has been reported in the United States from all states east of the Mississippi River except Vermont. It has been reported also in Missouri, Arkansas, and Louisiana. A summary of the present known distribution is presented for these states by county.– **William N. Cannon, Jr.,** *Northeastern Forest Experiment Station, Delaware, Ohio 43015.*

Descriptors: Locust leaf miner; Coleoptera; Chrysomelidae; *Odontota dorsalis*; distribution.

[3.0014]

GLUCOSE-U-C^{14} CATABOLISM IN *Plodia interpunctella* (Hübner)[1]

J. Harold Mohler and William J. Yurkiewicz[2]

Introduction

Most Lepidoptera show extreme sexual dimorphism in lipid content during development. Although this phenomenon has been extensively studied (Gilbert, 1967; Yurkiewicz, 1969) the metabolic basis for the higher lipid content of the male remains unclear. Domroese and Gilbert (1964) suggest that the male may metabolize more carbohydrate than the female during the pupal period, thus maintaining a higher lipid content. A study on the conversion of labeled glucose into lipid (Mohler and Yurkiewicz, in press) did not reveal any significant differences between the sexes, while experiments on castration and implantation of gonads (Gilbert and Schneiderman, 1961) indicate that egg development only partially explains the sexual dimorphism in lipid content. Gilbert (1967) implies that sexual dimorphism may ultimately be genetic in nature.

The Indian meal moth, *Plodia interpunctella* (Hübner), has a relatively short pupal period as compared to many Lepidoptera. Consequently, it could have a higher metabolic rate during the pupal period and any significant differences in carbohydrate metabolism between the sexes should be readily observable. This report is a study of the effects of sex on the rate of catabolism of labeled glucose to carbon dioxide during the pupal period of *Plodia interpunctella.*

Materials and Methods

P. interpunctella cultures were reared in glass containers at 30 degrees C and 60% RH using the Pablum medium described by Young (1961). Injections of glucose-U-C^{14} (Specific activity 3mC/mM) were made laterally in the abdo-

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[1] Accepted for publication February 18, 1970.

[2] Department of Biology, Millersville State College, Millersville, PA 17551.

men of last instar larvae with a microliter syringe. Each injection of 0.5 µl in volume consisted of enough glucose in water to produce 368,000 disintegrations per minute (dpm).

The larvae were allowed to pupate and were examined every 24 hours. As the larvae commenced pupation they were placed in separate 10 ml Erlenmeyer flasks. This was counted as day one. Respiratory quotient (RQ) studies (Domroese and Gilbert, 1964) on *H. cecropia* indicate that the greatest sexual dimorphism in RQ occurs about one-third through the pupal period. This corresponds to about day three in *P. interpunctella.* To equate this study with that of Domroese and Gilbert, it seems logical, since only one test is necessary, to select the equivalent period for this study. Therefore, forty-eight hours later on the third day of pupation the Erlenmeyer flasks were sealed with a rubber septum (Kontes Glass Co.) for periods of 12 and 24 hours, and evolving CO_2 was allowed to accumulate within the flask (Fig. 1). Three-tenths ml of 0.6N NCS (Nuclear Chicago Solubilizer, Amersham/Searle) was then placed in the plastic center well (Kontes Glass Co.) of the flask using a one ml ground glass syringe with a long steel needle. The NCS absorbed the evolved CO_2 (Hanson and Bush, 1967) and was allowed to remain within the Erlenmeyer flask for two hours.

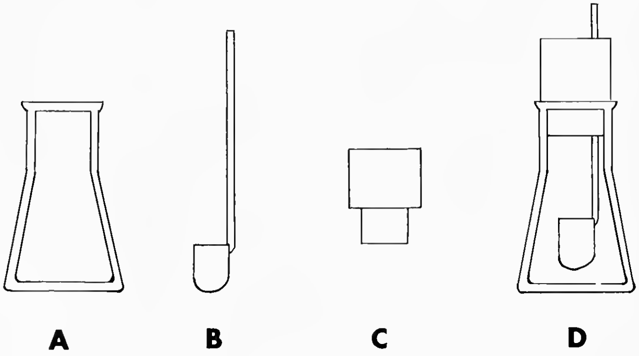

Figure 1. Flask for CO_2 collection: A. 10ml Erlenmeyer Flask; B. Plastic center wall; C. Rubber septum; D. Assembled flask.

When the two-hour absorption period was completed the septum, along with the center well, was removed from the flask. The center well was submerged in a vial of scintillation fluid. The cup portion was cut off and allowed to remain in the vial of scintillation fluid. The radioactivity within the sample was counted by standard liquid scintillation methods (Yurkiewicz, 1969). Results were corrected for quenching by the channels ratio technique.

Results and Discussion

The amount of label recovered in CO_2 was similar for both male and female in both 12 and 24 hour collections. (See table 1). These data indicate that the rate of catabolism of glucose to CO_2 is similar in both sexes. The male is apparently not catabolizing carbohydrates at a higher rate to complete adult development and to conserve lipid, nor is it converting carbohydrates to lipid at a higher rate than the female, and thus conserving lipid (Mohler and Yurkiewicz, in press). However, Yurkiewicz (1969) found that 62% of label from tripalmitin-1-C^{14}, injected into last instar larvae *P. interpunctella*, could be recovered from newly emerged adult males. Only 38% was recovered from adult females, indicating that males catabolize less lipid than females.

Table 1. Radioactivity in CO_2 recovered from pupal *Plodia interpunctella* injected at last larval instar with 368,000 dpm of glucose-U-C^{14}.

	Disintegrations per hour	
	12 hr collection	24 hr collection
MALE	5460 ± 1980[1] (N=26)	4200 ± 2340 (N=19)
FEMALE	5280 ± 3300 (N=31)	3600 ± 1560 (N=5)

[1] Standard deviation.

Adult *P. interpunctella* contain twice the amount of lipid as females (Yurkiewicz, 1969), but what mechanism the male uses to conserve lipid or what, if any, other substrate it may use to complete adult development remains unclear. The rate of conversion of labeled protein into lipid and CO_2 is currently being studied, and further experiments with other substrates are planned in hopes of explaining the sexual dimorphism in lipid metabolism in Lepidoptera.

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Yurkiewicz, W. J. 1969. Sexual dimorphism in neutral lipid metabolism in the Indian-meal moth *Plodia interpunctella* (Hübner). Ohio J. Sci., 69: 70-73.

2.0014 **Glucose-U-C^{14} Catabolism in *Plodia interpunctella* (Hübner.** Abstract.–Most Lepidoptera show extreme sexual dimorphism in lipid content during adult development. However, the metabolic basis for the higher lipid content of the male remains unclear. It has been suggested that the male may use other substrates instead of lipids to complete adult development. A study of the effects of sex in the Indian meal moth *Plodia interpunctella* on the conversion of labeled glucose to carbon dioxide during adult development, using a simple, efficient method for the collection of CO_2 from small insects, shows no significant difference in conversion of glucose to CO_2 between the male and female.– **J. Harold Mohler** and **William J. Yurkiewicz**, *Department of Biology, Millersville State College, Millersville, PA 17551.*

Descriptors: Glucose-U-C^{14} catabolism; Indian meal moth; *Plodia interpunctella*; sexual dimorphism; lipid.

Data Documents for Systematic Entomology

The following articles are available to specialists in complete form or as abstracts from The Institute for the Study of Natural Species (ISNS), 550 Elston Road, Lafayette, Indiana 47905, U. S. A. Copies are deposited in other Data Document centers as well. These documents are in addition to Data Document numbered articles and abstracts published in other sections of Entomological News.

2.0030 **A new Nearctic species of Dixinae (Culicidae: Diptera).**– One species of Nearctic Dixinae was omitted from the most recent revision. The adult, larval, and pupal stages of **Dixella alexanderi** Peters, NEW SPECIES, are herein described and illustrated:

Type locality.– Mississippi River, Sec. 34; T144N; R36W, Clearwater Co., Minn. Collected as a larva on July 9, 1963, by T. M. Peters and reared through to the adult stage in the laboratory. Location of type: Holotype, male adult, with last larval and pupal exuvium, United States National Museum, Type no. 70996, 5 male paratypes, 5 female paratypes, with associated larval and pupal exuviae.

Diagnosis: The adult may be distinguished from most other species of *Dixella* by a combination of the following characteristics: wing non-spotted; tarsal spiniform setal formula; genitalic conformation. The male may be distinguished from *D. californica* (Johannsen) by the more irregular caudal surface of the dististyle and sharper tip on the apical lobe of the basistyle; from *D. cornuta* (Johannsen) and *D. serrata* (Garrett) by the number of branches in the apical lobe of the dististyle (none in *cornuta*, one in *alexanderi*, and two in *serrata*); from *D. vespertina* Peters by the more irregular caudal surface of the dististyle and the more hooked terminal arm of the apical lobe. The female may be distinguished from *D. californica* (Johannsen) by the blunt apices of the cone-shaped sclerotized inflections of the bursa copulatrix; from *D. dorsalis* (Garrett) because its sclerotized inflections are more symmetrical; from *D. cornuta* (Johannsen) and *D. serrata* (Garrett) by its much larger sclerotized inflections.

So little is known of the immature stages of Nearctic dixines that no diagnosis of them has been included.– **T. Michael Peters** and **Pedro Barbosa**, *Department of Entomology, University of Massachusetts, Amherst, Massachusetts 01002.*

Descriptors: Diptera; Culicidae; Dixinae; *Dixella alexanderi*; Minnesota.

[Data Document Center, ISNS, 7 pp., 8 figs.]

Data Document comments.– The editor has received many comments on the introduction of the Data Document system as a part of Entomological News, but most of these have been prefaced by questions. These questions and their answers will be the basis for part of this section of the News for at least the next few issues. The following questions and comments have been received either in letters or through oral discussion. The interrogator is not identified because his permission was not requested. In the future questions and comments may be submitted to the editor and the author may be identified or not as he chooses.

QUESTION: What is "Data Documents for Systematic Entomology"? I do not understand the article that appeared in the News in January.

ANSWER: "Data Documents for Systematic Entomology" [DDSE] is a system for the selective dissemination of information [SDI] used by this journal. The two objectives are: 1) provide for immediate publication of all data, and 2) reduce the number of copies of a document to the actual number needed at the time of publication, with facilities for the immediate distribution of these data as needed in the future. It is restricted to descriptions of new taxa, pin label data, and similar data of a purely archieval nature, AND IT IS OPTIONAL.

QUESTION: Will DDSE eventually replace the present journal?

ANSWER: No. It is intended to provide only for immediate publication of new taxa as they appear in short, non-revisional papers. This is one of the major purposes of the News for the past 80 years. By using the DDSE system, more room is available for articles of a broader interest, plus giving this very rapid service for new taxa.

QUESTION: Suppose I decide to use the DDSE system; how will I be able to get reprints of my complete paper, and how much will they cost?

ANSWER: Although the original article published in the News described the system as a method of publication by means of duplication of the original manuscripts, it soon became apparent that most people objected to receiving copies of poorly typed originals. Since retyping each manuscript would be very time consuming, a modification of the original plan was made. All articles, upon acceptance for publication by the editorial board or reviewers, are set in type and the author is supplied with proof. Two forms are supplied with the proof; one is a conventional reprint order form. The other is a form requesting that the DDSE system be used. If the latter method of publication is chosen, the author may order as many free reprints (for the present at least) of the entire article as he needs to supply those of his colleagues working on the same group. The abstract (informative, not descriptive) is published, along with diagnoses of the new taxa, and the descriptors, in the next issue of the News. He is thus given immediate publication, validation of the taxa under the rules of the Code, and reprints to exchange with fellow workers. In addition, there is no need to store large quanities of reprints and there is never a time when his reprint stock is exhausted.

COMMENT: "I had the distinct impression that taxonomic descriptions are not alone read by a very few individuals but this applies to papers dealing with insecticides and with things that we might think were of general biological interest. For example, the nest building and habits of bees I discover I, myself, do not seem to read about with great care and neither do any of my colleagues."

COMMENT: "Though a ———— in taxonomic interests, I also follow cerambycid, scarabaeid papers and most papers on tropical taxa regardless of groups. This can be done only by "browsing" through library copies of journals."

COMMENT: According to the SATCOM report, if most biologists were actually aware of the amount of literature they miss on a given topic, even with a concentrated effort to make a complete literature survey, they would be discouraged to the point of abandoning the project. What then we might ask, is the merit of browsing compared to more suitable methods of information retrival?

[To be continued.]

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

3.0032 *Aeshna interrupta interrupta* **Walker, a subspecies of Odonata previously unreported from Pennsylvania.**– *Aeshnia i. interrupta* is a dragonfly hitherto recorded as occuring no farther south in the eastern United States than northern New York State. On September 15, 1969, a single male specimen of this species was taken alive by the writer from a web of the common orb-weaving spider *Argiope aurantia* at a small, shallow, cattail-fringed pond approximately one mile southeast of Lamar, Clinton County, Pennsylvania. The pond is one of two nearly-adjacent ponds on the property of the Lamar National Fish Hatchery. Four other species of *Aeshna* (*canadensis, tuberculifera, umbrosa,* and *verticalis*) were taken at one or both of these ponds.– **Clark Shiffer,** *Pennsylvania Fish Commission, Bellefonte, Pennsylvania 16823.*

Descriptors: Aeshnia interrupta interrupta Walker; Pennsylvania.

3.0041 **Chromosome number of the Indian meal moth,** *Plodia interpunctella* **(Hübner) (Lepidoptera: Pyralidae).**– During preliminary studies on *Plodia interpunctella* in 1969 the authors discovered a haploid chromosome number of n=31. This number is consistent with those of related Lepidoptera (Guthrie *et al.*, 1963; Makino, 1951; Virkki, 1963) and provides a basis for future cytogenetic studies. Counts were made from developing spermatocytes which were obtained from the testes of third and fourth instar larvae. Activity was slowed by placing the larvae on ice. The testes, easily seen externally by their color, were dissected into aceto-orcein fixative-stain on a slide and teased to release the spermatocytes. Counts were made of metaphase and early anaphase one cells. Slides were made permanent by using the dry ice method and euparal mountant. The authors are endebted to Dr. William Yurkiewicz and Mr. J. Harold Mohler of Millersville State College for supplying larvae.

Literature cited.– **Guthrie, W. D., E. J. Dollinger, and J. F. Stetson.** 1965. Chromosome studies of the European corn borer, smartweed borer, and lotus borer (Pyralidae). Ann. Ent. Soc. America, 58: 100; **Makino, Sajiro.** 1951. An atlas of the chromosome numbers in animals (2nd ed.). Ames, Iowa, 290 pp.; **Virkki, Niilo.** 1963. Gametogenesis in the sugarcane borer moth, *Diatraea saccharalis* (Fab.) (Crambidae). J. Agr. Univ. Puerto Rico, 47: 102.– **James C. Parks** and **Donna S. Terney,** *Millersville State College, Millersville, Pa. 17551.*

Descriptors: Lepidoptera; Pyralidae; *Plodia interpunctella*; Indian meal moth; chromosome number.

Schedule of laboratory division training cources.– A schedule of laboratory training courses to be offered by the Laboratory Division of the National Communicable Disease Center, Atlanta, George, for the period July 13, 1970 to June 25, 1971 may be obtained by writing to the Training Office, Laboratory Division, National Communicable Disease Center, Atlanta, Ga. 30333.– From *Communicable Disease Center* flyer.

3.0043 **Extension of insect ranges on the Arctic Alaskan Slope.**– A student reporting to us on his 1969 summer experiences in an oil camp on the shore of the Arctic Ocean near the mouth of the Colville River tells of mosquitoes as a considerable pest here. This seems noteworthy, since I was impressed in my own field work in 1948, 1949, and 1950 by their absence from Pt. Barrow and their repression by winds in other coastal areas. They were exceedingly abundant at Umiat, Anaktuvuk Pass and in the Brooks Range generally (see Weber, N. A. 1948. Ent. News, 59: 253-257; 1949, *loc. cit.* 60: 118-128; 1953, *loc. cit.* 64: 256-260; 1950, Trans. American Ent. Soc 76: 147-206; 1954, Proc. Ent. Soc. Washington, 56: 86-91). Among the mosquitoes identified were *Aedes communis, hexodontus, nearcticus, nigripes* and *punctor*. The common house fly had not yet reached Pt. Barrow (*loc. cit.* 1949, 1950). The syrphid, *Epistrophe bulbosus*, and a female *Aedes* were taken inside a DC-3 airplane from Fairbanks at Pt. Barrow (*loc. cit.* 1954).

The question arises whether these and other insects may not now be extending their ranges as a result of the shelters created by oil exploration activities through their buildings and new ponds and by the use of helicopters, making it a simple matter to transport insects from one place to another.– **Neal A. Weber,** *Swarthmore College, Swarthmore, Pa. 19081.*

Descriptors: Mosquitoes; range extensions; Arctic Alaskan Slope; Diptera; house fly; Syrphidae.

International Organization for Biological Control (IOBC).– Plans for a new global organization in biological control, building from the existing "Organization Internationale de Lutte Biologica" (OILB), under the title given in the above heading, were consummated at Amsterdam in November, as far as could be done at the time (1969). New statutes were proposed and approved by delegates, and other agreements reached. It is hoped that the widest possible interest and support can be made evident before February, 1971, at which time approval by the current OILB's General Assembly will presumably occur.

A fuller statement of the meeting in Amsterdam and of the aims and functions of this new organization, and the progress of development in other respects is being published in *The Bulletin of the Entomological Society of America*, to which interested parties are referred.– From *IOBC flyer.*

The Entomologist's Market Place

Advertisements of goods or services for sale are accepted at $1.00 per line, payable in advance to the editor. Notices of wants and exchanges not exceeding three lines are free to subscribers. Positions open, and position wanted notices are included here and may be referred to by box numbers. All insertions are continued from month to month, the new ones are added at the end of the column, and, when necessary, the older ones at the top are discontinued.

Rare Beetles, Butterflies from all parts of the World offered. Write: Michael Monguillon, 7 rue Berryer, Paris 8e, France.

For Sale: Determined beetles of all families from Middle Europe prepared for scientific study. O. Marek, Žamberk 831, Czechoslovakia.

Russian Entomological Literature Translated into English. One cent per word plus postage. Dr. V. P. Gargav, Department of Entomology, Jawaharlal Nehru Agriculture University, Jabalpur 4 (M.P.), India.

Bonnet: Bibliographia Araneorum. Vol. I of this classic monograph, which is essential to all research on spiders, has been reprinted. 832 pp., bound. $30.00. Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740, U. S. A.

Sharp & Muir: The Comparative Anatomy of the Male Genital Tube in Coleoptera. The classic 1912 monograph and six other papers by the same authors have been reprinted. 304 pp., 43 pls., bound. $10.00. An essential book for all coleopterists. Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740.

Bibliography of New Guinea Entomology (Gressitt and Szent-Ivany). Annotated, 6,140 references, through 1967; all fields of entomology: New Guinea, Bismarcks, Solomons; all subjects indexed. Pacific Insects Monogr. 18, 674 pp., map, 1968. $12.50 bound; $11.50 wrappers. Bishop Museum Press, Box 6037, Honolulu, Hawaii 96818.

For Sale: Goliath beetles, 14 different aberrations, 200 other species of beetles. Russell Dunn, Box 468, Sedona, Ariz. 86336.

Wanted: Live spiders to photograph their eyes. Earl Broderick, 5305 Douglas Dr., Yakima, Washington 98902.

Exchange Spanish Lepidoptera and Coleoptera. Pedro A. Talavera Torralba, Avd. Tirso de Molina, No. 1-4A, Cartagena (Murcia), Spain.

Wanted: Beginning collector wishes any back date or duplicate ent. lit., or reprints available (esp. on Coleopt.). Postage reimbursed. Also, to buy Dillon and Dillon, Manual of Common Beetles. Dennis H. Bartow, 601 Media Pky., Wallingford, Pa. 19086.

For sale: Copy of Blatchley's Coleoptera of Indiana, complete, front cover gone; Introduction to Entomology, 1st ed., 1924, poor condition. Send offer to Dr. R. C. Dobson, Dept. Entomology, Purdue University, Lafayette, IN. 47907.

Oedemeridae: determined promptly from any part of the World. Ross H. Arnett, Jr. Department of Entomology, Purdue University, Lafayette, IN 47907.

Wanted: Customers; am trying to liquidate large stock of Lepidoptera as well as my own collection. Discounts on all orders–write for list. Russell L. Dunn, Sedona, AZ 86336.

Wanted: Adult Cuterebridae (Diptera) for revision in progress. Prompt return or report. Curtis W. Sabrosky, Systematic Entomology Laboratory, USDA, c/o U. S. National Museum, Washington, DC 20560.

For sale: Books, periodicals, and reprints from private medical entomology library. Cornelius B. Philip, Rocky Mountain Laboratory, Hamilton, MT 59840.

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ENTOMOLOGICAL NEWS

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COMING NEXT ISSUE: Oviposition in Archilestes grandis (Odonata)

THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS

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MANUSCRIPTS and all communications concerning same should be addressed to: **Prof. R. H. Arnett, Jr., Institute for the Study of Natural Species, 550 Elston Road, Lafayette, IN 47905.** The receipt of all papers will be acknowledged and, if accepted, they will be published as soon as possible. Articles longer than eight printed pages may be published in two or more installments, unless the author is willing to pay the cost of a sufficient number of additional pages in any one issue to enable such an article to appear without division.

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EDITORIAL POLICY: Manuscripts on insect life and related terrestrial arthropods are appropriate for submission to Entomological News. Titles, to facilitate computer recording, should be limited, if possible to 80 characters including spaces and punctuation, and should include key words to the contents for indexing. A short informative abstract (not a description of the paper) of about 150 words or less should precede the article. The Editor may reword the abstract for brevity and scope for republication in **Biological Abstracts.** The author's complete mailing address, including zip code number, should be given as a footnote. All papers describing new taxa would be greatly improved by including illustrations of a part or the whole form, and by referring to existing keys, or if none exist, by including an identification key to related taxa. Immediate publication will be given to new distribution records, short field notes, and news in **"The Entomologist's Record"** section; literature notices and books received in **"The Entomological Library,"** and study notices, want items, for sale notices, positions open, and position wanted notices in **"The Entomologist's Market Place."** Articles of wide interest to the general entomologist and non-specialist on the subject of the article are especially desirable. Articles of an archival nature will be recommended for **"Data Documents."** Instructions for the latter will be furnished on request (see vol. 81, pp. 1–11).

Second-class postage paid at Lafayette, Indiana

[3.0047]

REDISCOVERY OF *Heliconius nattereri* IN EASTERN BRAZIL[1,2]

Keith S. Brown, Jr.[3]

I. HISTORY

Heliconius nattereri is a very striking and practically unknown member of a characteristically neotropical genus of striking and generally well known butterflies. It was first described from Bahia, in eastern Brazil, by the Felders in 1865; alleged type specimens are present in the British Museum (Natural History) and in the Weiner Museum in Austria, the latter being the true holotype through designation by the Felders. To our knowledge, during the hundred years following its description, only fourteen additional specimens were obtained, all from the same area and all males. Two of these, not mentioned in the literature (Riffarth, 1901; Emsley, 1965) or in European collections, are in the collection of the Museu Nacional in Rio de Janeiro, and are the only two of the sixteen specimens which bear accurate locality and date labels: Fazenda São João, Agua Preta (today called Uruçuca), inland from Ilhéus, Bahia, September 1928, collected by E. May; and Santa Teresa, Espírito Santo, May 19, 1928, collected by O. Conde, from the collection of Julius Arp. Eduardo May, an intense and assiduous field collector, also mentioned (1939) seeing another male in the Uruçuca area, and observing a male flying too high to be captured in October 1936 in the woods along the road between Colatina and Nova Venezia, in northern Espírito Santo.

A very closely related butterfly species, with identical red basal spots on the underside of the wings (regarded presently as very important in *Heliconius* systematics; see Emsley, 1963, 1964, and 1965) was originally noted in an unpublished Boisduval manuscript as *H. teridas*, and finally legitimately named by Riffarth in 1898 as *H. fruhstorferi.* The type of *H. teridas*, in the British Museum, came from "Pernambuco" (including parts of at least four present-day states) and is a female. The presumed Riffarth type, and an additional two *H.*

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[1] The Heliconians of Brazil. (Lepidoptera: Nymphalidae). Part 1.

[2] Accepted for publication May 26, 1970.

[3] Centro de Pesquisas de Produtos Naturais, Faculdade de Farmácia, U. F. R. J. Praia Vermelha, Rio de Janeiro ZC-82, Brazil.

Ent. News, 81: 129-140, 1970

fruhstorferi, all females, all originally from the Fruhstorfer collection and now in the British Museum (Natural History), were captured in Espírito Santo, almost surely in the Santa Teresa area (which is the "Santa Leopoldina" of the German literature in general and the Lepidopterorum Catalogus of Junk). An additional female from "Bahia" is present in the Paris Museum, and a further two females, presently in the Museum of the Humboldt-Universität in Berlin, were mentioned by Riffarth (1901).

Although *H. nattereri* and *H. fruhstorferi* were tentatively linked by some early authors as male and female of the same species, they are so different in overall appearance (Figures 1 and 2), and sexual dimorphism is so rare in heliconians, that they have been maintained up until the present as nomenclaturally distinct entities. The two were apparently never captured together, and the total number of specimens of each in existence in 1964 was so small that in a definitive revision of the genus *Heliconius* it was suggested that they might even be color-morphs unassociated with sex (Emsley, 1965).

We have recently begun intensive biochemical investigations of the genus *Heliconius* (Brown, 1965, and 1967; Brown and Domingues, 1970; Tokuyama *et al.*, 1967), and needed to acquire full information on the species occurring in extra-Amazonian Brazil. This eventually led us to prepare a complete supplementary revision to Emsley's papers, developed with Dr. Emsley's cooperation, in the light of many new data on both Brazilian and extra-Brazilian species (Brown and Mielke, *in press*). It also required a definition of the relationship between *H. nattereri* and *H. fruhstorferi*, as well as breeding of this (or these?) species, since it was placed by Emsley as the most primitive of all *Heliconius* spp. and therefore directly next to the biochemical and cytological "hinge" of the tribe Heliconiini: more primitive genera and *Eueides* do not store 3-hydroxy-L-kynurenine as a tegument pigment (above reference) and all except *Philaethria* and *Podotricha*) have 31 pairs of chromosomes (de Lesse, 1967; T. Emmel, personal communication; Soumalainen, Cook, and Turner, *in press*; de Lesse and Brown, unpublished results); while all species of *Heliconius* store the pigment and almost all, except most evolved forms, show n=21.

Extensive preliminary travels in the broad area of tertiary tablelands in coastal Bahia, northern Espírito Santo, and eastern Minas Gerais revealed that almost all of the primary vegetation in this faunal subregion (which is notable, in remnants of virgin forest, for a wealth of typically Amazonian plants and animals, as well as a very high percentage of endemic species) had been substituted by arid grassland and poor second growth. The sandy Amazon-basin type soil did not permit even the partial recuperation of primary woods; where the original vegetation was cut and burned, it was rapidly and permanently replaced by sterile saw-grass fields or scrub. Of the known localities for *H. nattereri*, the woods north of Colatina had long since disappeared, and the forests of the Fazenda São João had been totally cleared of their undergrowth (probably including all *Passiflora* spp. vines, the exclusive food plants of heliconians) to plant cacao.

Very extensive virgin forests were found to still exist, however, in the highlands around Santa Teresa, where a populace enlightened over several decades in the principles of wildlife conservation (in the last thirty years chiefly by Dr. Augusto Ruschi, world famous for his studies of orchids and hummingbirds) had preserved much of the original vegetation, and created several public and private forest preserves. Here, in preliminary collecting characterized principally by very unfavorable weather, we verified the existence of an exceedingly rich mixture of butterfly faunas from adjacent areas (Brown and Mielke, manuscript in preparation; for example, seventeen of the eighteen species of heliconian, and all eight *Morpho* species, known from extra-Amazonian Brazil fly in Santa Teresa). Though we did not observe any *H. nattereri*, we left Claudionor Elias, a local insect collector, instructed in its habits and appearance, in hopes that he might relocate the species in periods of better weather.

Results came in the following year, 1967. Mr. Elias captured two males of *H. nattereri* in areas of heavy steep virgin forest at 600-800 meters elevation near Santa Teresa, and sent them to the collection of the Departamento de Zoologia in Curitiba, Paraná. The credit for the species' modern rediscovery thus belongs with him; as noted below, he also provided key assistance at other points in this study.

Concentrating my efforts in the Santa Teresa area, I was able to locate and capture a further two males in June of 1968, in one of the two areas in which Mr. Elias had collected the species in the previous year. I also captured in the other area a female of *H. fruhstorferi*, evidently the first to be seen in this century and the first to be found in immediate association with *H. nattereri* (seen one hour later at the same spot). The female proved to be totally intractable even in our largest cages and eventually died without laying any eggs. In the second half of 1968, a long period of very cold weather made the species disappear totally from these areas in which it had been present in June.

A small population reappeared, however, in one of the two areas, near the Santa Teresa-Santa Leopoldina boundary, in early 1969. During 14 collecting days in February to April, many males and females were extensively observed in this forest and an additional three male *H. nattereri* and four female *H. fruhstorferi* were captured. It was now evident that the species was indeed sexually dimorphic, the only one strongly so in the genus *Heliconius* (some silvaniforms and *H. demeter* Staudinger (see Turner, 1966) are weakly sexually dimorphic). In the 1969 collecting, the presence of the species was also verified in the two largest public forest reserves in the Santa Teresa area, thus guaranteeing its survival (barring major natural disasters) in the foreseeable future.

One of the females captured in 1969 had revealed to me her food plant, which proved to be a nearly unknown Passifloraceous species, distinguished from all others by the four carpels in the fruit, and thus placed in a separate genus, *Tetrastylis*, the species being *T. ovalis* Velloz. Its ordinary (entire, elongated) leaf shape, very seldom produced and inconspicuous cream-colored flowers, and treetop habitat (we have seen vigorously growing shoots over fifty feet from the ground, evidently seeking sun in the closed and dark virgin forest) have prevented this vine from being noted by most botanists or represented in herbaria; a single specimen from southern Bahia (Pôrto Seguro) was found in the Jardim Botânico in Rio de Janeiro, catalogued as "*Mitostemma*? sp." This plant is evidently confined to the littoral area of eastern Brazil and may represent a strongly limiting factor not only on the distribution of *H. nattereri*, but also, as it is used by at least four other very common and highly adaptable members of the genus *Heliconius (ethilla, melpomene, erato,* and *sara)* in the area, on the numbers, and continued existence of large colonies, of *H. nattereri*.

The female observed in February 1969 had originally called my attention to a relatively low *T. ovalis* vine (about fifteen feet up in a small tree) by investigating it cursorily twice in fifteen minutes. I climbed the tree and brought a growing shoot of the plant down to eye level; two weeks later, a female was captured in characteristic pre-egg-laying fluttering before this graceful tip. From one of the females captured in 1969, a single fertile egg was obtained by gentle expression of the abdomen; all other methods of obtaining eggs from live females failed. The larva was reared in Rio de Janeiro through the fourth instar before succumbing, probably to excessive photography and consequent dehydration, coupled with drying out of the *T. ovalis* leaves brought back to Rio de Janeiro; this plant species could not be located in the Rio de Janeiro area.

In July 1969, after I had confirmed a new reduction in *H. nattereri* numbers with the onset of cold weather in June, Claudionor Elias (now living in northern Espírito Santo, where he had not been able to locate the species in any of a large number of extensive virgin forests) provided the eventual key to the full study of the biology of *H. nattereri*, summarized briefly here and discussed in detail in Part II of this series (Brown and Mielke, *in press*). In a revisit to Santa Teresa, he discovered the species still present and evidently not uncommon in a previously unvisited area on the edge of over 100 square kilometers of virgin forest (including one of the largest reserves) east of Santa Teresa. I confirmed its presence in this area in the dead of winter (September) 1969, and explored the entire area for field work in the following summer.

As might have been predicted from the species' presence in winter, this area in late summer 1970 proved to be a veritable nest of *H. nattereri*; as many as nineteen individuals were seen in a single day's collecting. The unusual population density of *H. nattereri* in the area was surely due to an abundance of flower food (mostly *Lantana camara*) and to the presence of a large number of vigorous vines of *T. ovalis* in constant and exceedingly rapid growth in the sun along the forest edges and in small clearings, enough to serve all four adaptable species (see above) and still have many growing shoots left over for *H. nattereri*. This high density, with consequent frequent encounters between individuals, also provoked appreciable changes in the species' overall quantitative (but not qualitative) behavior. The behavior delineated below for the adults is typical of the more sparse (and probably more normal) populations which we have observed intensively in other areas near Santa Teresa.

II. BIOLOGY

After a number of failures in attempts to breed *H. nattereri* adults in Rio de Janeiro, from eggs expressed from females captured in the previously mentioned large colony, I decided to carry out the breeding program in the forest near Santa Teresa, right by the food plant. Larvae were maintained in separate pint jars in the shade, and fresh leaves were provided two or three times a week. Even with this care, protection, and relatively natural environment, mortality between egg and adult exceeded 50%; but nearly a doven viable adults were obtained, sufficient to observe all normal variations in the juvenile stages and development of the species. No parasitism was observed even in eggs and larvae found in nature; two young larvae in one jar died from evident virus infection, but the most frequent cause of mortality appeared to be difficulties in molting, possibly produced in some instances by excessive handling during photography. In nature, the most frequent cause of larval death is almost surely ant and spider attack on young larvae or even eggs.

The egg of *Heliconius nattereri* (Fig. 3) is very similar to those of *H. ethilla* or *H. melpomene* (Beebe, Crane, and Fleming, 1960), but somewhat smaller, generally darker yellow, and with fewer (14, rarely 16) vertical ridges. It is laid at the end of a tendril (or rarely a small leaf) shortly back from a vigorously growing tip of *Tetrastylis ovalis*, and takes in the Santa Teresa environment (mean temperature in late summer and early fall somewhat under 20° C) the rather extended range of three to seven days (normally six days; three days is usual for heliconians) to hatch. The newly emerged larva (uniform light yellow and 2 mm in length) does not normally eat its eggshell, perhaps a sign (Alexander, 1961) of the tolerance it shows throughout all its larval life towards other, even much smaller, caterpillars on the same plant. In the case of the *H. nattereri* larva occupying the same growing tip as caterpillars of other more successful and less tolerant species (such as *H. ethilla narcaea, H. melpomene* *nanna,* or particularly the aggressive and cannibalistic *H. erato phyllis*), this tolerance would probably be a fatal disposition. The progress of the larva through five instars (Figs. 4-8) is marked by the progressive lightening of the ventral and lateral body color from deep yellow-brown (in the mature first instar) to pure white, with the appearance of a typically melpomeneform pattern of small black pigment spots, and by deepening of the ventral color (below sublateral scoli) from brown to nearly black. The thorax and the abdomen of the mature larva are not unlike those of *H. erato*, but have a different spot-pattern and much longer scoli (Fig. 6). The color and pattern of the head undergo dramatic changes in each instar, highly characteristic of *H. nattereri* larvae. The first stage head is deep yellow-brown, dark brown around the pseudoocelli; the second instar has a uniformly black head with medium length scoli; the third stage head is still very dark, with scoli about as long as its height, and frequently shows a suggestive differentiation, being lighter dorsally and darker ventrally. In the fourth instar the head is masked, principally yellow dorsally and laterally, black ventrally and frontally, with a black prong extending to the base of each scolus, and the area around the mandibles yellow. In the mature larva (Figs. 7 and 8) the head is light yellow, with the mandibles, area around the eyes, and center of the frontal plate black, and a black sickle-shaped mark starting in front of each ring of eyes, curving forward and upward to follow the frontal sutures, and then outward to meet the base of each scolus (which may be as much as twice the head height in length). Thus, while the overall larval appearance is suggestive of the relationship of *H. nattereri* to the *silvana, melpomene,* and *erato* groups of the genus, the head-pattern and very long scoli remain as primitive characters (Beebe, Crane, and Fleming, 1960) and suggest the relationship of *H. nattereri* to *Philaethria dido, Dryas iulia,* and *Eueides* species.

Each larval instar except the fifth takes two to four days to complete; the last normally takes seven days, including a thirty-hour hanging-up period at the end. Maximum lengths in the instars are normally 5.5-6, 9-10, 14-16, 23-25, and 33-37 mm.

The chrysalis of *H. nattereri* (Figs. 9 and 10) is nearly identical in form to that of *H. ethilla* or *H. melpomene*, and dimorphic without relation to sex: dark brown or light cream-colored (occasionally intermediate), with short but well-marked cephalic projections, melpomeneform antennal and abdominal spines and flanges, and six large and four small silvered patches on the dorsal surface of the prothorax, metathorax, and first two abdominal segments. The chrysalis, like most heliconian pupae, makes violent swinging motions (through lateral bending of the abdomen at about the fifth segment) when disturbed; these are unaccompanied by any detectable creaking noise or odor, however. The total duration in Santa Teresa is 14 to 18 days, unusually long for heliconian pupae, and emergence is in very early morning (5-8 AM), with the first meconium voided being deep chestnut-colored, almost brown.

The adults of *H. nattereri*, as with many butterfly species showing sexual dimorphism, occupy poorly overlapping ecological niches in the deep virgin forest which is their home; they meet principally at favored red flowers, mostly (in these days) introduced *Lantana camara* at the edge of the forest, or *Gurania sellowiana* (a native Cucurbitaceous vine) within it. The females fly quite slowly, except when startled, when they either mimic *Mechanitis* spp. flight (mild disturbance) or fly rapidly and directly upward and away (strong fright). They are seen very rarely within the forest except near their food plants (10:30 AM to 2 PM, probably two or three visits per day), and keep to the undergrowth when on the forest edge, infrequently flying in the bright sun. They thereby join very effectively the predominant south Brazilian black-yellow-orange mimetic complex whose principal distasteful members are slow-flying, shade-loving ithomiines (several ithomiine species endemic to the same faunal region as *H. nattereri* are strikingly similar to these females). The males have a high, dashing flight, with a shallow, rapid, and irregular wingbeat and much gliding; they spend most of the day promenading over a set and repeated path, high above the ground within the forest, with an average frequency (passing one observation post in one direction) of fifteen minutes and area exclusively occupied over 50,000 square meters. They always fly in the bright sun, resting during cloudy periods, and are most often observed momentarily as they pass high overhead (five to twenty meters) in steep, humid areas of primary forest.

Both sexes are best observed and captured at flowers. The females tend to come once in very early morning (7.45 AM or first bright weather) and twice more during their egg-laying period (usually once in late morning, again in early afternoon). Males visit flowers profusely in mid-morning or first bright weather, and very occasionally (more often in the large colony discussed previously) later in the day, during their promenade period (up until two o'clock). We have seen but two fragmentary courtships in the wild, at 10:05 and 11:50 AM; one involved an aerial phase with extensive horizontal spiralling on barely fluttering wings, the pair heading slowly from open second growth (where they encountered near a lantana patch) toward the deep woods; the other (Stage II) involved first back fanning and then front fanning by a male over a stationary female with wings held half open, similar to the courtship of *H. melpomene* (Crane, 1957).

The normal life span of *H. nattereri* in the wild is probably somewhat over one month; at least one recognizable male was observed in the same area near Santa Teresa for over eleven weeks.

III. MORPHOLOGY

The male genital valves of *H. nattereri* are typically silvaniform, very similar to those of *H. ethilla narcaea* but less elongate, as figured by Emsley (1965). We have confirmed that the androconia do not occur on the membrane of the hindwing, and have not discovered them over as many veins as indicated by Emsley, though our method (scale removal) might prevent detection of a very sparse distribution; on the forewing, the androconia seem restricted to vein 1A. We cannot confirm the female morphology reported by Emsley. The abdominal processes are strongly curved at the base, as in all members of the silvana- and melpomene-groups, and the bursa copulatrix bears medium long, evenly arcuate, symmetrical 3- or 4-tooth signa, similar to those of *Heliconius aoede* or *H. doris.* The spermatheca is typical of the genus *Heliconius*, with a broad duct to the diverticulum, and the paronychial processes on the metapretarsi are narrow, pointed, and equal in length.

IV. EVOLUTION

Heliconius nattereri is evidently a very primitive species in its genus, but its biology as well as adult morphology place it near the evolutionary line from the *Dryas* junction to the silvaniform heliconians, and not near to the genus *Eueides* or the *hierax, aoede, wallacei, doris,* or *xanthocles* groups of the genus *Heliconius.* Indeed, the overall juvenile and adult characters of *H. nattereri* would place it within the silvaniforms, were it not for (1) the larval head pattern and long scoli, the gradually curved signa on the female bursa copulatrix, and the lack of androconia on the membrane of the male hindwing (all closer to primitive groups), and (2) the dark underparts of the mature larva, and the adult male color pattern (hard to assign in evolutionary terms but not silvaniform). In a tentative reformulation of the evolution of *Heliconius* and related genera (in full paper, Brown and Mielke, *in press*), we place the *H. nattereri* junction as shortly toward the silvaniforms from the hypothetical historico-evolutionary bifurcation of the advanced *Heliconius* line into the *silvana* and *melpomene* groups on one hand, and the *erato* and highly evolved *charitonia* (or *sara*) groups on the other.

V. SUMMARY AND PERSPECTIVE

What is the future for this apparently declining and highly specialized primitive heliconian species? We have tried many times to adapt it to life in a cage, without success even for hand-reared individuals; it presumably would need a very large and impractically high enclosure to feel unconfined. A final attempt at domestication is being made in the largest of Dr. Ruschi's hummingbird aviaries in Santa Teresa (50 x 17 x 7 meters), where two *T. ovalis* plants have been introduced but are still growing slowly; any colony established there, however, would be at most fragmentary and non-natural. As mentioned previously, the species should survive in the two large forest reserves in Santa Teresa. Most hopefully, the owner of most of the forests and clearings in the area of the large and unusual colony discovered in mid-1968 is an enlightened conservationist who intends to preserve these areas in the foreseeable future. The focus of the *H. nattereri* colony, however, is not on his property, and efforts are presently underway in collaboration with Dr. Ruschi to purchase and preserve this part as a biological reserve of the Museu Mello Leitão in Santa Teresa, one of the first to be created to protect an endangered butterfly species. The area, however, seems to be not only exceptional for *H. nattereri* but also rich in a wide variety of plants, insects, birds, and mammals, and is apparently a funnel for insect migration comparable to the well known Portachuelo Pass at Rancho Grande, Aragua, Venezuela.

In terms of other areas in eastern Brazil, from our field observations, we calculate that at least a square kilometer of steep, humid, and food-plant-rich virgin forest should be necessary for the existence of a healthy colony of *H. nattereri*. As very few such tracts still exist in its former range, and many of those which do are falling to ax and fire each year, we still regard *H. nattereri* as a species with an uncertain future, surely to be listed along with those other specialized, primitive, and forest-adapted animals presently placed in danger of extinction by the intervention of man.

Acknowledgments

In addition to Dr. Augusto Ruschi and Mr. Claudionor Elias, several persons contributed to the field work summarized here: Olaf H. H. Mielke, Nirton Tangerini, and Luis Otero (all of Rio de Janeiro; O. Mielke now in Curitiba), and K. Ebert (Rio Claro, São Paulo). Stimulating discussions and assistance were obtained from Dr. H. Ebert (Rio Claro), and Dr. J. R. G. Turner (York, England), and Dr. M. G. Emsley (Trinidad and Philadelphia; now Fairfax, Virginia), and pointers on breeding from Dr. Jocelyn Crane Griffin (New York and Trinidad). Botanical identifications were provided by Apparicio Duarte (Rio de Janeiro, now Belo Horizonte) and Dr. S. M. Tillett (Barquisimeto, Lara, Venezuela). Information on museum specimens came from R. I. Vane-Wright (British Museum (Natural History)), Dr. H. de Lesse (Muséum National d'Histoire Naturelle, Paris), Dr. H. J. Hannemann (Humboldt-Universität, Berlin), and R. Imb and H. and R. Holzinger (Naturhistorisches Museum, Vienna). Photographs are by the author, with enlargements made by Mr. José A. Pires Ferreira. Financial support is gratefully acknowledged, from the National Science Foundation (Grant GB 5389X and GB 5389X1), the Conselho Nacional de Pesquisas (including a stipend as Pesquisador-Conferencista and much aid in travel expenses), the Banco Nacional de Desenvolvimento Econômico (general support of the C. P. P. N.), and the

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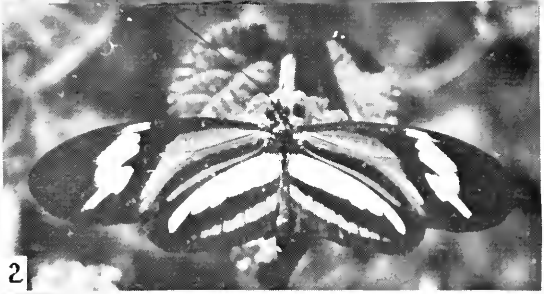

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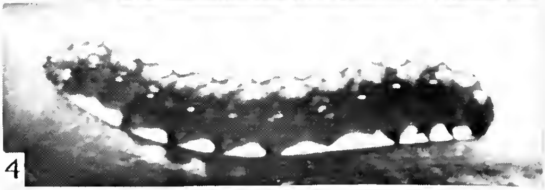

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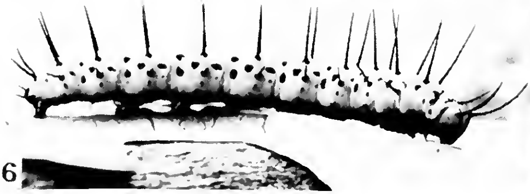

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(See p. 140 for explanation of figures.)

2.0047 **Rediscovery of *Heliconius nattereri* in Eastern Brazil (Lepidoptera: Nymphalidae). The Heliconians of Brazil. Part 1. Abstract.**—Since *Heliconius nattereri* was first described in 1865, only 14 additional specimens were collected until very recently when it was found in relative abundance in Santa Teresa, Espírto Santo, Brazil. The uniquely dimorphic female has been known as *H. fruhstorferi.* The egg and pupa are very close to those of the silvaniform *Heliconius*, while the larva, feeding on *Tetrastylis ovalis*, shows relationships to this group and to more primitive and more evolved heliconian species. The adults are difficult to observe in nature except on flowers of *Lantana camara.* The adult male and female morphology are very close to those of members of the silvaniforms. *H. nattereri* is evidently a very primitive species in its genus, linking *Dryas ivlia* to the *silvana, melpomene,* and *erato* groups of *Heliconius*; its rarity today, and probable continued decline in the future, are ascribed to great specialization to a disappearing biotype and competition from more evolved and adaptable species of *Heliconius.*—**Keith S. Brown, Jr.,** *Centro de Pesquisas de Produtos Naturais, Faculdade de Farmacia, U. F. R. J., Praia Vermelha, Rio de Janeiro ZC-82, Brazil.*

Descriptors: Lepidoptera; Nymphalidae; *Heliconius nattereri*; Brazil; distribution; biology; evolution.

Figures 1-10. *Heliconius nattereri.* Fig. 1, typical male, life size; Fig. 2, yellow-barred female, life size. A small number of females also have the hindwing median bar partly or totally suffused with orange; Fig. 3, egg, 15X life size; Fig. 4, mature first instar larva, 10X life size; Fig. 5, second stage larva in molt, 6X life size; Fig. 6, mature larva, 2X life size; Fig. 7, mature larva, detail of head, 3X life size; Fig. 8, mature larva, front view of head, 2½ X life size; Fig. 9, dark pupa, dorso-lateral, life size; Fig. 10, light pupa, lateral, life size.

[3.0029]

A REVIEW OF THE *Culicoides Nigrigenus* GROUP, WITH TWO NEW SPECIES (DIPTERA: CERATOPOGONIDAE)[1]

Willis W. Wirth[2] and Franklin S. Blanton[3]

The *Culicoides nigrigenus* group (Wirth and Blanton, 1959) includes five previously known species from Central America and the West Indies: *C. decor* (Williston) from St. Vincent, *C. nigrigenus* Wirth and Blanton from Panama, *C. lutealaris* Wirth and Blanton from Panama, *C. chrysonotus* Wirth and Blanton from Panama, and *C. hayesi* Matta from Honduras. We are taking this opportunity to add descriptions of two new species from the West Indies, to give a redescription of *C. decor*, to provide a key for the separation of the seven known species, and to present some new distribution records. The known distribution of the group is shown in fig. 1.

The following measurements and special terms are used in our descriptions of the female and in our summary of numerical characters in Table 1. Wing length is measured from the basal arculus to the wing tip; Costal Ratio (CR) is the length of the costa measured from the basal arculus to the tip of the second radial cell (2RC) divided by the wing length. Antennal Ratio (AR) is the combined length of the five elongated distal segments (in this paper the flagellomeres for convenience are called segments) divided by the combined length of the preceding eight. Sensory pattern is distribution of antennal segments bearing distal sensory tufts. Palpal Ratio (PR) is the length of the third palpal segment divided by its greatest breadth. Proboscis/Head Ratio (P/R Ratio) is the length of the proboscis measured from the distal end of the labrum-

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epipharynx to the anterior margin of the tormae divided by the distance measured from the latter point to the median hair socket between the eyes.

Material studied is in the collection of the U. S. National Museum in Washington, D. C.

We are greatly indebted to Miss Linda Heath for making the illustrations.

Table 1. Numerical characters of species of the *nigrigenus* group of *Culicoides.*

	Wing Length mm	Costal Ratio	Antennal Ratio	Antennal Sensoria	Palpal Ratio	Mandibular Teeth	P/H Ratio
chrysonotus	1.66	0.60	2.10	3,8-15	2.4	14	0.74
decor	1.20	0.60	1.25	3,8,10-15	3.2	15	0.85
dominicanus	1.22	0.62	1.85	3-15	2.3	15	0.75
farri	1.25	0.60	1.35	3,10-15	2.0	13	0.68
hayesi	1.36	0.58	1.48	3-15	2.5	15	0.91
lutealaris	1.56	0.58	1.30	3-15	2.0	14	0.70
nigrigenus	1.11	0.64	2.00	3-15	1.9	13	0.83

The species treated in this paper are members of the subgenus *Anilomyia* Vargas (type-species, *C. covagarciai* Ortiz), which is characterized as follows: Neotropical species of medium to large size with the 2RC ending in a pale spot, no pale area in the base of cell M_4 bordering veins M_{3+4} and Cu_1; sensory pattern 3, 11-15, and sometimes also on some or all of segments 4-10; two sclerotized spermathecae and a rudimentary third present, a sclerotized ring present or absent; scutum yellowish to brownish, without conspicuous pattern; leg markings various, characteristic for each species and species group; hind tibial comb with 4 to 6 spines; male genitalia with dorsal and ventral roots slender, subequal; apicolateral processes of ninth tergum usually well developed, the caudal margin between them usually transverse; parameres usually separate.

The subgenus *Anilomyia* comprises two species groups, the *covagarciai* group (Wirth and Blanton, 1959) containing the type-species and four other Neotropical species, and the *nigrigenus* group with seven species, all Neotropical and circum-Caribbean (fig. 1). The male genitalia of the species placed by Wirth and Blanton (1959) in the *covagarciai* group are rather diverse in structure and some species will have to be transferred elsewhere, but the species of the *nigrigenus* group are remarkably uniform in their genitalia, coming reasonably close to the type found in *C. covagarciai* Ortiz.

The species of the *nigrigenus* group have in common the following characters: Eyes contiguous to narrowly separated, bare. Antenna with distal five segments elongated, antennal ratio 1.25-2.10; sensory pattern 3-15; 8-15; or 3, 8, 10-15. Palpus with third segment bearing a distinct sensory pit which is usually deep and opens in a round pore, sometimes smaller in diameter than the pit. Pale wing markings usually extensive, frequently interconnected; wing usually with abundant macrotrichia. Hind tibial comb with four spines; legs always with all the knees bearing a conspicuous black spot, the legs usually extensively yellowish. Spermathecae without a sclerotized ring on the membranous duct. Male genitalia with parameres always separate, a strong basal knob present, distal portion slender, abruptly bent laterad and ventrad with sharp simple tip; aedeagus without transverse sclerotized bar across the base of the arch or a papilliform tip; apicolateral processes always well developed, usually long and slender, diverging dististyles slender with bent, pointed tip.

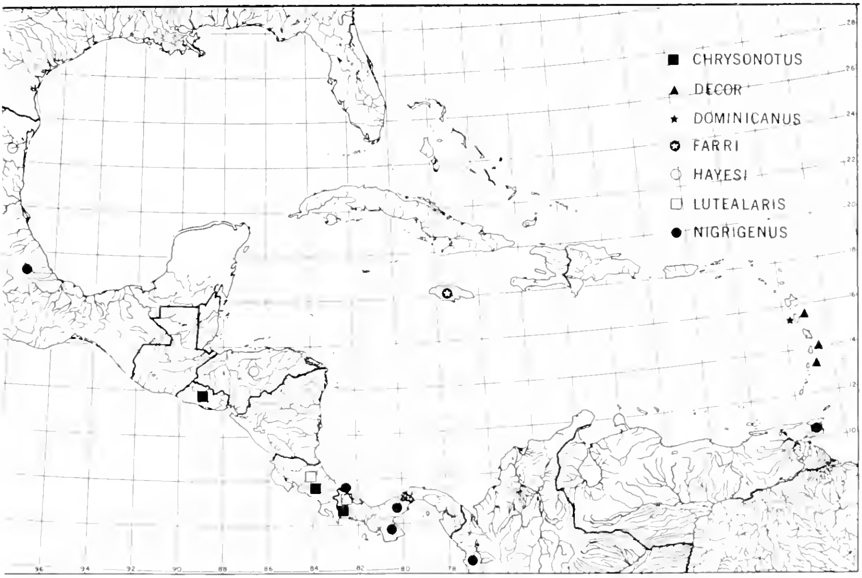

Figure 1. Distribution of the *Culicoides nigrigenus* group in the Caribbean.

Biology.– The biting habits of the females are unknown. The immature stages so far as known are found in bromeliads. Dr. R. W. Williams reared *C. nigrigenus* from a bromeliad of the genus *Guzmania* in Trinidad, and H. A. Trevino reared *C. hayesi* from a bromeliad in Tamaulipas, Mexico.

Key to the Species of the *nigrigenus* Group (females)

1. Hind femur pale, a conspicuous dark band only on midportion 2
Hind femur dark, with only a subapical pale band 3

2(1). Spermathecae small and subequal, each measuring 0.057 by 0.044 mm; distal antennal segments very elongate, 11 1.5 as long as 9-10 combined; AR 2.00; sensory pattern 3-15 . . . . nigrigenus Wirth and Blanton
Spermathecae large and unequal, measuring 0.130 by 0.090 mm and 0.102 by 0.068 mm; distal antennal segments moderately elongate, 11 0.9 as long as 9-10 combined; AR 1.25; sensory pattern 3, 8, 10-15 . . . . decor (Williston)

3(1). Antenna with sensory pattern 3, 8-15 or 3, 8, 10-15 4
Antenna with sensory pattern 3-15 5

4(3). Antenna with segment 11 1.5 as long as 9-10 combined; AR 2.10; large species, wing 1.66 mm long; wing pattern dark, pale spot straddling middle of vein M_2 isolated. . . . . chrysonotus Wirth and Blanton
Antenna with segment 11 not as long as 9-10 combined; AR 1.35; small species, wing pale, pale spot straddling middle of vein M_2 not isolated. . . . farri n. sp.

5(3). Wing paler, pale spot straddling middle of vein M_2 not isolated; smaller species, wing 1.22 mm long dominicanus n. sp.
Wing darker, pale spot straddling middle of vein M_2 isolated from adjacent pale spots; larger species, wing 1.36-1.56 mm long 6

6(5). Proboscis long, P/H Ratio 0.91; third palpal segment longer and not as stout, PR 2.5; wing 1.36 mm long . . . . hayesi Matta
Proboscis short, P/H Ratio 0.70; third palpal segment stouter, PR 2.0; wing 1.56 mm long . . . . lutealaris Wirth and Blanton

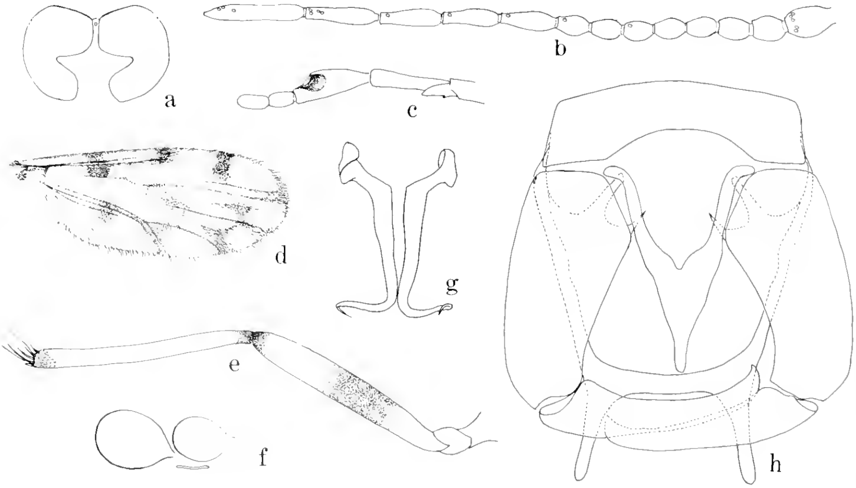

Figure 2. *Culicoides decor.* **a**, female eye separation; **b**, female antenna; **c**, female palpus; **d**, female wing; e, hind femur and tibia; **f**, spermathecae; **g**, male parameres; **h**, male genitalia, parameres removed.

Culicoides chrysonotus Wirth and Blanton

Culicoides chrysonotus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 226 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia); Wirth and Blanton, 1959, Proc. United States Nat. Mus. 109: 312 (redescribed; fig. wing, scutum, palpus, tibial comb, spermathecae, male genitalia).

A large dark brown species, wing 1.66 mm long. Antenna with segment 11 1.5 as long as 9-10 combined; AR 2.10; sensory pattern 3, 8-15. Third palpal segment moderately long, PR 2.4; sensory pit relatively small and deep. Proboscis short, P/H Ratio 0.74. Legs brownish with markings as found in *C. decor*; pale wing markings more restricted than in *decor*, with an isolated pale spot straddling middle of vein M_2. Spermathecae small and slightly unequal, with short, relatively stout necks. Male genitalia with ninth tergum bearing long, divergent apicolateral processes; aedeagus with short basal arch and stout basal arms, the distal process tapering to a blunt point; parameres with main portion relatively stout.

Distribution: Costa Rica, El Salvador, Panama.

New records: COSTA RICA: Cartago, Navarro, July, 1962, F. S. Blanton, light trap, 2 females. EL SALVADOR: Santa Ana, Ayutuxtepea, 3000 ft., 18 November 1961, J. Calvo, 1 female; Las Navanjos, 1000 m, 19 November 1961, J. Calvo, 2 females; Volcano. 14 November 1961, J. Calvo, 1 female. PANAMA: Chiriqui, El Volcan, 22 July 1966, A. Broce, light trap, 1 female.

Culicoides decor (Williston)

Ceratopogon decor Williston, 1896, Trans. Ent. Soc. London 1896: 281 (female; St. Vincent, W. I.; fig. wing).

Culicoides decor (Williston); Johannsen, 1943, Ann. Ent. Soc. America 36: 779 (combination); Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 227 (notes on type; comparison); Forattini, 1957, Arq. Fac. Hig. Saude Pub. Univ. Sao Paulo 11: 265 (notes, comparison; fig. wing).

Female.– Length of wing 1.20 mm.

Head: Eyes (Fig. 2a) narrowly separated. Antennae (Fig. 2b) with lengths of flagellar segments in proportion of 36-25-25-24-24-23-23-24-45-48-50-50-76, AR 1.25; sensory pattern 3, 8, 10-15. Palpal segments (Fig. 2c) with lengths in proportion of 20-40-70-20-27, PR 3.2; third segment long, slightly swollen distally, with a large, deep, round pit opening by a slightly smaller pore. Proboscis moderately long, P/H Ratio 0.85; mandible with 15 teeth.

Thorax: Yellowish brown; scutum with dense grayish pollen, scutal pits and anterior margin between them dark brown; scutum with numerous erect yellowish hairs; pleuron dark brown below. Legs (Fig. 1e) yellowish, knee spots blackish; proximal 0.6 of femora and distal 0.6 of tibiae on fore and mid legs brownish, hind femur with prominent dark brown band in midportion, and hind tibia with narrow apex brown; hind tibial comb with four spines, the one nearest the spur longest.

Wing (Fig. 2d): Pattern as figured; distal 0.6 of 2RC in a pale area; pale areas large, leaving the dark areas forming a narrow zig-zag pattern; CR 0.60; radial cells both elongate, with broad lumens; macrotrichia numerous, extending to base of wing in anal cell. Halter pale.

Abdomen: Yellowish, becoming brownish distally. Spermathecae (Fig. 2f) large and ovoid, with short, slender necks; unequal measuring 0.130 by 0.090 mm and 0.102 by 0.068 mm.

Male.– Similar to the female with the usual sexual differences; antenna with yellowish brown plume, last three segments with lengths in proportion of 70-56-75. Genitalia (Fig. 1h). Ninth sternum with shallow caudomedian excavation, the ventral membrane not spiculate; ninth tergum moderately long and tapering, with long, slender apicolateral processes. Aedeagus with basal arch extending to nearly half of total length, basal arms slender and curved; distal portion tapering to long, slender median point. Parameres (Fig. 2g) each with slender anterolateral process; main portion long and straight, tapering to slender simple tip abruptly bent laterad and ventrad.

Distribution.– Dominica, St. Lucia, St. Vincent.

Specimens examined: DOMINICA: Clarke Hall, January-March 1965, W. W. Wirth, light trap, 40 males, 50 females; April-June 1964, O. S. Flint, light trap, 8 males, 22 females; July-August 1964, T. J. Spilman, light trap, 18 males, 24 females; Layou River mouth, 20 January 1965, W. W. Wirth, light trap, 3 females; Macoucheri, 12 February 1965, W. W. Wirth, light trap, 3 females; South Chiltern Estate, 19 February 1965, W. W. Wirth, light trap, 2 females. ST. LUCIA: Castries, Fairview, 14 April 1959, R. Darsie, light trap, 1 male; Gros Islet, Yacht Club, 27 October 1967, J. B. Davies, at light, 1 female; St. Lucia Beach Hotel, 27 October 1967, J. B. Davies, at light, 1 female.

Culicoides dominicanus Wirth and Blanton, NEW SPECIES

(Figure 3)

Female.– Length of wing 1.22 mm.

Head: Eyes (Fig. 3a) narrowly separated. Antenna (Fig. 3b) with lengths of flagellar segments in proportion of 32-20-20-20-20-20-20-20-50-56-60-60-92, AR 1.85; sensory pattern 3-15. Palpal segments (Fig. 3c) with lengths in proportion of 15-40-52-17-17, PR 2.3; third segment swollen distally, with a large, round, deep, sensory pit. Proboscis moderately short, P/H Ratio 0.75; mandible with 15 teeth.

Thorax: Yellowish brown, scutum yellowish pollinose, dark brown on anterior margin; pleuron dark brown below; scutum with abundant yellowish hairs. Legs (Fig. 3e) brownish, knee spots blackish; fore and mid femora with subapical, and fore and mid tibiae with basal, broad yellowish bands; hind femur dark brown with broad subapical yellowish ring, hind tibia yellowish except at extreme tip; hind tibial comb with four spines, the second from the spur longest.

Wing (Fig. 3d): Pattern as figured, as in *C. decor*; CR 0.62; macrotrichia numerous, extending to base of wing in anal cell. Halter pale.

Abdomen: Yellowish, becoming brownish distally. Spermathecae (Fig. 3f) ovoid with short slender necks; moderately small, slightly unequal, measuring 0.080 by 0.058 mm and 0.072 by 0.055 mm.

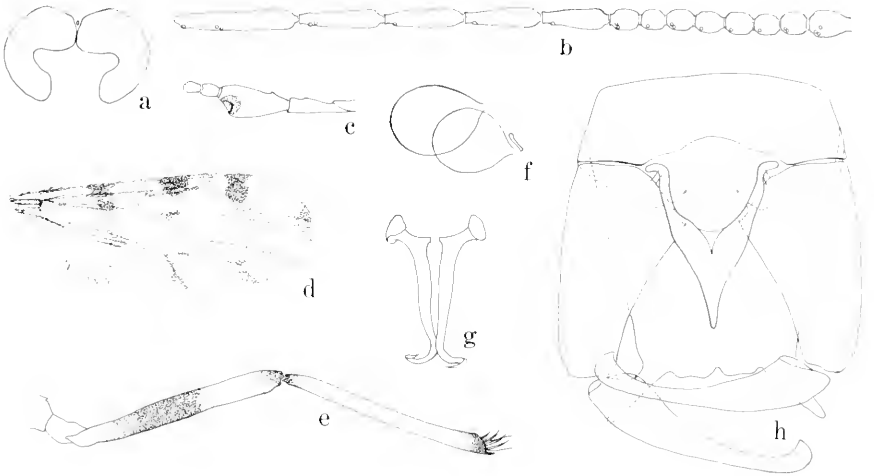

Figure 3. *Culicoides dominicanus.* **a**, female eye separation; **b**, female antenna; **c**, female paplus; **d**, female wing; **e**, hind femur and tibia; **f**, spermathecae; **g**, male parameres; **h**, male genitalia, parameres removed.

Male.– Similar to the female with the usual sexual differences; antenna with yellowish plume, last three segments with length in proportion of 82-65-93. Genitalia (Fig. 3h): Ninth sternum with shallow caudomedian excavation, the ventral membrane not spiculate; ninth tergum short and tapering, with moderately long, slender, diverging apicolateral processes. Aedeagus with basal arch extending to more than half of total length, rather angulate mesad, basal arms moderately stout and slightly bent; distal portion tapering to long slender median point. Parameres (Fig. 3g) each with short anterolateral arm; mid portion straight and moderately swollen at base, tapering distally to slender simple tip abruptly bent laterad and ventrad.

Distribution: Dominica.

Types.– Holotype, female, allotype, male, Dominica, 0.3 mi e Point Casse, 6 May 1964, O. S. Flint, at light (Type no. 70653, USNM). Paratypes, 53 males, 37 females, as follows:

DOMINICA: Castle Bruce Junction, 21 March 1965, J. F. G. Clarke, 4 males; Dleau Gommier, 17 March 1956, J. F. G. Clarke, at light, 5 males, 2 females; Point Lolo, 25 January 1965, W. W. Wirth, at light, 3 females; Point Casse, June 1964, O. S. Flint, at light, 41 males, 15 females, 12 March 1965, W. W. Wirth, light trap, 9 males, 8 females; South Chiltern Estate, 19 February 1965, W. W. Wirth, light trap, 4 males, 9 females.

Discussion.– In Dominica, where both *C. decor* and *dominicanus* have been taken, the endemic species is found only at the higher elevations, while the more widespread *C. decor* is restricted to lowland habitats.

Culicoides farri Wirth and Blanton, NEW SPECIES
(Figure 4)

Female.– Length of wing 1.25 mm.

Head: Eyes (Fig. 4a) narrowly separated. Antenna (Fig. 4b) with lengths of flagellar segments in proportion of 32-22-22-22-22-22-23-24-45-45-50-54-70, AR 1.35; sensory pattern 3, 10-15. Palpal segments (Fig. 4c) with lengths in proportion of 15-30-46-15-18, PR 2.0; third segment short and broad, with a large, round, moderately deep, sensory pit. Proboscis short, P/H Ratio 0.68; mandible with 13 teeth.

Thorax: Yellowish brown, pleuron and anterior and lateral margins of scutum dark brown. Legs (Fig. 4e) brownish, knee spots blackish; fore and mid femora with subapical, and fore and mid tibiae with basal, broad yellowish bands; hind femur dark brown with broad subapical pale band, hind tibia yellowish except dark brown at extreme tip; hind tibial comb with four spines, the one nearest the spur longest.

Wing (Fig. 4d): Pattern as figured, as in *C. decor*; CR 0.60; macrotrichia numerous, extending to base of wing in anal cell. Halter pale.

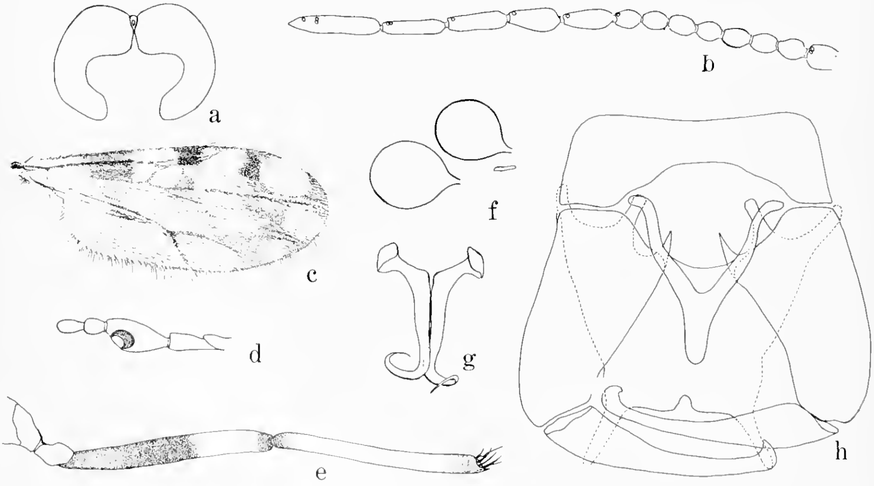

Figure 4. *Culicoides farri.* a, female eye separation; **b**, female antenna; c, female wing; **d**, female palpus; e, hind femur and tibia; **f**, spermathecae; **g**, male parameres; **h**, male genitalia, parameres removed.

Abdomen: Yellowish, becoming brownish distally. Spermathecae (Fig. 4f) ovoid with long slender necks, small and slightly unequal, measuring 0.064 by 0.046 mm and 0.058 by 0.042 mm.

Male.– Similar to the female with the usual sexual differences; antenna with yellowish brown plume, last three segments with lengths in proportion of 87-70-75. Genitalia (Fig. 4h): Ninth sternum with shallow caudomedian excavation, the ventral membrane not spiculate; ninth tergum short and tapering, with very long and slender, divergent, apicolateral processes. Aedeagus with basal arch extending to not quite half of total length, basal arms slender and curved; distal portion tapering to mederately slender, bluntly pointed tip. Parameres (Fig. 4g) each with moderately long anterolateral arm; mid portion straight and moderately stout, tapering to slender, simple tip, abruptly bent laterad and ventrad.

Distribution.– Jamacia.

Types.– Holotype female, allotype male, Hardwar Gap, Green Hills Cabin, Jamaica, 20 February 1969, W. W. Wirth, light trap (Type no. 70654, USNM). Paratypes, 1 male, 2 females. Same data.

Discussion.– We take pleasure in dedicating this species to Dr. Thomas H. Farr of the Institute of Jamaica in Kingston, in recognition of his important contributions to our knowledge of Jamaican Diptera.

Culicoides hayesi Matta

Culicoides hayesi Matta, 1967, Florida Ent. 50: 75 (male, female, larva, pupa; Honduras; fig. wing, antenna, palpus, tibial comb, eye separation, spermathecae, male genitalia, larval pharyngeal comb, pupal respiratory horn).

A moderately large, bright yellow and brown species; wing 1.36 mm long. Leg markings as in *C. dominicanus*; wing markings as in *decor* with the brown zig-zag bands somewhat broader than in *decor*, with an isolated pale spot straddling the middle of vein M_2. Antenna with segment 11 as long as 9-10 combined, AR 1.48; sensory pattern 3-15. Third palpal segment moderately swollen distally, PR 2.5; with a large, round, moderately deep sensory pit. Proboscis long, P/H Ratio 0.91. Spermathecae subequal, relatively small, ovoid, with short slender necks. Male genitalia with apicolateral processes of ninth tergum long and slender; aedeagus with basal arch extending to slightly more than half of total length, the distal process slender; parameres with main portions quite slender.

Distribution.– Honduras, Mexico.

Specimens examined.– HONDURAS: La Tigra, Dist. Central, 6000 ft., 10 June 1966, J. F. Matta, light trap, 2 males, 4 females (holotype, allotype). MEXICO:

Tamaulipas, Ciudad Victoria, Rancho del cielo, 4 April 1963, H. A. Trevino, reared from bromeliad, 3 males, 3 females, 2 larvae, 2 pupae (paratypes).

Culicoides lutealaris Wirth and Blanton

Culicoides lutealaris Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 225 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia); Wirth and Blanton, 1959, Proc. United States Nat. Mus. 109: 310 (redescribed; fig. wing, scutum, palpus, tibial comb, spermathecae, male genitalia).

A moderately large, yellowish brown species; wing 1.56 mm long. Leg markings as in *C. dominicanus*; wing pattern with an isolated pale spot straddling middle of vein M_2. Antenna with segment 11 1.1 as long as 9-10 combined; AR 1.30; sensory pattern 3-15. Third palpal segment short and swollen, PR 1.9; with a large, round, deep sensory pit. Spermathecae small, subequal in size, with short, stout necks. Male genitalia with apicolateral processes of ninth tergum long and slender, divergent; aedeagus with basal arch extending to half of total length, the distal process very slender; parameres with main portion relatively slender.

Distribution.– Panama, Costa Rica.

New records.– COSTA RICA: Cartago, Navarro, July 1962, F. S. Blanton, light trap, 2 females; Sabalito, August 1953, F. S. Blanton, light trap, 1 female. PANAMA: Chiriqui, El Volcan, July 1964, A. Broce, light trap, 1 female.

Culicoides nigrigenus Wirth and Blanton

Culicoides nigrigenus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 222 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia); Wirth and Blanton, 1959, Proc. United States Nat. Mus. 109: 308 (redescribed; fig. wing, scutum, palpus, tibial comb, spermathecae, male genitalia).

A moderately small, pale grayish yellow species; wing 1.11 mm long. Wing markings as in *C. decor*, the dark zig-zag bands becoming more or less interrupted by the more extensive pale markings; leg markings as in *C. decor*, the base of the hind femur broadly pale. Antenna with segment 11 1.3 as long as 9-10 combined, AR 2.00; sensory pattern 3-15. Third palpal segment short and swollen, PR 1.9; with a large, round, deep sensory pit. Spermathecae small, subequal, with short, stout necks. Male genitalia with apicolateral processes of ninth tergum long and slender, divergent; aedeagus with basal arch extending to half of total length, distal process with relatively stout tip; parameres with main portion moderately stout.

Distribution.– Colombia, Mexico, Panama, Trinidad.

New records.– COLOMBIA: Rio Raposo, Valle Prov., July 1963, V. H. Lee, 1 female. MEXICO: Fortin de las Flores, Vera Cruz, June 1964, F. S. Blanton, light trap, 12 females. PANAMA: Los Santos, Los Santos Prov., 24 October 1952, F. S. Blanton, light trap, 1 female. TRINIDAD: Locality unknown, 29 August 1963, R. W. Williams, reared from *Guzmania*, 1 female; Macqueripe, 11 January 1956, T. Aitken, light trap, 1 male, 1 female; Tembladora, May 1958, T. Aitken, light trap, 2 females; United States Naval Station, January, November 1958, T. Aitken, light trap, 4 females.

Discussion.– Like *C. decor*, which it closely resembles in leg markings, *C. nigrigenus* is a lowland species.

Literature Cited

Wirth, W. W. and F. S. Blanton. 1959. Biting midges of the genus *Culicoides* from Panama (Diptera: Heleidae). Proc. United States Nat. Mus. 109: 237-482.

2.0029 A review of the *Culicoides Nigrigenus* **Group, with two new species (Diptera: Ceratopogonidae).**

Abstract.– The *Culicoides* subgenus *Anilomyia* and within it, the *C. nigrigenus* group are characterized, and a key is presented to the seven known species, including the following which are described as new: *C. dominicanus* from Dominica and *C. farri* from Jamaica. Brief diagnoses and new distribution records are given for the five other speices. The distribution of the group is circum-Caribbean; female biting habits are unknown; the immature stages are found in bromeliads.– **W. W. Wirth,** *Systematic Entomology Laboratory, Agriculture Research Service, USDA,* and **Franklin S. Blanton,** *Department of Entomology, University of Florida, Gainesville, Florida 32601.*

Descriptors: Diptera; Certopogonidae; *Culicoides; Culicoides nigrigenus* group; Mexico; Central America; West Indies; n. South America.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

3.0046 **A singular method of feeding of Mutillid wasps.**– Information on the feeding habits of adult Mutillid wasps seems to be very scarce in entomological literature. As a matter of fact, even in the neotropical region, where these Hymenoptera are very abundant, it is rare to surprise them at their feeding activities.

An inedited observation was made during my field research in the savannahs of the "cerrado" type in the Fazenda[1] Retiro das Telhas near Três Lagoas, in the State of Mato Grosso, Brazil, on the 22nd of October, 1964. We found in this locality a shrub of about 60 cm in height, belonging to the genus *Cordia* (Borraginaceae), with the leaves invaded by a large number of small nymphs of a species of leaf-hoppers (Cicadellidae), measuring from 2 to 3 mm. On three of the leaves, among the leaf-hoppers we observed three female Mutillid wasps, belonging to two different species: *Traumatomutilla latevittata* (Cresson, 1902), two specimens, and *Cephalomutilla distincta* Mickel, 1960, one specimen. They were running about in what seemed a disorderly fashion, knocking against the nymphs of the cicadellids, and dislocating them from the places where they were busy sucking the leaves. Removed from the suction points, the cicadellids excreted by the anus small drops of honeydew that adhered to the leaf hairs. The cicadellids did not seem to mind the interruption, taking new positions and continuing the sucking process. The mutillids, after dislocating several nymphs, slowed down their running and rapidly consumed the excreta left by the leaf-hoppers. Soon after they continued their knocking techniques, provocking new emissions of honeydew. After repeating this process for a number of times, the Mutillids passed on to other leaves occuppied by yet undisturbed nymphs and again repeated the same tactics. Finally they abandoned the plant and decended to the ground.

Besides the excreta, the dislodged nymphs left, very often, small drops of sap on the points where they were sucking, but they didn't feed on them.

On another occassion (X/17/1964) in the Fazenda Beija-flor, also near Três Lagoas, we observed a female of one of these Mutillids, *Traumatomutilla latevittata*, feeding on the secretion of extrafloral nectaries on the petioles of leaves of *Mimosa* tree (Leguminosae). – **Karol Lenko,** *Instituto Biológico, Caixa Postal 7119, São Paulo, SP, Brazil.*

Accepted for publication May 25, 1970.

[1] "Fazenda" is the name given to large rural properties in Brazil, equal to "Ranch".

Descriptors: Hymenoptera; Mutillidae; feeding habits; Brazil.

[3.0034]

A NEW GENUS AND NEW SPECIES OF CECIDOMYIIDAE ON PINYON PINE (DIPTERA)[1]

RAYMOND J. GAGNÉ[2]

Pinyonia edulicola, new species, which causes a spindle-shaped gall at the base of pinyon pine needles in New Mexico and Colorado is described now to make the name available for a biological study in progress. In 1968 John Durkin of New Mexico State University, Las Cruces, N. M., sent the first specimens of this species for determination and, in 1969, Wayne Brewer of Colorado State University, Fort Collins, Colo., submitted a long series of adults. I gratefully acknowledge their help in providing additional specimens and their permission to describe the new species. Its biology is the subject of a thesis being prepared at Colorado State University by a student of Dr. Brewer.

Pinyonia, NEW GENUS

ADULT. Postvertical peak absent. Eyes broadly joined at vertex, facets circular. Male flagellomeres binodose, each node with 1 circumfilum. Palpus 1 or 2 segmented. Claws simple, evenly curved, shorter than empodium. Female terga I-VIII and male terga I-VI with caudal and lateral setae and without scales; male tergum VII with only caudolateral setae and tergum VIII without setae. Male genitalia: tergum and sternum X bilobed, the sternum deeply so; aedeagus very long, parallel sided, slightly curved in lateral view; telomere dorsoventrally flattened. Ovipositor short but protrusible; lamellae closely juxtaposed medially and, in dorsal view, tapering abruptly to pointed apex.

LARVA. Spatula lost. Papillae not evident. Cuticle smooth except for cephaloventral rows of spinules on abdominal segments.

TYPE SPECIES. *Pinyonia edulicola*, n. sp.

Pinyonia belongs to the tribe Contariniini of the supertribe Cecidomyiidi because of the untoothed, evenly curved claws, the characteristic shape of the

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[1] Accepted for publication April 24, 1970

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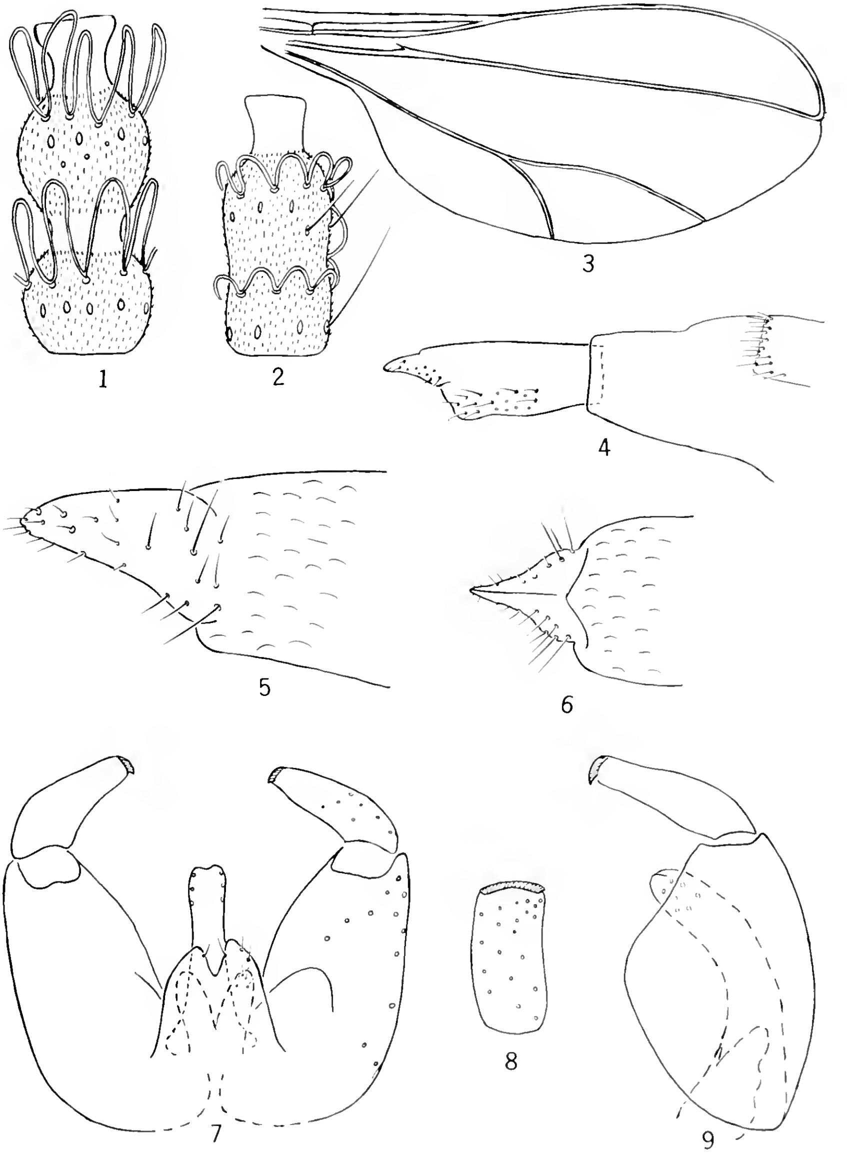
male tergum and sternum X, and the piercing-type ovipositor. It is, however, a very distinctive genus in its very long aedeagus, short ovipositor with the distinctively shaped lamellae, and the most featureless larva I've seen to date. The larva with its lack of spatula and papillae greatly limits the number of characters on which to base judgements concerning relationships to other genera. *Thecodiplosis* Kieffer, which contains many species associated with pine needle galls, resembles this genus in the elongated empodium. This character, however, while possibly indicating relationship, is characteristic of most species in many genera of the Cecidomyiidi and Oligotrophidi that are associated with conifers. Thecodiplosis differs from *Pinyonia* in the much smaller straight aedeagus (subequal in length to sternum X), the presence of a full caudal row of setae on the male tergum VII, the long ovipositor with the soft, usually apically rounded lamellae, and the good key character of the three to four segmented palpus. The larvae of *Thecodiplosis* have a spatula, and the full complement of papillae are evident including the enlarged, sclerotized terminal pair. The figures of the genitalia of *Agevillea abietis* Hubault (1945), a needle miner of *Abies alba* Mill. in France, resemble *Pinyonia* in the long aedeagus and dorsoventrally flattened telomeres. On the other hand, the remaining figures in Hubault (1945) show a long ovipositor with soft, apically rounded lamellae, trifilar male flagellomeres, a four segmented palpus, and a strongly curved R_5. The larva of *A. abietis* lacks conspicuous papillae also except for one tiny terminal pair, but does have a spatula.

Pinyonia edulicola, NEW SPECIES

ADULT. Wing length (from arculus), 1.55-1.82 mm. Flagellomere III of male and female as in figs. 1 and 2, respectively. Palpus usually 1 segmented but occasionally with a second segment about ½ length of first. Wing as in fig. 3. Male genitalia as in figs. 7-9. Ovipositor as in figs. 4-6.

Holotype, male, emerged from needle galls of *Pinus edulis* Engelm., VI-20-1968, Raton, Colfax Co., New Mexico, A. Woodburn, USNM, Type no. 70807. *Paratypes*: female, same data as holotype; 8 males, 2 females, VI-8-1969, Fort Collins, Colo., M. W. Houseweart; 18 larvae, *ex* spindle galls *P. edulis*, VI-4-1969, Fort Collins, Colo., M. W. Houseweart.

The only other described species of Cecidomyiidae found associated with pinyon pine needles are *Janetiella coloradensis* Felt and *Contarinia cockerelli* (Felt). The former is in a different supertribe, the Oligotrophidi, and can be separated from *P. edulicola* by the short R_5 which does not reach the apex of the wing, the uninodose male flagellomeres, and the single dorsal lamella of the ovipositor. *C. cockerelli*, known from the female only, is separated from the new species by the long ovipositor, which is approximately as long as the remainder of the abdomen, and by the dorsoventrally flattened, sclerotized lamellae.



Figures 1-9, *Pinyonia edulicola,* n. sp. Fig. 1, male flagellomere III; Fig. 2, female flagellomere III; Fig. 3, wing; Fig. 4, ovipositor; Fig. 5, lamellae of ovipositor (lateral); Fig. 6, same (dorsal); Fig. 7, male genitalia (dorsal); Fig. 8, telomere (caudal); Fig. 9, paramere and aedeagus (lateral).

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Hubault, E. 1945. Un parasite non encore signalé des aiguilles du sapin blanc (*Abies alba* Mill.). Bull. Biol. de la France et de la Belgique. 79: 17-30, pls. II-V.

2.0034 **A new genus and new species of Cecidomyiidae on pinyon pine (Diptera).** Abstract.–*Pinyonia edulicola*, new genus and new species belong to the tribe Contariniini of the supertribe Cecidomyiidi. *P. edulicola* forms a spindle shaped gall at the base of pinyon pine needles. This new species is distinguished by the long R_5 which reaches the apex of the wing, the binodose flagellomeres of the male, and the short ovipositor of the female. It is distinct from *Contarinia cockerelli*, the only other species of the tribe associated with needles of pinyon. Type locality: Raton, Colfax Co., New Mexico.–**Raymond J. Gagné**, *c/o U. S. National Museum, Washington, D. C. 20560.*

Descriptors: Diptera; Cecidomyiidae; *Pinyonia edulicola*; pinyon pine needle gall.

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[3.0026]

OVIPOSITION IN *Archilestes grandis* (Rambur) (ODONATA: LESTIDAE)

George H. Bick[1] and Juanda C. Bick[1]

Few Zygoptera species routinely oviposit in nonaquatic plants well above or away from water. Kennedy (1915a,b) considers *Archilestes californica* a dragonfly that lays eggs in trees because of the large size of the *Salix* and *Alnus* in which it oviposited .6-3.1 m above water. In Ohio, Williamson (1931) observed three pairs of *A. grandis* oviposit in *Salix, Ulmus,* and *Platanus* .3-3.1 m above water. In Malaysia, *Orolestes wallacei* inserted eggs into a sapling 68 cm high, 14 m away from water (Lieftinck, 1939), and *Selysioneura cornelia* deposited eggs about 2.5 m above water in galls of a woody plant probably produced by some other insect (Lieftinck, 1953). Oviposition in woody materials is recorded for *Lestes viridis* (Nielsen, 1954; Loibl, 1958; Schiemenz, *in* Robert, 1958), and for *Lestes barbarus* and *Sympecma paedisca* (Robert, 1958).

For several summers at the University of Oklahoma Biological Station, we made random observations of a small population of *Archilestes grandis* at Cowan Creek, the previously described site of several earlier studies (Bick and Bick, 1958, 1968; Bick and Sulzbach, 1966). During the summer of 1968, we observed this population almost daily, studying oviposition substrates in particular and obtaining cinematographic records. The largest numbers were at the headwaters near a small pool about 4 m in diameter and less than 1 m deep. Our study area extended along the Creek 20 m above and 45 m below the pool.

Although demography was not a primary concern, irregular counts of all individuals along the 65 m stretch of stream averaged 12 per day. The mean "age" (actually a minimum age since all individuals were mature when marked) of 19 individually marked males was 25 days, the maximum, 51. This mean is much longer than the average we (1961) record for *Lestes d. australis.*

Kennedy (1915a) considers *A. californica* an "autumnal insect." His first

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[1] Biology Department, Saint Mary's College, Notre Dame, Indiana 46556. The research was conducted at University of Oklahoma Biological Station where the Senior Author was Visting Professor. Accepted for publication March 10, 1970.

Ent. News, 81: 157-163, 1970

specimens were obtained July 27, the population was not large until early August, and mating did not occur until early September. Likewise, Williamson (1931) in Ohio and Ferris (1951) in Pennsylvania record October oviposition for *A. grandis.* Contrastingly, *grandis* in Oklahoma was common and oviposition frequent by June 15, the earliest date of our observations.

Reproductive behavior of *A. grandis* was similar to that of *Lestes* (Bick and Hornuff, 1965), *Agria* (Bick and Bick, 1965a), and *Enallagma* (Bick and Bick, 1963) in that *grandis* females were usually not present at water unless ready to mate. Neither males nor females exhibited courtship behavior, and unreceptive females showed no refusal signs; they were simply not at water or escaped by rapid flight. Although 41 males were readily secured for marking during a six-week period, only two unaccompanied females were at water, and the population was too small to disturb pairs in tandem.

In *grandis* we observed no difference between a female escape flight and the flight wherein the female allowed herself to be captured. The one seizure witnessed was in flight as Kennedy (1915a) describes for *californica*. Immediately after seizure, the pair flew high in a sycamore (*Platanus*) where tandem sperm translocation and copulation occurred.

Sperm translocation, lasting 32 sec, was 3.6 m above water in *Platanus.* The event was longer (Bick and Bick, 1965b) and much higher above water than in other zygopterans we have studied. Copulation followed immediately at the same spot. Only interrupted or partial copulations were observed, so complete information on duration was not obtained. During copulation the female clasped her abdomen with six legs as Kennedy (1915a) figures for *californica.*

The substrates explored and utilized by *grandis* were recorded for eight ovipositions (Table 1). During all lengthy sequences, exploratory activity preceded and often interrupted actual insertion of eggs. For example, the pair observed on July 25 shifted 56 times during 32 minutes of exploration briefly visiting and testing species of *Rosa, Paspalum, Verbena, Rumex, Polygonum, Bidens, Andropogon,* 25 cm to 2.3 m above water, as well as 21 spots on one *Celtis* sp., 1.6-5 m above water, and 16 spots, nearly all petioles, on one *Platanus,* 2-3 m above water. None of these stops was lengthy enough for insertion of eggs. The actual oviposition of this pair, lasting 58 minutes, occurred only in two *Platanus* petioles, 2-3 m above water. Similarly, Harwood (1960) records that *L. congener* perched on and probed many different plants but completed oviposition only in dead parts of *Glyceria.*

Three of the eight pairs utilized *Platanus*, and 55% of the total oviposition time for all pairs was at this plant. Every other plant used for actual oviposition was also nonaquatic (Table 1) species of: *Rumex, Monarda, Erigeron, Eupatorium, Verbena.* Water cress (*Nasturtium* sp.), abundant along the creek and fre-

Table 1. Oviposition records of eight pairs of *Archilestes grandis.*

Date	*Hour*	*Plant Species*	*Plant part*	*Height above water (m)*	*Minimum duration of exploration (min)*	*Minimum duration of oviposition (min)*	*No. of eggs*
6-19	0951	*Rumex crispus*	stem	0.7	10	27	123
6-20	1115	*Platanus occidentalis*	petiole	10.0			
	1137	*Platanus occidentalis*	petiole	10.0			
	1200	*Platanus occidentalis*	?	13.3			
	1257	*Platanus occidentalis*	petiole	3.3			
	1307	*Platanus occidentalis*	petiole	2.0			
	1323	*Platanus occidentalis*	petiole	2.3	50	109	
6-26	1452	*Platanus occidentalis*	stem tip	2.7			
	1518	*Platanus occidentalis*	petiole	2.0			
	1542	*Monarda punctata*	stem	1.3	32	87	
7-2	1102	*Erigeron canadensis*	stem	1.0	0	15	
7-2	1102	*Erigeron canadensis*	stem	1.0	0	18	
7-13	1545	*Eupatorium coelestinum*	stem	1.0	0	19	
7-18	0957	*Verbena urticaefolia*	stem	2.3			
	1012	*Eupatorium coelestinum*	stem	0.7	36	15	22
7-25	1318	*Platanus occidentalis*	petiole	2.3			
	1349	*Platanus occidentalis*	petiole	3.0	32	58	149

quently used for oviposition by other zygopterans, was not used by *grandis* either for perching or for oviposition.

Although three sycamores were along the creek within the study area, *grandis* oviposited only in the one large tree having almost all branches over water. Apparently either one or both members of the pair could see the reflections of water below them even when they were as high as 13 m. Regardless of the plant utilized, no fallen prolarva would have been more than .7 m from water's edge. Similarly, prolarvae from the *grandis* ovipositions in Ohio (Williamson, 1931) and from the *californica* ovipositions (Kennedy, 1915a) would have fallen directly into water.

Oviposition in *A. grandis* differed in three ways from both *A. californica* and *L. viridis.* *A. grandis* sometimes oviposited in herbaceous nonaquatic plants (Table 1), the other two odonates entirely in trees and shrubs. *L. viridis* oviposited in 21 woody species (Nielsen, 1954; Schiemenz, *in* Robert, 1958) and *A. californica* in *Salix* and *Alnus* (Kennedy, 1915a). Second, *californica, viridis,* and the Ohio population of *grandis* oviposited in branches, whereas *grandis* in Oklahoma, when ovipositing in trees, almost always used petioles. The use of petioles of deciduous trees is possible only in species such as *grandis* which do not overwinter in the egg stage. Lastly, *viridis* oviposition has not been reported higher than 2 m and *californica* higher than 3.1 m, whereas *grandis* regularly probed 8-10 m high in trees and actually oviposited at 13 m.

St. Quentin (1962) correlates hardness of oviposition material with size and number of teeth on the lateral gonapophyses of several members of the family Lestidae. We compared the ovipositor of *grandis* with that of *L. d. australis,* a species common at ponds in southern Oklahoma. Although the former oviposits in nonaquatics and the latter only in soft aquatic material, the two showed structural differences in gonapophyses insufficient to account for the major difference in oviposition habits. Structurally, *australis* seems just as well equipped as *grandis* to oviposit in trees and shrubs.

All pairs oviposited in tandem, but, after 56 minutes of tandem oviposition, one male left the female who continued to lay eggs unaccompanied for 31 more minutes. *A. grandis* in Ohio (Williamson, 1931), *A. californica* (Kennedy, 1915a) and *S. paedisca* (Robert, 1958) also oviposited in tandem. In contrast, Lieftinck's (1939, 1953) Malaysian species oviposited alone, and the European species *viridis* and *barbarus* oviposited sometimes in tandem, sometimes unaccompanied (Robert, 1958).

Pairs perched vertically when ovipositing in herbaceous stems, but sometimes hung upside down when using *Platanus* petioles, as Robert (1958) illustrates for the unaccompanied *viridis* female. Like other species routinely ovipositing in nonaquatic plants, all *grandis* females kept their ovipositors between their mesoand metathoracic legs thus affording greater leverage when inserting eggs. This resulted in a very slight bend at the juncture of abdominal segments II-III and a double right angle bend at IV, rather than at III as Kennedy (1915a) illustrates for *californica*. During oviposition, as well as during nontandem perching, both males and females of *grandis* held the wings almost completely outspread.

On all substrates, the female moved backward at the very slow rate of 1-2 mm per min producing incisions in approximately a straight line. During this time, her abdomen was never gradually extended as in *Lestes unguiculatus* (Bick and Hornuff, 1965) but was always between her legs. In one sequence the female of a pair inserted eggs from the middle of the petiole to the blade and then from the petiole base back to its middle, moving backward all the time.

In each incision, *californica* deposited six eggs (Kennedy, 1915a), *viridis*, four (Loibl, 1958; Robert, 1958) in precise arrangements. Both species oviposited only in trees and shrubs, all probably with very little parenchyma. On the other hand, *grandis*, which oviposited in diverse kinds of vegetation, inserted a varying number of eggs irregularly placed in each incision. An average of 10 eggs, almost completely filling the large central pith, was removed from each incision in *Rumex*. But only one or two eggs per incision were recovered from *Platanus* petioles which lacked a large central pith. It seems logical that *grandis*, so flexible in using various oviposition substrates (Table 1), would also be flexible in arrangement and number of eggs inserted in each incision.

Robert (1958) states that a single *viridis* female can deposit 200-400 eggs, Kennedy (1915a), that *californica* deposits 70-180 in any one oviposition sequence. We are uncertain that any of our sequences for *grandis* were complete, but the maximum number for any one female was 149 eggs placed in two *Platanus* petioles (Table 1). Apparently neither species of *Archilestes* deposits as many eggs in one sequence as does the one species of *Lestes* which uses parts of woody plants and for which there are egg counts.

Either the beginning or the end of each oviposition was not observed, hence our duration figures (Table 1) are partial. However, the lengthy performance of some pairs shows that the whole oviposition sequence including exploration may last more than two hours. Unlike many zygopteran species reproductively active near noon, *grandis* pairs oviposited at various times from as early as 0951 hours to as late as 1545 (Table 1).

Eggs removed from plant tissue a few hours after oviposition were white with a dark anterior pole, similar to Kennedy's (1915a) drawing of *californica*. The *grandis* egg was 1.9 mm long and .28 mm in greatest diameter, slightly larger than that of *viridis* (Robert, 1958).

Lutz and Pittman (1968) report that eggs of *Lestes eurinus* removed from plants and maintained in pond water hatched in 19 days, that those in nature above water level required 45 days, and that immersion is not essential for subsequent development but hastens the rate. This does not seem true for *grandis.* On June 19, immediately after oviposition, we removed 123 eggs from the *Rumex* stem and placed them in a dish of water. Fifteen days later eight hatched in spite of mold which destroyed the rest. On June 26 we dug up the *Monarda,* following oviposition, and planted it in a flower pot in such a way that the vegetation leaned over a white pan of water. Sixteen days later 55 second instar larvae were in the pan. The eggs had hatched without wetting of any kind under almost natural conditions. Wetting did not seem to influence rate of egg development.

Kennedy (1915a) supposed that *californica* eggs wintered in the live cambium of the twigs. Corbet (1956), Robert (1958), and Gower and Kormondy (1963) also report overwintering in the egg for *L. sponsa, L. viridis,* and *L. rectangularis* respectively. But in the warmer climate of North Carolina, eggs of *L. eurinus* hatched by mid July, and overwintered in several larval stages (Lutz and Pittman, 1968). Because *grandis* eggs deposited on June 26 hatched after only 16 days under almost natural conditions, it seems that in Oklahoma this species also overwinters in the late larval stages.

We twice observed hatching of *grandis* eggs. Events were unanticipated and, without recorder and timer, we failed to keep precise records. In one instance, a worm-like newly hatched prolarva under the stereoscope was being observed wriggling within the cavity of the stem when suddenly it seemed to "jump." One minute later an obvious second instar larva was found in the water of the petri dish beneath the stem. The prolarval stage could have lasted hardly more than one minute. In another instance, a newly hatched prolarva, being observed in a drop of water on a slide, "jumped" in a similar fashion and was permanently lost. Pierre (*in* Corbet, 1963) found that the prolarva of *viridis* could remain active on the ground for up to two hours before its frequent jumping brought it to water where it molted to the second instar.

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2.0036 **Oviposition in *Archilestes grandis* (Rambur) (Odonata: Lestidae).** Abstract.– A population of *Archilestes grandis* (Rambur) in Oklahoma oviposited in tandem between 0951 and 1545 hours entirely in nonaquatic plants including: *Platanus* petioles, 13 m above the surface, and stems of species of *Eupatorium, Rumex, Monarda, Erigeron,* and *Verbena.* At all sites, no fallen prolarva would have been more than .7 m from water. During oviposition the female's abdomen always remained between her legs as she moved backward 1-2 mm per min, producing incisions in an approximately straight line and depositing an average of 10 eggs per incision in *Rumex*, with a large central pith, 1-2 in *Platanus* petioles without a large pith. The longest oviposition time recorded, including exploration, was 159 min; maximum egg production was 149 in 58 min. Because oviposition was frequent by June 15, and eggs hatched after only 16 days under almost natural conditions, the population probably overwinters in late larval stages.– **George H. Bick and Juanda C. Bick**, *Biology Department, Saint Mary's College, Notre Dame, Indiana 46556.*

Descriptors: Odonata; Lestidae; *Archilestes grandis*; oviposition in nonaquatic plants.

3.0044 **A self-maintaining window trap for collecting flying insects.**– Window flight traps have been used as a relative method of sampling flying insects for a number of years. Chapman and Kinghorn (1955) introduced one of the original designs, consisting of a pane of glass supported vertically over a trough of preservative. Insect flying against the glass drop into the preservative and are periodically removed. The original design has been modified by reducing the size of the trap as well as providing a means of collecting live specimens. Ethylene glycol has been used also as a temporary preservative where evaporation loss was important (Nijholt and Chapman, 1968). Window traps described by these authors require a certain amount of frequent maintenance in the form of replenishing preservative and removing rain water from the trap. Often an entire sample is lost by the overflowing of the trough due to rain. The window trap can be rendered easily maintenance free by providing an automatic drain and using a preservative which is of low volitility and nonmiscible in but lighter than water.

The automatic drain system consists of an inverted U-shaped siphon positioned at the end of the trap with one arm inside and the other outside the trough. The arm inside the trough should reach to within one-half inch of the bottom of the trap (Fig. 1). The outside arm should be of the same length or shorter than the inside arm. A layer of preservative is added to the trap at the beginning of the study. During rain storms the water accumulates in the bottom of the trough raising the level of the preservative. When the preservative reaches the level of the top of the drain, water will then siphon from the bottom of the trough until the level of the preservative again drops below the top of the drain. Captured insect specimens float in the layer of preservative and are not lost when excess rain water siphons out.

Kerosene is a suitable preservative, if captured insect specimens are removed periodically. If kerosene is used, the insect specimens will require cleaning, which can be accomplished by rinsing with dioxane and preserving in alcohol.

We have found this modified window trap suitable for collecting most orders of flying insects with the exception of Lepidoptera, which are extensively damaged by the kerosene preservative.

Literature cited.– **Chapman, J. A.** and **J. M. Kinghorn.** 1955. Window flight traps for insects. Canadian Ent. 87: 46-47; **Nijholt, W. W.** and **J. A. Chapman.** 1968. A flight trap for collecting living insects. Canadian Ent. 100: 1151-1153.– **Robert N. Coulson,** *Texas A. & M. University, Texas Forest Service, P. O. Box 310, Lufkin, Texas 75901,* **Rudolph T. Franklin,** and **D. A. Crossley, Jr.,** *Department of Entomology, University of Georgia, Athens, Ga. 30601.* Accepted for publication May 12, 1970.

Descriptors: Collection technique; window trap; flight trap; sampling technique.

Figure 1. The modified self-maintaining window flight trap showing automatic siphon system.

[3.0037]

PRELIMINARY SURVEY OF SARCOPHAGIDAE (DIPTERA) OF KENTUCKY[1]

R. W. RUMMEL and F. W. KNAPP[2,3]

The family Sarcophagidae is a group within the Order Diptera comprising some 48 genera and 327 species in America north of Mexico (Stone *et al.*, 1965).

There is considerable diversity within this family, the adults of which are commonly called Flesh Flies. So far as known the females are ovoviviparous, depositing larvae rather than eggs. Various species of the family are associated with manure, while others are associated with decaying organic matter. Other species of the group are either facultative or obligate parasites. These species may produce certain types of intestinal or cutaneous myiasis. The family includes species which are parasitic on lower animals including other insects.

Little work has been done on this group in Kentucky. Dr. Lee H. Townsend, Department of Entomology, University of Kentucky, had previously (1939-1952) collected 5 Kentucky species which were not taken in this survey. His specimens are in the collections of the Kentucky Agricultural Experiment Station, Lexington.

MATERIALS AND METHODS

This survey was accomplished primarily by the use of fly bait traps. Ten modified USDA traps (Schoof, 1952) were constructed for this study. The basis of this trap was a metal cylinder 6 in. in diameter and 9 in. tall (Fig. 1). The cylinder itself consisted of a piece of galvanized stove pipe with a removable

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[1] The investigation reported in this paper, no. 70-7-3, is in connection with a project of the Kentucky Agricultural Experiment Station and is published with the approval of the Director. Accepted for publication March 13, 1970.

[2] Graduate Assistant (present address: Department of Entomology, Virginia Polytechnic Institute, Research Division, Blacksburg) and Associate Professor respectively.

[3] Appreciation is expressed to H. Rodney Dodge formerly at Washington State University, Pullman, and to Raymond J. Gagné of the Entomology Research Division, Agr. Res. Serv., USDA for identifying the male Sarcophagidae collected.

screen top. A cone made from a circular piece of screen wire 8.5 in. in diameter with a ¾ in. hole cut from the center was fitted into the bottom of the trap. A triangular section with a 6 in. base and a height of 4¼ in. was cut from one side of the screen. The straight sides of the screen were soldered together to form the cone which was fitted into the bottom of the trap and soldered there.

The base of the trap was extended 2 in. by the addition of a strip of ½ in. mesh hardware cloth. This prevented the cylinder of the trap from sitting flush against the ground, thereby preventing the flies from entering. The mesh hardware cloth also protected the bait from scavenging animals.

A metal stand 25 in. tall and having a metal cross-piece 15 in. from the base supported the trap. The metal cross-piece was used to push the stand into the ground. The trap was secured to the stand by a metal loop.

Traps baited with sheep or horse liver were used to do most of the collecting and to determine the seasonal occurrence of the species. Other baits tried included decaying fruits such as apples and bananas, beer, ammonia, and a malt mixture consisting of 1 part hop malt, 2 parts water, and 1/8 oz of Fleischman's active dry yeast.

All locations were baited with liver. In addition, the locations were irregularly baited with all other baits. In the collection notes for the individual species, the omission of a bait indicates that it was ineffective.

Collections of flies from the traps were made daily from April through August of 1966 and 1967 with irregular collections made through October primarily in Fayette County, Kentucky, however, some collections were made in other areas of the state. The captured flies were killed by placing them in a closed chamber containing carbon tetrachloride. The chamber was a durable, cylindrical, cardboard container large enough to hold the entire trap plus a small container of carbon tetrachloride in the bottom.

After collection the specimens were returned to the laboratory for sorting and identification. It was necessary to expose the genitalia of the males for them to be identified. This was sometimes difficult because of the tendency of the specimens to dry when several hours were required to return to the laboratory. This problem was overcome by Tindale's method for using chlorocresol in field collecting (Tindale, 1962). By employing this technique the specimens could be maintained in a relaxed condition for long periods of time.

Only the males were identified owing to the difficulty in identification of the females. The technique used in spreading the genitalia was that described by Aldrich (1916).

Larval specimens also were obtained from various types of breeding media. Infested dead animals, such as rabbits, squirrels, oppossums, snakes, and manure found in fields or along roadsides were brought to the laboratory and caged until

Table 1. Species of male Sarcophagidae collected and their relative abundance

Species	*Percent of Total Males Collected*
Oxysarcodexia ventricosa (Wulp)	62.62
Sarcophaga utilis Aldrich	10.59
Ravinia derelicta (Walker)	4.67
Ravinia lherminieri (Robineau-Desvoidy)	4.05
Sarcophaga sarracenioides Aldrich	3.12
Sarcophaga bullata Parker	2.49
Helicobia rapax (Walker)	2.49
Blaesoxipha impar (Aldrich)	2.49
Ravinia querla (Walker)	1.87
Sarcophaga haemorrhoidalis (Fallen)	1.87
Sarcophaga crassipalpis Macquart	1.25
Boettcheria cimbicis (Townsend)	1.25
Blaesoxipha basalis (Walker)	0.62
Oxysarcodexia galeata (Aldrich)	0.31
Ravinia latisetosa Parker	0.31

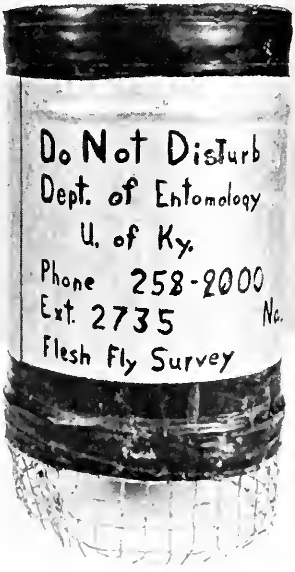

Figure 1. Fly bait trap.

the adult flies emerged. A sweep net was used on vegetation and in places where adult Sarcophagidae were suspected to occur.

RESULTS AND DISCUSSION

By the method of collection in the present survey a total of 37,393 Diptera specimens from four families were collected. Of this total number, Calliphoridae ranked first (20,728 specimens), Muscidae second (8,011 specimens), and Anthomyiidae third (4,461 specimens). Sarcophagidae ranked fourth (4,193 specimens), comprising 11.2% of the total number of Diptera collected, and males comprised 7.65% (321 specimens) of the Sarcophagidae collected. In the present survey 15 species[4] of the family Sarcophagidae as determined from males only were collected. Their relative abundance is shown in Table 1 and in the following list.

Sarcophaga Meigen

S. utilis Aldrich.– This species accounted for 10.59% of the total number of male Sarcophagidae collected. It was collected from May through September from traps baited either with liver, banana, or malt mixture.

S. sarracenioides Aldrich.– Accounted for 3.12% of the total number of male Sarcophagidae collected; collected from May through September from traps baited with liver.

S. haemorrhoidalis (Fallen).– Accounted for 1.87% of the total number of male Sarcophagidae collected; collected only during the early part of the summer before the middle of June; also collected only from traps baited with liver. This species is capable of producing intestinal myiasis in man.

S. crassipalpis Macquart.– Accounted for 1.25% of the total number of male Sarcophagidae collected; collected only during the months of August, September, and October, and only by sweeping.

S. bullata Parker.– This species accounted for 2.49% of the total number of male Sarcophagidae collected; collected early in the season and only from traps baited with liver.

Ravinia Robineau-Desvoidy

R. (Chaetoravinia) derelicta (Walker).– This species accounted for 4.67% of the total number of male Sarcophagidae collected. It was collected in large numbers throughout the months of June, July, August, and September; collected by trapping either with liver, banana, beer, or malt mixture.

R. (Chaetoravinia) latisetosa Parker.– Comprised 0.31% of the total number of male Sarcophagidae collected; collected only early in the season from traps utilizing liver as the bait.

R. (Ravinia) lherminieri (Robineau-Desvoidy).– Comprised 4.05% of the total number of male Sarcophagidae collected; collected from June through September from traps

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[4] Five additional species were collected earlier (1939-1952) by Dr. Lee H. Townsend: *Ravinia pusiola* (Wulp); *R. ochracea* (Aldrich); *Boettcheria latisterna* (Parker); *B. bisetosa* Parker, and *Blaesoxipha hamata* (Aldrich).

baited either with liver, banana, or malt mixture.

R. (Ravinia) querla (Walker).– Comprised 1.87% of the total number of male Sarcophagidae collected; collected from June through August in traps baited either with liver, banana, or malt mixture.

Oxysarcodexia Townsend

O. (Oxysarcodexia) ventricosa (Wulp).– This species accounted for 62.62% of the total number of male Sarcophagidae collected. It was collected throughout the summer from traps baited with either liver, banana, or malt mixture.

O. (Oxysarcodexia) galeata (Aldrich).– Comprised 0.31% of the total number of male Sarcophagidae collected; collected only early in the season from traps baited with liver.

Helicobia Coquillett

H. rapax (Walker).– This species accounted for 2.49% of the total number of male Sarcophagidae collected. It was collected throughout the summer from traps baited either with liver, banana, or malt mixture.

Blaesoxiphia Loew

B. (Kellymia) impar (Aldrich).– This species accounted for 2.49% of the total number of male Sarcophagidae collected. It was collected during the early part of the season from traps baited either with liver, banana, or malt mixture.

B. (Spirobolomyia) basalis (Walker).– Comprised 0.62% of the male Sarcophagidae collected; collected in the early part of the season from trap s baited with the malt mixture.

Boettcheria Parker

B. cimbicis (Townsend).– This species accounted for 1.25% of the total number of male Sarcophagidae collected; collected only during April and from traps baited with liver.

Literature Cited

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Stone, A. *et al.* (eds.). 1965. A catalog of the Diptera of America north of Mexico. United States Dep't. Agric. Handbk. no. 276, 1696 pp. (Pp. 933-961).

Tindale, N. B. 1962. The chlorocresol method for field collecting. J. Lepidopt. Soc. 15(3): 195-197.

2.0037 **Preliminary survey of Sarcophagidae (Diptera) of Kentucky.** Abstract.– A survey based on collections from fly bait traps utilizing liver as the primary bait is reported. Banana, beer, ammonia, and a mixture consisting of malt, yeast, and water also were used as baits. The traps were operated from April through August of 1966 and 1967 and were located primarily in Fayette County, Kentucky. The seasonal occurrence of the various collected species was recorded also. Fifteen species were collected: *Oxysarcodexia ventricosa* Wulp, *O. galeata* (Aldrich), *Sarcophaga utilis* Aldrich, *S. bullata* Parker, *S. haemorrhoidalis* (Fallen), *S. crassipalpis* Macquart, *S. sarracenioides* Aldrich, *Ravinia derelicta* (Walker), *R. lherminieri* (Robineau-Desvoidy), *R. querula* (Walker), *R. latisetosa* Parker, *Helicobia rapax* (Walker), *Blaesoxipha impar* (Aldrich), *B. basalis* (Walker), and *Boettcheria cimbicis* (Townsend).– **R. W. Rummel**, *Department of Entomology, Virginia Polytechnic Institute, Blacksburg, Va. 24061* and **F. W. Knapp**, *Department of Entomology, University of Kentucky, Lexington, Ky. 40506.*

Descriptors: Diptera; Sarcophagidae; bait traps; Kentucky.

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

Hymenoptera

Malyshev, S. I. 1968. Genesis of the Hymenoptera and the phases of their evolution. [Translated by the National Lending Library for Science and Technology, edited by O. W. Richards and Boris Uvarov, Methuen and Co., London.] Barnes and Noble, Inc., N. Y. (translation), viii + 319 p., illus. Cloth, $ 10.00.

This is a translation from the Russian which reads as smoothly as if originally written in English. It describes the supposed origin of the Hymenoptera in Mecoptera-like ancestors living on decaying plant tissues through all the progressive stages of evolution to plant feeders, gall makers, inquilines in galls, the development of parasitoid phases in several different branches of the order and finally to nest builders and in the bees a reversion to stocking nests with plant foods. The publication is sufficiently detailed to consider the differences in the biology of different species within the same genus.

This book is the last publication of Professor Malyshev who spent a long lifetime (1911 to 1966) studying and publishing on the paths of evolution in the Hymenoptera which are undoubtedly more varied and diverse than in any other order of insects. The translation, published posthumously has been edited by the distinguished English entomologists, Professor O. W. Richards and Sir Boris Uvarov. The book is based in part on Malyshev's own extensive research, supported by reviews of several hundred other research articles on the biology of diverse groups, many of which occupy quite specialized nitches in the environment and in their totality covering all large areas of the world. The reviews include the work of numerous Russian workers hitherto relatively unknown to entomologists outside of Russia. Two very valuable features of this book are the indices, (1) to authors, and (2) to names of insect species, genera, and families.

To this reviewer the arguments presented for the course of evolution in the biology and habits of the many diverse groups are exceedingly well presented, and in general most convincing, although in some instances Malyshev has taken a position quite different from other well-known students of Hymenoptera.

One small criticism of the book is that despite the scores of text references to sources, sometimes these are not present. This is the case in one area in which the reviewer has had direct experience. On pages 119 and 120, *Tiphia popilliavora* is stated to be a North American species and a parasite on species of the genus *Amphimallon.* This is not a North American species and has never been reared on species of the genus *Amphimallon.* It is, however, an eastern Asiatic species, parasitic on species of the genus *Popillia.* Original work on its biology was done in Japan and Korea and was published by Clausen and co-workers. My only criticism of the book is that a few of the photographic reproductions lack satisfactory sharpness.–**H. W. Allen.**

(Continued on page 176.)

[3.0049]

A KEY TO THE DRYOPID GENERA OF THE NEW WORLD (Coleoptera, Dryopoidea)[1]

HARLEY P. BROWN[2]

INTRODUCTION

Seven genera representing the family Dryopidae have thus far been reported from the Western Hemisphere. Of these, only three are common and widely-distributed within the hemisphere: *Dryops, Helichus,* and *Pelonomus.* These three occur within the United States, and are included in the keys of Arnett (1963), Leech and Chandler (1963), and Leech and Sanderson (1959). All of these keys are satisfactory for the species within the United States, but none of them will serve for some of the Neotropical species, as is evident from the remarks by Hinton (1937a) concerning the characters used by Musgrave (1935) to separate *Dryops* from *Helichus.* Furthermore, no one has published a key including the other four genera. One is needed, hence this attempt.

Blackwelder (1944) lists the species recorded to that date, with an indication as to the country from which each was described. His extensive bibliography (1957) provides citations of the original descriptions of all such species, so I shall not duplicate the references or species list here. The genus *Lutrochus* listed by Blackwelder is now placed in the family Limnichidae (*cf.* Hinton, 1939), and the species he listed under the genus *Parygrus* should be transferred to the genus *Helichus* (Hinton, 1936a).

I have had no opportunity to examine specimens of *Protoparnus, Sostea,* or *Sosteamorphus*, so the characters relating to these genera in the key below are extracted solely from the literature. The only feature I note in Pascoe's (1860) description of the genus *Sostea* or elsewhere that really distinguishes it from the genus *Helichus* is the large, laminate basal segment of the antenna (Fig. 1), which he further describes thus: ". . . when in repose it appears to act as a

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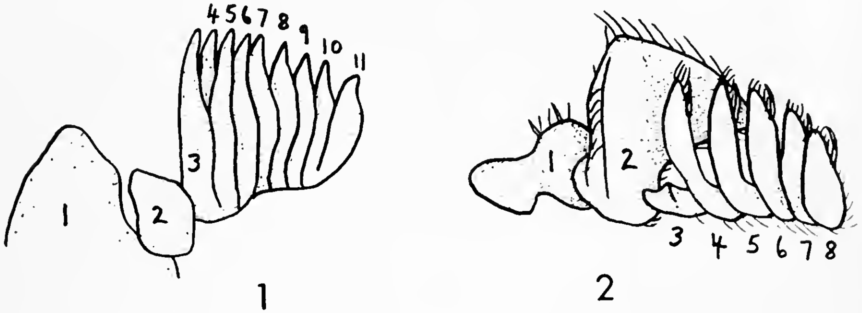
valve, closing in entirely the rest of this organ. . ." (the antenna). If this applies to the Brazilian species as well as to the southeastern Asiatic species examined by Pascoe, it should suffice, for it certainly does not fit the species of *Helichus* I have seen or found described. In *Helichus*, the second segment of the antenna is typically much more inflated than the first, tending to enclose the segments beyond it, rather than to be covered by the first (Fig. 2). However, Hinton (1937b) remarked that there seemed to be no good character for separating these two genera, so the antennal character used here may be invalid.

KEY TO NEW WORLD GENERA OF THE FAMILY DRYOPIDAE

1. Hind wings absent 2
Hind wings present 3
2(1). Pronotum with median longitudinal impression; elytral intervals coarsely tuberculate (1 sp. from Chile) . . . . Sosteamorphus Hinton 1936
Pronotum without median longitudinal impression; elytral intervals not tuberculate (1 sp. from St. Vincent, Lesser Antilles; 4 spp. from New Zealand). . . . . Protoparnus Sharp 1883
3(1). Pronotum with a sublateral longitudinal carina or virtually complete sulcus on each side 4
Pronotum without sublateral carinae or nearly complete sulci 5
4(3). Hairs on pronotum and elytra sparse and inconspicuous; pronotum with sublateral carinae; margin of each elytron with a densely pubescent depression at about apical fourth (1 sp. from Panama, 1 from Venezuela, 1 from Mexico). . . . . Elmoparnus Sharp 1882
Pronotum and elytra densely and conspicuously pubescent; pronotum usually with sublateral sulci; margin of elytron without pubescent depression at apical fourth (ca. 21 spp. ranging from southern United States to Chile and Brazil; many Old World spp., of which 1 has become established in eastern Canada, probably extending into parts of Maine). . . . . Dryops Olivier 1791
5(3). Second segment of antenna dilated or produced into an earlike structure which may partially enclose apical segments 6
Second segment of antenna not thus dilated; dorsum typically pubescent, with conspicuous erect hairs (ca. 12 spp. from central United States to Argentina; also in Old World). . . . . Pelonomus Erichson 1847
6(5). Basal segment of antenna laminate, distinctly larger than second segment, may cover all other segments when antenna is withdrawn (Fig. 1) (3 spp. from Brazil; many spp. from Madagascar to Philippines). . . . . Sostea Pascoe 1860
Basal segment of antenna not laminate, usually smaller and less inflated than second segment (Fig. 2) (ca. 26 spp. from Canada to Argentina; many spp. in Old World). . . . . Helichus Erichson 1847

COMMENTS

For the four genera that do not extend into North America, the specimens reported to date from the entire New World are: *Protoparnus*, 1; *Sosteamorphus*, 6; *Sostea*, 2 of 1 species, 1 each of 2 species; *Elmoparnus*, 2 of the species from Panama, "a few" of that from Venezuela, and 1 of a species from Mexico which I am describing elsewhere. In view of the abundance and widespread distribution of *Helichus, Dryops,* and *Pelonomus,* it is surprising that the remaining genera should be so rare. A single collection of any of these three often includes more specimens than the total sum of all reported specimens of the other four genera combined. For example, I have taken more than 18 specimens of *Helichus* in 55 collections. Nor is this attributable to overwhelming success of any single species, for 10 different species of *Helichus* are represented by 19 or more specimens in a single collection. In contrast, I have collected about 35,000 specimens of Neotropical dryopoids, working carefully in stream habitats in many localities of Central America, the West Indies, and northern South America, and have taken but a single specimen representing any of the four rare genera: one of *Elmoparnus* from a small cataract in southeastern Mexico. Since both adults and larvae of such genera as *Sostea* are terrestrial, it is perhaps not surprising that I should fail to collect them. Obviously, I have not worked in the proper habitat. Perhaps a major reason for the apparent rarity of these beetles is simply that we do not know much about them and their ecology. In the case of *Sosteamorphus,* for example, we know nothing more than the



Figures 1-2. Fig. 1. Antenna of *Sostea westwoodii* from Borneo, with segments numbered. (Redrawn from Fig. 6 of Pascoe, 1860). Fig. 2. Antenna of *Helichus suturalis* from Oklahoma, with segments numbered. Ventral aspect of left antenna of male. Segments 3-8 may be withdrawn beneath part of segment 2.

country from which the specimens were taken—nothing even of locality or date. It is to be hoped that anyone who knowingly collects any representatives of these genera will report not only locality and date, but details of the microhabitat and observations upon behavior. Perhaps it goes without saying that I should greatly appreciate specimens of (and data concerning) any of these genera.

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———. 1883. Some new species and genera of Coleoptera from New Zealand. Ent. Mon. Mag. 20: 23-27.

2.0049 **A key to the Dryopid genera of the New World (Coleoptera, Dryopoidea).** Abstract.–To date, 7 genera represent the family Dryopidae in the Western Hemisphere. *Dryops, Helichus,* and *Pelonomus* are common, widely distributed, and represented by many species. *Protoparnus* and *Sosteamorphus* are each represented by but one species reported once from but a single locality. *Sostea* and *Elmoparnus* are each represented by 3 species, each of which is rare and known from no more than 2 localities. No key has previously been published covering these genera. Such a key is presented, based in part upon characters drawn solely from the literature.–**Harley P. Brown,** *Department of Zoology and Stovall Museum of Science and History, University of Oklahoma, 730 Van Vleet Oval, Norman, Oklahoma 73069.*

Descriptors: Coleoptera; Dryopoidea; Dryopidae. genera of Dryopoidae; key; New World.

(Continued from p. 170.)

Identification Aids

Orthoptera

Strohecker, H. F., W. W. Middlekauff, and D. C. Rentz. 1968. The grasshoppers of California (Orthoptera, Acridoidea). Bull California Ins. Surv. 10. 177 p.

Keys to the California acridoids with descriptive and distributional material.

Neuroptera

Stange, Lionel A. 1970. Revision of the ant-lion tribe Brachynemurini of North America (Neuroptera: Myrmeleontidae). Univ. California Publ. Ent., 55: 1-192. Paper $ 5.50.

Includes all of the known species in the United States and Mexico, plus information on their biology.

Diptera

Cole, Frank R. (with the collaboration of **Evert I. Schlinger**). 1970. The flies of Western North America. Univ. California Press, Berkeley. xi + 693 p. Cloth, $ 25.00.

This large work is essentially a compilation from the literature—only a few families such as the Acroceridae and Cecidomyidae were revised especially for the work. The lengthy introduction defines the area studied and discusses its ecology, biogeography, life zones, etc. There is also a short section on Geologic history and a lengthy discussion of general anatomy. The key to families is modified from that in Brues and Melander (1932). Each family treatment contains keys to subfamily (if necessary) and to genera. Under each genus the original citation is given and there is a listing and some discussion of the western species which fall in that particular genus. There are no keys to species and it would be very difficult to identify species with this work. The illustrations, particularly the full figures by Dr. Cole, are very good and are well reproduced. A great many are reproduced from Curran's Manual.

This book was many years in preparation and consequently some of the families or subgroups have been more recently revised but this would be true of any compilation of this kind. Since the source of each key is given the reader can refer back to the original work and is aware of the date of the key in question.

One unfortunate error has occurred in the table (p. 100) comparing the Townes–Johannsen classification of the Chironomidae with that of Freeman. The lines below Limnophyes through Tanytarsus in the second column do not correspond to their equivalents in column 1. The reader should consult the table on p. 143 of the Catalogue of North American Diptera.

The closing sections of the volume consist of a glossary, selected bibliography and an index to families, subfamilies, tribes, genera, and species.—**S. S. Roback.**

[3.0042]

A NEW PHOLISORA WITH NOTES ON *P. alpheus* (Edw.) (LEPIDOPTERA: HESPERIIDAE)[1]

C. DON MacNEILL[2]

This paper provides a name for a species of *Pholisora* for use in several other works currently in preparation. This new species is the third member of the closely related group designated by Dyar (1905: 118) as the genus *Hesperopsis.* These three species are fundamentally similar with respect to wing markings, secondary sexual characteristics, genitalic structure of males, and egg morphology, in striking contrast to the two remaining species of *Pholisora* (which also are vastly divergent from one another). This unit, recognized by Dyar, comprises at least a subgenus *Hesperopsis* Dyar and includes *Pholisora (Hesperopsis) alpheus* (Edw.), *P. (H.) libya* (Scud.) and *P. (H.) gracielae,* new species. *P. (H.) gracielae* is very closely related to *P. alpheus* with which it has been confused in the literature. This paper will consider only these two species of this subgenus but polytypic *P. libya* is also in need of distributional scrutiny in the future.

Pholisora gracielae, NEW SPECIES

(Figures 1, 2, 5, 6)

Diagnosis: This is a small species with very long palpi. The forewings above usually have a post-discal sigmoid series of poorly defined, short blackish spots, which are scarcely elongate wedge-shaped, running from the soiled white subapical spots to the vannal margin. The hindwings above usually have a pale brown or buff curved band of spots extending from the cell end to the vannal fold, and a less conspicuous submarginal series of poorly defined separated buff spots. The lower surface of the hindwing has a conspicuous curved series of white spots separated by dark veins extending from the end of the cell to the vannal fold, which is contrastingly gray overscaled. The submarginal white spots are usu-

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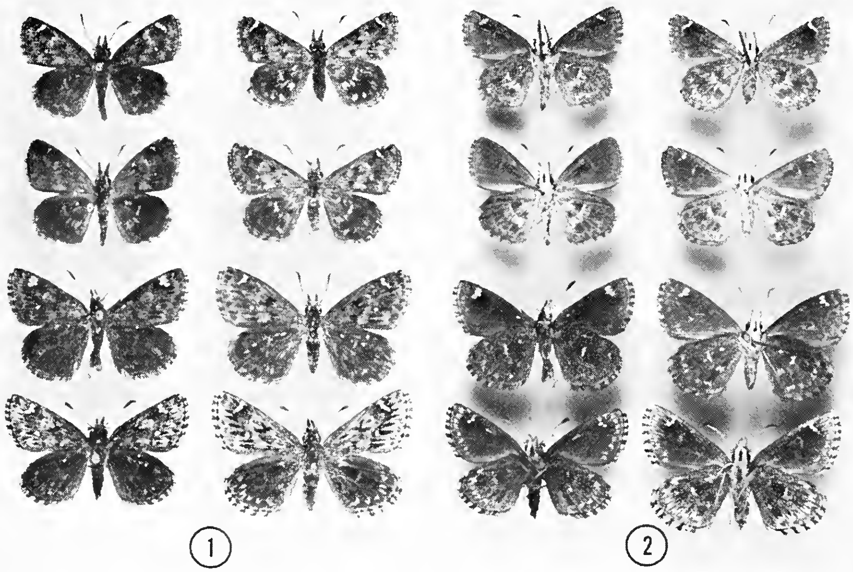
ally well developed only on the vannal one-half of the wing, and are never more prominent than the discal series of curved white spots. The length of the forewing of males ranges from 9 mm to 11.5 mm; that of the females from 10 mm to 12 mm.

The species is named for my wife, who was a great help to me during all phases of this study.



Figures 1-2. Adults of *Pholisora.* Top tier, *P. gracielae* (spring); second tier, *P. gracielae* (fall); third tier, *P. alpheus alpheus*; bottom tier, *P. alpheus oricus.* Fig. 1, upper side, males left, females right. Fig. 2, lower side, males left, females right.

Holotype MALE: Head with palpi long, projecting forward from below center of eye a distance greater than greatest width of head. Upper surface of forewing brown, liberally dusted with buff overscaling. Subapical spots sullied white and not prominent, their proximal margin defined by a minute curved blackish line continuing as a sigmoid series of ill-defined small dark spots, not wedge-shaped, to the vannal margin, and enclosing in spaces 2, 4, and 5 obscure buff spots. Fringe brownish buff, obscurely checkered with dark brown. Forewing length: 10 mm. Hindwing dark blackish brown with buff overscaling restricted to vannal fold, a submarginal series of vague pale spots on vannal one-half of wing, and an ill-defined curved pale band from cell to vannal fold. Fringe brownish buff, obscurely checkered with dark brown. Lower surface of hindwing dark brown, densely overscaled with buff. Submarginally with a series of poorly defined white spots gradually becoming obsolete on the costal one-half of the margin. A curved series of white spots extends from end of cell to vannal fold, and in mid cell is one white dot. Vannal fold buffy gray. Genitalia with caudal process of valva very slender, directed laterally, and slightly ventrad, the terminal portion flattened horizontally by disto-lateral position of subterminal wings. Penis with caudal bevel prolonged, the ventral tip exceeding the dorsal portion by a distance much greater than caudal diameter of penis.

Allotype FEMALE: Much as in male but upper surface of forewing paler with dark markings more distinct, especially the discal series through middle of cell, and a small subbasal dark spot in cell. End of cell defined by vague pale bar. The sigmoid series of dark spots running from subapical spots to vannal margin conspicuous, a few short wedge-shaped, and several enclosing small pale buff spots. Forewing length: 10 mm. Hindwing dark brown, less blackish than in male, and with pale spots buff-white and better defined. Lower surface of hindwing as in male but with white spots more sharply defined.

Material examined: HOLOTYPE, male: CALIFORNIA, San Bernardino Co., Bennett Wash, vicinity Parker Dam, IV-22-51 (C. D. MacNeill). ALLOTYPE, female: same data as holotype. PARATYPES: 92 specimens as follows: same data as holotype, 10 males, 2 females; CALIFORNIA, San Bernardino Co., nr. Earp, IV-29-49 (C. D. MacNeill) 1 male, 5 females; 10 mi. n.e. Earp, IV-18-64 (Langston and MacNeill) 35 males, 1 female; Needles, IV-17-64 (Langston and MacNeill) 3 males, 3 females; Riverside Co., Blythe, IV-10-21, 1 male; nr. Blythe, IV-27-49 (C. D. MacNeill) 2 males, 1 female; Blythe, VII-8-56 (A. Menke, Jr.) 1 female; ARIZONA, Yuma Co., Colorado R. at Parker, IV-18-64 (Langston and MacNeill) 21 males, 6 females.

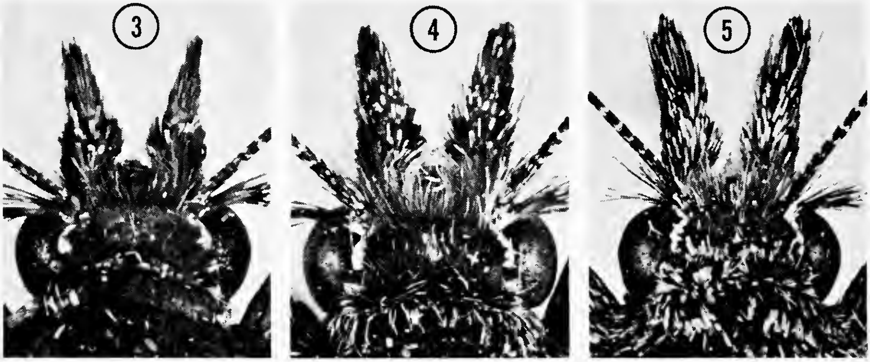
The holotype and allotype will be deposited in the collection of the California Academy of Sciences. Paratypes will be placed in the collections of the following institutions and individuals: California Academy of Sciences, Los Angeles County Museum, American Museum of Natural History, California Insect Survey, J. M. Burns, H. A. Freeman, K. C. Hughs, R. O. Kendell, R. L. Langsron, C. D. MacNeill, K. Roever, and J. W. Tilden.

In addition to the type material, 37 males and 8 females of the spring brood (dated April and May) from the Imperial Valley of southern California have been examined, and 43 males and 11 females of the late summer brood have been seen. These represrnt localities from near Parker in Yuma Co., Arizona, south to Yuma, and in the Imperial Valley of California. Dates of collection of these specimens extend from late July to October.

DISCUSSION

Adults of *P. gracielae* representing the late summer and fall brood are noticably much darker insects, particularly the males. In these the upper surface may be almost entirely unmarked, with even the subapical pale spots absent. The slightly curved band of pale spots extending from the end of the cell to the pale vannal fold on the lower surface of the hindwing may be the only whitish spots on males of this late brood, although this band is usually suggested on the upper surface in lighter brown.

On the upper surface of the forewing *P. gracielae* differs from *P. alpheus* in that the post-discal sigmoid series of black marks are short, generally not conspicuously elongated into slender wedge-shaped dashes. The overscaling is buff in color, not white, and it is especially prominent in females where the nondescript black markings are contrasting. The pale spots of the forewing are usually buff, not white, and the fringes of both wings are obscurely buff and dark brown or black checkered. The lower surface of the hindwing is usually distinctive in that the curved series of whitish spots running from the cell end to the pale vannal fold is at least as prominent as the submarginal series of pale spots. This latter is generally poorly developed and the spots become obsolete on the costal one-half of the wing. The palpi are generally distinctly longer in *P. gracielae* than in *P. alpheus.* The male genitalia are very similar to those of *P. alpheus.* The long caudal process of the valva extends backward in a curve directed laterally as in *P. alpheus*, but the minute subterminal wing of that process which gives the tip a flattened aspect, is located laterally and the consequent horizontally flattened tip tends to be directed very slightly ventrad (see fig. 6). This condition seems to obtain only in certain populations of *P. alpheus* which, however, are superficially quite unlike *P. gracielae.* Because of the laterally divergent arc these processes demonstrate in both species, the additional dorsal or ventral deflection of the tip is difficult to ascertain once the genitalic parts have been separated after dissection. This critical deflection is relative to the position of the valvae in situ, and it is essential to compare these structures from the same lateral viewing angle. Therefore, it is difficult to determine from the numerous published illustrations of "*P. alpheus*" genitalia the actual identity of the species figured. *Pholisora gracielae* has been figured as *P. alpheus* by Comstock (1927) (late summer brood) and his (1929) reference to the early stages of *P. alpheus* refers to *P. gracielae.*



Figures 3-5. Head and palpi of *Pholisora* males, dorsal aspect. Fig. 3, *P. alpheus alpheus*; Fig. 4, *P. alpheus oricus*; Fig. 5, *P. gracielae* (Holotype).

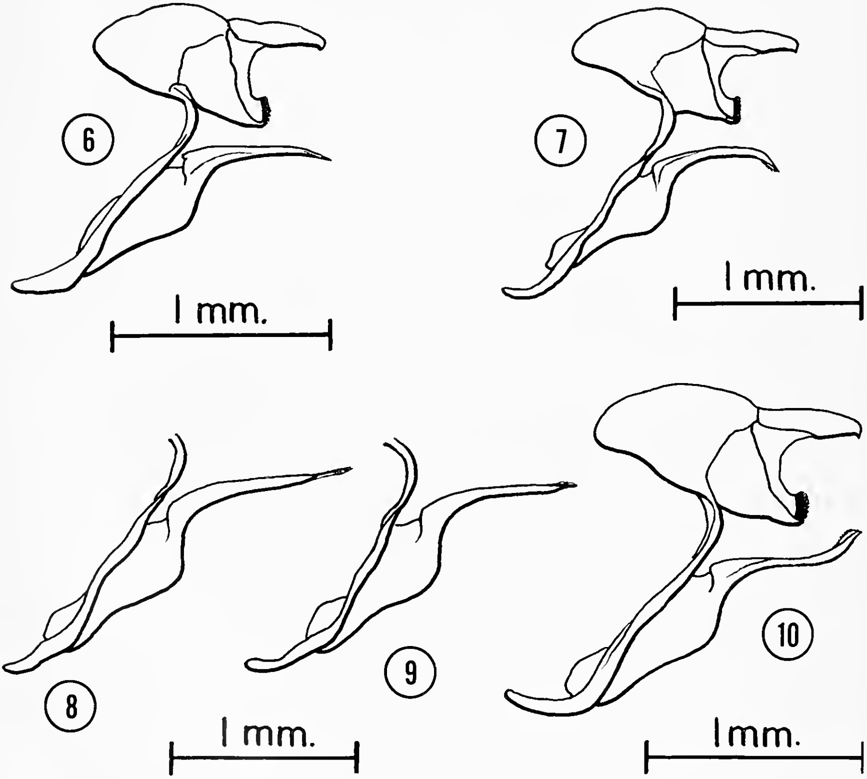
This species is very closely associated with the larval food plant, *Atriplex lentiformis* (although Comstock gives *A. expansa* as the food plant), a very large shrub that forms dense thickets as a sub-riparian associate of the drainage systems of the lower Colorado River in Arizona, Nevada, California, and adjacent Mexico. It is here that *P. gracielae* occurs, and it is in such situations that this species demonstrates a distinctive behavioral characteristic. The flight of *P. gracielae* is very weak, a fluttering bouncy flight that is quite slow even when away from the larval food plant. Adults tend to remain well within the shrubbery, where their flight is "moth-like", especially slow and weak, and their progress from bush to bush seems to preferentially be restricted to a route through twiggery. They will select a course through a low and dense slash pile to traverse a small interspace between shrubs apparently in preference to a short passage in the open.

Pholisora alpheus is generally a larger insect than is *P. gracielae* and there is less difference in wing markings between the sexes. The upper surface of the forewing in *P. alpheus* usually has conspicuous white subapical spots, and from these to the vannal margin is a series of elongate wedge-shaped dashes which, in females, may enclose several small white spots. The fringes may be nearly blackish or distinctly checkered black and white. On the lower surface of the hindwing there is generally a thin white bar at the end of the cell, and a submarginal series of small white spots which are always at least as prominent as any suggested pale band between the cell end and the dark vannal fold. The palpi are relatively shorter than are those of *P. gracielae. Pholisora alpheus* is widely distributed in the arid west and demonstrates a considerable geographic differentiation through its range. At least two subspecies can be superficially recognized.

The nominate subspecies, *P. a. alpheus* (figs. 1, 2, 3, 7) is a dark insect with little white overscaling on either the upper surface of the forewing or on the hindwing below. The tip of the caudal process of the valvae of males tends to be directed ventrally (in addition to the lateral curve) (see fig. 7) and the minute subterminal wing is almost ventral in position so the flattened tip of the process is somewhat obliquely vertical rather than horizontally oriented. *Pholisora alpheus alpheus* is evidently at least two brooded and individuals of the second brood are somewhat darker than earlier adults. The wing pattern is not obscured, however, in second brood adults. This subspecies ranges from Mexico into Texas, New Mexico, southern Arizona and probably eastern and southern Colorado. According to Roever (personal communication) this subspecies is associated with *Atriplex canescens* in Arizona.

In extreme southern Texas is a population of *P. alpheus* the adults of which are rather small and have wing markings curiously suggestive of *P. gracielae.* The palpi are shorter than are those of *P. gracielae* and though the wing features, particularly of females, resemble that species, they are in detail more characteristic of *P. alpheus.* The male genitalia are rather like those of northern and eastern populations of the following subspecies in that the caudal process of the valva is horizontally flattened at the tip where it is directed slightly dorsad. The posterior tip of the penis is evidently variable, some examples having a long terminal bevel as in *P. gracielae*, and others having a more abrupt bevel as in most *P. alpheus.* This population is not typical of either *P. alpheus alpheus* or the following subspecies.

Pholisora alpheus oricus Edwards (1879: 51) (NEW STATUS) (figs. 1, 2, 4, 8, 9, and 10) is a striking insect which appears quite different when fresh from any of the populations previously mentioned. Adults are usually large and have on the upper surface of the forewing a heavy vestiture of white overscaling,



Figures 6-10. Male genitalia of *Pholisora*, left lateral aspect of uncus and gnathos, vinculum, and left valva. Fig. 6, *P. gracielae* (Type locality); Fig. 7, *P. alpheus alpheus* (Big Bend, Texas); Fig. 8, *P. alpheus oricus* (n.w. Utah) (vinculum and valva only); Fig. 9, *P. alpheus oricus* (w. Nevada) (vinculum and valva only); Fig. 10, *P. alpheus oricus* (s. California).

particularly distal to the series of wedge-shaped spots where these are in effect outlined in white. The subapical spots are usually large and conspicuously white. The fringes of both wings are boldly black and white checkered. The lower surface of the hindwing appears grizzled owing to heavy white overscaling and the submarginal series of white spots is usually well developed. The male genitalia of the populations inhabiting the Mojave Desert of California are distinctive in that the caudal process of the valve is terminally directed dorsad (see fig. 10), and the minute subterminal wing is almost dorsally placed causing the plane of the flattened tip to be almost vertical. This condition changes, however, in the Great Basin, where the end of the caudal process, one might say, has "rotated" laterally so that the tip is only slightly, if at all, directed dorsad (see figs. 8 and 9), and the wing being lateral imparts a horizontal orientation to the flattened tip. It is in this feature that the genitalia most closely resemble those of *P. gracielae* but even so the tip is usually directed very slightly dorsad rather than slightly ventrad as in *P. gracielae.* Superficially the majority of these Great Basin adults entirely resemble those of the Mojave Desert. In central Arizona, northwestern New Mexico and central Colorado these populations should meet *P. alpheus alpheus* and both the wing characteristics and the features of the end of the valvae can be expected to change toward the condition typical of the nominate subspecies. This subspecies is evidently single brooded, adults being taken only from April to June. This subspecies ranges from the Mojave Desert of California, northward and eastward through Nevada, eastern Oregon, Utah, western Colorado, northern Arizona and extreme northwestern New Mexico. The food plant of this subspecies is *Atriplex canescens* and adults are not found far from this shrub. The flight behavior of this insect is direct, fairly rapid, and in general quite skipper-like when traveling. In the immediate vicinity of *A. canescens* the flight becomes somewhat erratic and hesitant, but adults show no desire to penetrate the shrubbery for long periods or to shun open space.

Acknowledgments

I am grateful to the following individuals for the loan of material in their care or personal collections: P. H. Arnaud (California Academy of Sciences, San Francisco); D. L. Bauer; F. M. Brown; J. M. Burns; P. J. Herlan; C. L. Hogue (Los Angeles County Museum); K. C. Hughes; R. O. Kendall; R. L. Langston; L. M. Martin (Los Angeles County Museum); J. A. Powell (California Insect Survey, University of California, Berkeley); K. Roever; J. A. Scott; O. E. Sette. For considerable help in the field with several populations of this complex I wish to thank the following people: R. L. Langston, D. D. Linsdale, M. R. Lundgren, C. A. Tauber, and M. J. Tauber. The photographs were taken by Stennett Heaton of Oakland, California, and his assistance is gratefully acknowledged. Finally, for rewarding discussions and most fruitful suggestions I especially appreciate the counsel of John M. Burns, Jerry A. Powell, Kilian Roever, and O. Elton Sette.

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2.0042 A new *Pholisora* **with notes on** *P. alpheus* **(Edw.) (Lepidoptera: Hesperiidae).** Abstract.–The species *P. alpheus* (Edw.), *P. libya* (Scud.), and *P. gracielae*, NEW SPECIES, comprise the subgenus *Hesperopsis* Dyar of the genus *Pholisora.* The new species, *P. gracielae*, restricted to the lower Colorado River drainage, has as its principal distinguishing features very long palpi; forewings above usually with a post-discal sigmoid series of poorly defined, short blackish spots, which are scarcely elongate wedge-shaped, running from the soiled white subapical spots to the vannal margin. The hind wings above usually have a pale brown or buff curved band of spots extending from the cell end to the vannal fold, and a less conspicuous submarginal series of poorly defined separated buff spots. The lower surface of the hindwings has a conspicuous curved series of white spots separated by dark veins extending from the end of the cell to the vannal fold, which is contrastingly gray overscaled. The submarginal white spots are usually well developed only on the vannal one-half of the wing, and are never more prominent than the discal series of curved white spots. The length of the forewing of males ranges from 9 mm to 11.5 mm; that of the females from 10 mm to 12 mm. Type locality: Bennett Wash, vicinity Parker Dam, San Bernardino Co., California. Its closest relative is *P. alpheus.* The peculiarly retiring flight behavior is characteristic of the new species, contrasting with the behavior in some populations of *P. alpheus.* The larval food plants of *P. gracielae* and *P. alpheus* are two different species of *Atriplex. Pholisora alpheus* is polytypic and the name *P. oricus* Edwards is resurrected from the synonymy to apply to the Great Basin and Mojavian populations of *P. alpheus.* There is some further geographic differentiation between populations of *P. alpheus oricus* with respect to male genitalia.–**C. Don MacNeill,** *Division of Natural Sciences, Oakland Museum, Oakland, California 94607.*

Descriptors: Lepidoptera; Hesperiidae; *Pholisora; Hesperopsis; Pholisora gracielae; Pholisora alpheus alpheus; Pholisora alpheus oricus.*

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(Continued on back inside cover.)

SECOND-CLASS POSTAGE PAID AT LAFAYETTE, INDIANA

[3.0051]

A TACHINID PARASITE OF FIREFLIES
(Diptera, Tachinidae; Coleoptera, Lampyridae)[1]

Curtis W. Sabrosky[2] and Bernard H. Braun[3]

Tachinid flies have not been recorded parasitizing beetles of the family Lampyridae, as far as we can determine from a survey of the usual sources and summaries of host-parasite records. Van Emden (1950) reviewed "Dipterous parasites of Coleoptera" on a world basis, but listed none from Lampyridae. Paul H. Arnaud, Jr. (in litt.) has kindly informed us that he found no published records from that family for his nearly completed manuscript of a host-parasite catalog of North American Tachinidae. Therefore, the following record is believed to be the first report of a tachinid parasite of lampyrid beetles.

Early in 1970, one of us (Braun) collected a few adult lampyrids, *Ellychnia corrusca* (L.) [det. Robert D. Gordon], on trunks of trees at Beltsville, Maryland. On 27 and 28 February, three small maggots emerged from one of four adult beetles which were collected on 19 February and held alive in jars. By evening of the 28th, all had pupated, and these were delivered to Sabrosky for observation. On the morning of 12 March, shortly after some moisture was supplied, two flies emerged and proved to be the small and common tachinid, *Hyalomyodes triangulifer* (Loew) [det. Sabrosky].

This parasitism was apparently not isolated or aberrant. After the maggots were noted, large numbers of the beetles were collected in March and April, and over 30 maggots were found at various times. Some were accidentally lost or

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[1] Accepted for publication July 27, 1970.

[2] Systematic Entomology Laboratory, United States Department of Agriculture, c/o United States National Museum, Washington, DC 20560.

[3] Pesticide Chemicals Research Branch, Agricultural Research Center, Beltsville, MD, 20705.

molded, but nine matured and emerged as adults. All were *H. triangulifer.*

W. R. Thompson (1954) reviewed the known biology of *Hyalomyodes triangulifera (sic),* described and figured all larval stages and puparium in detail, noted that its known hosts were beetles, and named six genera of Chrysomelidae, Alleculidae, Coccinellidae, and Curculionidae. Other published records known to us list the species from the vegetable weevil, *Listroderes costirostris obliquus* (Klug), another weevil, *Sitona lepidus* (Gyll.), and the three-spotted flea beetle, *Disonycha triangularis* (Say). Wellso and Hoxie (1969) have recently recorded it from the cereal leaf beetle, *Oulema melanopus* (L.), and they also mention rearings from the alfalfa and clover leaf weevils, *Hypera postica* (Gyll.) and *H. punctata* (F.). Data from the collection of the U. S. National Museum and from identifications by Sabrosky yield the following host records:

Coleoptera

Cerotoma trifurcata (Forster), the bean leaf beetle: Greenwood, Miss., July 21 and 23, 1916 (C. F. Turner); Crawford Co., Ark., Apr. 23, 1970 (H. P. Tugwell); Magazine, Ark., July 4, 1968 (L. D. Newsom); Lacassine Refuge, La., June 14, 1968 (L. D. Newsom).

Hypera postica (Gyll.), the alfalfa weevil: Beltsville, Md., Mar. 8, 1965.

H. punctata (F.), the clover leaf weevil: Muirkirk, Md., Oct. 13, emgd. Dec. 17, 1965 (C. C. Blickenstaff); Forest Grove, Ore., Nov. 8, 1924 (M. M. Reeher), probably from *H. punctata* adult.

Nodonota puncticollis (Say), the rose leaf beetle: Chambersburg, Penn., June 27, 1921 (F. M. Craighead).

Elateridae: Walla Walla, Wash., June 1932 (M. C. Lane), "in cage of adult wireworm beetles."

Lepidoptera

Rhyacionia buoliana (Schiff.), the European pine shoot moth: Maumee State Forest, Ohio, 1956.

Dermaptera

Forficula auricularia L., the European earwig: Kingston, R. I., Sept. 20, 1953 (K. E. Hyland, Jr.).

Hemiptera

Anasa tristis (DeGeer), the squash bug: Beltsville, Md., Dec. 5, 1958 (R. I. Sailer), emerged in laboratory.

Murgantia histrionica (Hahn), the harlequin bug: Athens, Ohio, Aug. 16, 1933 (H. C. Mason); St. Mary's City, Md., Aug. 6, 1939 (Doris H. Blake).

Undoubtedly a survey of other collections would reveal additional hosts, but these records are sufficient to indicate that *Hyalomyodes triangulifer* parasitizes a variety of Coleoptera, and sometimes other orders. The range of dates suggests several generations of the parasite. Thompson noted that all records up to that time showed emergence as adults the same year, after a short pupal period;

however, in the very early rearing from Lampyridae the larvae found in February must have overwintered in the body of the host. This rearing does confirm Thompson's conclusion that the larvae leave the body of the host for pupation.

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Wellso, S. G., and **Hoxie, R. P.** 1969. *Hyalomyodes triangulifer* parasitizing the cereal leaf beetle, *Oulema melanopus.* Ann. Ent. Soc. America 62: 923-924.

2.0051 **A tachinid parasite of fireflies (Diptera, Tachinidae; Coleoptera, Lampyridae).**– The tachinid *Hyalomyodes triangulifer* emerged in the laboratory from the lampyrid *Ellychnia corrusca.* This species is known to parasitize species of Chrysomelidae, Curculionidae, Scarabaeidae, and Elateridae in addition to this new record for Lampyridae. Records of parasitism on Lepidoptera, Dermaptera, and Hemiptera also have been reported.–**Curtis W. Sabrosky,** *Systematic Entomology Laboratory, c/o U. S. National Museum, Washington, DC 20560* and **Bernard H. Braun,** *Pesticide Chemicals Research Branch, ARC, Beltsville, MD 20705.*

Descriptors: Diptera; Tachinidae; Coleoptera; Lampyridae; *Hyalomyodes triangulifer;* parasitism; Chrysomelidae; *Cerotoma trifurcata; Hypera postica; Hypera punctata; Nodonota puncticollis*; Elateridae; Lepidoptera; *Rhyacionia buoliana*; Dermaptera; *Forficula auricularia*; Hemiptera; *Anasa tristis; Murgantia histrionica.*

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

[3.0050] **The spider *Loxosceles rufescens* (Dufour) in Illinois: A correction.**–Whitmyre and Wills (1970. Ent. News 81(3): 70) reported that, "On September 26, 1969, a Luzerne County housewife discovered a mature male *Loxosceles rufescens* (Dufour) in a new plastic pitcher purchased from a retail store in Wilkes-Barre, Pennsylvania. The plastic pitcher was introduced in a shipment from Chicago, Illinois, where *L. rufescens* is reported from the southern part of the state (Gorham, 1968. Coop. Econ. Ins. Rept. 18(10): 171-175.)" The implication here is that the specimen of *L. rufescens* came from Chicago, also that it occurred in southern Illinois. *L. rufescens* has been introduced into the United States and is now established along the East Coast and the Gulf states (Gertsch, 1958. American Mus. Nov. No. 1907. 46 pp.). This species could have been transported from Chicago to Wilkes-Barre, but Whitmyre and Wills' evidence indicates only that *L. rufescens* was discovered in a plastic pitcher in Wilkes-Barre and that the pitcher came from Chicago. There is no direct evidence that the specimen originated in Chicago. I have examined all the specimens of *Loxosceles* collected in Chicago, and they have all been the brown spider, *L. reclusa* Gertsch and Muliak.

Whitmyre and Wills' reference to Gorham's southern Illinois record of *L. rufescens* is based on a misinterpretation of his distribution map (fig. 1, p. 174) of the species of *Loxosceles* in the United States. The symbol for *L. rufescens* is placed within the boundaries of Illinois but a guideline points to St. Louis, Missouri. This record was taken from Gertsch (1958) who recorded the species from St. Louis, Missouri, not Illinois. I have been studying the genus *Loxosceles* in Illinois for seven years, and extensive collections from throughout the state since 1959 indicate that *L. reclusa* is the only species of *Loxosceles* now present in Illinois.–**John D. Unzicker**, *Illinois Natural History Survey, Urbana, Illinois 61801.*

Accepted for publication July 25, 1970.

Descriptors: Loxosceles rufescens; Illinois; Araneae; Scytodidae.

[3.0052] ***Blaesoxipha uncata* (Wulp) (Diptera, Sarcophagidae), a parasite of the grasshopper, *Dissosteira carolina* (L.) (Orthoptera, Acrididae).**–Six maggots emerged from between the third and fourth abdominal segments of an adult female *Dissosteira carolina* (L.) collected alive in south eastern Cook County, Illinois, on September 19, 1969. The maggots pupated shortly afterward in sawdust kept at 23° C and adults emerged three weeks later. They were identified as *Blaesoxipha uncata* (Wulp) by Dr. Maurice T. James, University of Washington. A review of the literature has failed to reveal any previous mention of this parasitic association.–**Jaclin S. Lewbin** and **Bernard Greenberg**, *Department of Biological Sciences, University of Illinois at Chicago Circle, Chicago, Illinois 60680.*

Accepted for publication July 29, 1970.

Descriptors: Blaesoxipha uncata; Sarcophagidae; Diptera; parasite; *Dissosteira carolina;* Orthoptera; Acrididae.

(Continued on p. 197.)

[3.0045]

STUDIES ON THE BYRON BOG IN SOUTHWESTERN ONTARIO XLIV. FLIES (SARCOPHAGIDAE, MUSCIDAE AND TACHINIDAE) TRAPPED IN THE BOG[1]

W. W. JUDD[2]

In 1956 a study of filth flies occurring in the Byron Bog in London, Ontario was made (Judd, 1958). The flies were trapped from May 15 to November 15 in a baited trap set out on the *Sphagnum* mat of the bog and located as shown on the map included by Judd (1957). The structure and use of the trap are described by Judd (1956). During 1956 the population of nineteen species of flies was studied and is reported on by Judd (1958).

In addition to the flies reported by Judd (1958), several other species were found in the trap in 1956, particularly in the fall, and a report on them is included herewith. The flies were identified by members of the staff of the Entomology Research Institute, Department of Agriculture, Ottawa: D. M. Wood (Tachinidae) and G. E. Shewell (Muscidae, Sarcophagidae). All specimens are deposited in the collection of the Department of Zoology, University of Western Ontario except two of *Oxysarcodexia ventricosa* kept in the National Collection in Ottawa.

Sarcophagidae

Boettcheria cimbicis (Townshend): 21 flies, October 25 to November 5. This species is recorded by Stone *et al.* (1965) as occurring in the eastern United States.

Boettcheria latisterna Parker: 6 flies, October 25 to November 5. This species is recorded by Stone *et al.* (1965) as occurring in the eastern United States and Canada and was trapped in London in 1953 by Judd (1956).

Oxysarcodexia cingurus (Aldrich)?: 4 females, October 26 to November 3. *O. cingarus* is recorded by Stone *et al.* (1965) as occurring in the eastern United States and Canada and was trapped in London in 1953 by Judd (1956).

Oxysarcodexia ventricosa (Wulp): 4 flies, October 26 to November 3. This species is

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[1] Accepted May 21, 1970

[2] Department of Zoology, University of Western Ontario, London, Ontario

recorded by Stone *et al.* (1965) from the eastern United States and Canada and was trapped in London in 1953 by Judd (1956).

Ravinia derelicta (Walker): 1 fly, November 5. This species is recorded by Stone *et al.* (1965) from the eastern United States and Canada.

Ravinia lherminieri (R.-D.): 4 flies, October 25 to November 4. This species is recorded by Stone *et al.* (1965) from much of the United States and Canada and was collected in 1953 at London by Judd (1956).

Ravinia querula (Walker): 16 flies, October 25 to November 6. This species is recorded from much of North America by Stone *et al.* (1965) and was collected in London in 1953 by Judd (1956).

Sarcophaga melanura Meigen: 1 fly, November 6. This species is recorded from the eastern United States by Stone *et al.* (1965).

Sarcophaga sinuata Meigen: 3 flies, October 25, November 4, 5. This species is recorded from much of North America by Stone *et al.* (1965) and was collected in London in 1953 by Judd (1956).

Muscidae

Muscina assimilis (Fallen): 1 fly, November 2.

Graphomya maculata auct.: 12 flies, October 29 to November 6.

Both of these species are recorded by Stone *et al.* (1965) as occurring over much of North America.

Tachinidae

Voria ruralis (Fallen): 2 flies, October 25, 26. This species is recorded as occurring in eastern North America by Stone *et al.* (1965) and is a parasite of caterpillars, particularly the larva of the Cabbage Looper, *Trichoplusia ni* (Huebner) (Elsey and Rabb, 1970).

Exorista mella (Walker): 1 fly, October 26.

Winthemia rufopicta (Bigot): 3 flies, November 1, 5, 6.

Both of these species are recorded by Stone *et al.* (1965) as occurring over much of North America.

Literature Cited

Elsey, K. D. and **R. L. Rabb.** 1970. Biology of *Voria ruralis* (Diptera: Tachinidae). Ann. Ent. Soc. America. 63: 216-222.

Judd, W. W. 1956. Results of a survey of calyptrate flies of medical importance conducted at London, Ontario during 1953. American Midl. Nat. 56: 388-405.

Judd, W. W. 1957. Studies of the Byron Bog in southwestern Ontario I. Description of the bog. Canadian Ent. 89: 235-238.

Judd, W. W. 1958. Studies of the Byron Bog in southwestern Ontario VIII. Seasonal distribution of filth flies. American Midl. Nat. 60: 186-195.

Stone, A., C. W. Sabrosky, W. W. Wirth, R. H. Foote, and J. R. Coulson. 1965. A catalog of the Diptera of America north of Mexico. United States Dept. Agric., Agric. Res. Serv. Handbk. no. 276. 1696 pp.

2.0045 **Studies of the Byron Bog in Southwestern Ontario XLIV. Flies (Sarcophagidae, Muscidae, and Tachinidae) trapped in the Bog.** Abstract.–Nine species of Sarcophagidae, two of Muscidae and three of Tachinidae were collected in a baited trap in the Byron Bog at London, Ontario in the fall of 1956.–**W. W. Judd**, *Department of Zoology, University of Western Ontario, London, Ontario, Canada.*

[3.0054]

A NEW TREEHOPPER OF THE GENUS *Cyrtolobus* FROM WISCONSIN (HOMOPTERA, MEMBRACIDAE)[1]

Clifford J. Dennis[2]

The genus *Cyrtolobus* Goding is a difficult one, containing several closely related species which present problems in determination. It has often been implied that the females show less variation than the males and bear more distinctive patterns so that more meaningful comparisons can be made using females to designate species. I would take issue with this since I have found that in several species of *Cyrtolobus* the females vary greatly too, notably in what can be called the "*vau*" group. In some species, such as *C. querci* (Fitch), the male certainly is distinctive.

Since so many recognized species do intergrade, it was interesting to find these strongly marked new males. They were collected by two students attending an N. S. F. Institute at the Pigeon Lake field station of Wisconsin State Universities. They are Mr. Robert Battles of Ankeny, Iowa, and Mr. Wayne Suoja of Virginia, Minnesota. They were part of a group collecting from bur oak, jack oak, and hazel in the pine barrens, but specific plants from which these insects were taken are unknown. However, since the members of this genus are common inhabitants of several kinds of oaks and hickories as well as black locust, either the bur or jack oak is the probable host for this species.

The genus *Cyrtolobus* contains about 42 species in North America, of which 17 have been known previously from Wisconsin.

The insect described here keys readily to the genus *Cyrtolobus* in Funkhouser's (1923) Hemiptera of Connecticut. On page 171 it comes out to the subfamily Smiliinae. On page 172 of his key to genera of Smiliinae it comes out in the second part of couplet 18 to *Cyrtolobus*. In my (1952) keys on

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[1] Accepted for publication August 14, 1970.

[2] Wisconsin State University, Whitewater, WI 53190.

pages 130 and 131 it runs easily to subfamily Smiliinae, tribe Smiliini, genus *Cyrtolobus*. However, it will not fit in my key to species at all. The simplest way to modify the key to males on page 132 would be to make the first couplet a triplet to read as follows:

1. Pronotum distinctly green and black . . . . maxinei Dennis
Pronotum with bright yellow markings 2
Pronotum without distinct green and black or bright yellow markings 3

Cyrtolobus maxinei NEW SPECIES

(Figures 1, 2, 3)

Male: Medium sized, relatively low, in form resembling *C. flavolatus* Woodruff. Pronotum strikingly and distinctly marked with green and black.

Face between eyes nearly twice as broad as tall, coarsely punctate, yellow-green with deep brown as sparce, scattered spots and irregularly bordering epicranial suture and as an irregular line from each ocellus toward lower corner of eye and along medial 2/3 of lower edge of vertex. Ocelli hyaline, equidistant from each other and eye. Eye red. Clypeus abruptly narrowed apically, yellow-green with deep brown along lower margin and as two irregular vertical bars arising from point of abrupt narrowing. Lateral aspect of head black with posterior borders of sclerites narrowly testaceous. Base of antenna pale testaceous.

Pronotum coarsely punctate, scantily haired, little elevated, regularly curved to the subacute apex which attains half of the terminal areole. Metopidium green with yellow-green surrounding and between the callosities. Callosities and irregular spots between them deep brown. A black stripe arising on the median carina between the callosities and broadening as it rises and continues posteriorly to the anteapical vitta before which it attains the margin of the pronotum. Sides of the pronotum and anteapical vitta green. Tip of pronotum black.

Body beneath black, with posterior margins of sclerites testaceous. Abdomen black with posterior margin of segments yellow. Subgenital plate yellow with a median patch of black and a pair of short longitudinal black bars arising from the base, equidistant from each other and the lateral borders of the plate.

Coxae black with obscure proximal and distal testaceous bands. The middle and rear coxae with postero-lateral protuberance yellow. Trochanters testaceous. Femora black with proximal and distal testaceous bands. Tibiae and tarsi testaceous.

Tegmina hyaline; base, veins, membrane beyond cells, extreme posterior of terminal areole and of two cells above it deep brown.

Holotype dimensions: Total length, 4.9 mm. Maximum width of pronotum 2.0 mm. Holotype male: 14 miles west of Drummond, Bayfield Co., Wisconsin, July 23, 1970 (Robert Battles).

Paratype male: same locality and date (Wayne Suoja). This specimen is slightly more yellowish on the face and metopidium, and the tip of the pronotum is missing.

Both specimens are in my collection.

Female: unknown; however, in the same area I have found females which are green with a slight yellow cast and closely resemble those of *C. inermis* (Emmons) but differ by being larger. It is possible that these are females of this new species; however, in the absence of definitive evidence I do not wish to designate these as the females of the species described here.

This species is dedicated to my wife, Maxine, who has patiently and materially aided in my collecting for many years.

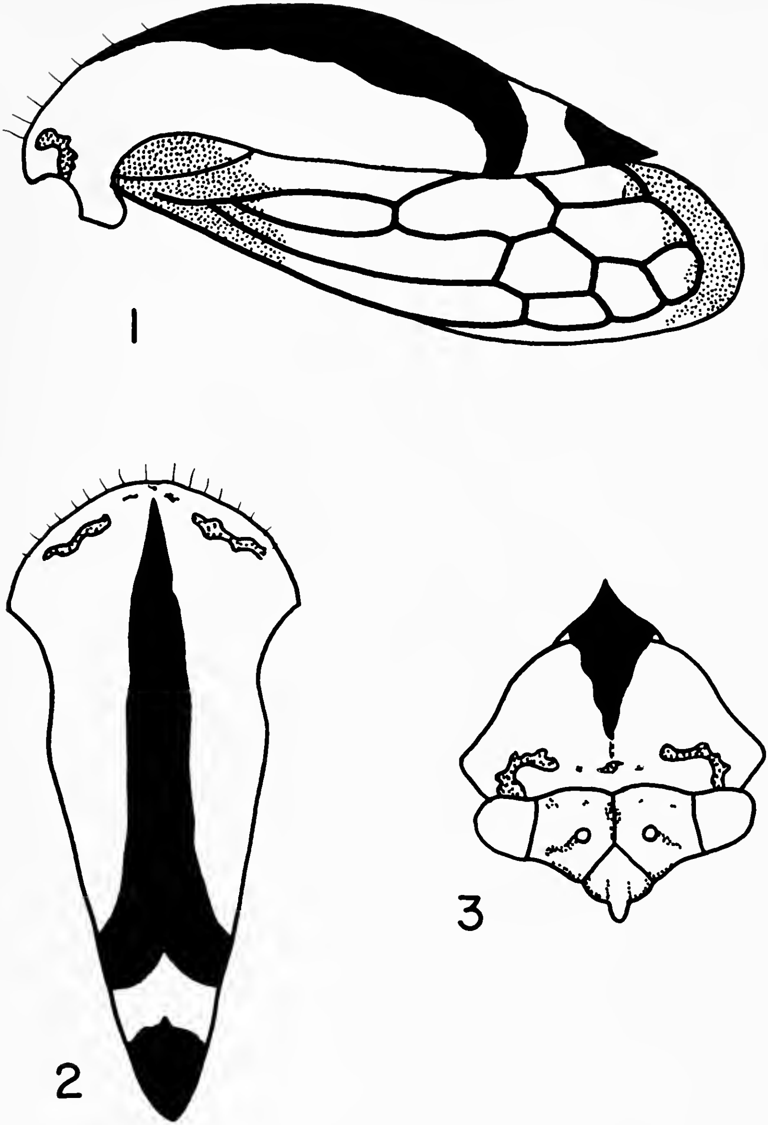
Literature Cited

Dennis, Clifford J. 1952. The Membracidae of Wisconsin. Trans. Wisconsin Acad. Sci., 41: 130-132.

Funkhouser, W. D. 1923. Family Membracidae *in* **Britton's** *Guide to the insects of Connecticut.* Part IV. The Hemiptera or sucking insects of Connecticut. Bull. Connecticut Geol. Nat. Hist. Surv., 34: 171-172.

2.0054 A new treehopper of the genus *Cyrtolobus* from Wisconsin (Homoptera, Membracidae).—The new species, *Cyrtolobus maxinei* Dennis is a medium sized, relatively low in form species resembling *C. flavolatus* Woodruff. The pronotum is strikingly and distinctly marked with green and black. The type locality is 14 miles west of Drummond, Bayfield Co., Wisconsin.—**Clifford J. Dennis,** *Wisconsin State University, Whitewater, WI 53190.*

Descriptors: Homoptera; Membracidae; *Cyrtolobus maxinei; Cyrtolobus flavolatus.*



Figures 1-3. Cyrtolobus maxinei new species. Fig. 1, left lateral view of pronotum and tegmen; Fig. 2, dorsal view of pronotum; Fig. 3, anterior view of face and pronotum. All drawn to same scale.

[3.0057]

A LECTOTYPE DESIGNATION AND A KEY TO THE SPECIES OF *Acrocyum* (COLEOPTERA, CHRYSOMELIDAE, ALTICINAE)[1]

Edward C. Mignot[2]

The genus *Acrocyum* Jacoby was erected in 1885 for 4 new species also described at the same time. Since then no additional species have been added to the genus. Of the 4 species, 3 occur in Mexico and 1 in Guatemala. The range of 1 of the 3 Mexican species, *A. sallaei* Jacoby, extends into southern Arizona.

As with most of the Jacoby species from the *Biologia Centrali-Americana*, no holotypes were designated. My current revisionary work on the Alticinae of the United States and Canada has necessitated the designation of a lectotype for the only species of *Acrocyum* that occurs in the United States.

Since specimens of species of *Acrocyum* are rarely collected, the genus remained little known. Therefore, the genus is redescribed here.

Acrocyum Jacoby

Acrocyum Jacoby, 1885. Biologia Centrali-Americana, Insecta, Coleoptera, 6(1): 380.

Description of the genus.—These are moderately sized beetles, elongate, oval, quite convex.

Head: oval, glabrous except around mouth, free, inserted in pronotum to just behind eyes; tubercles flattened or absent; fovea very small, shallow, near each eye; apex of mandibles pointed; maxillary palpi moderate in size; eyes small to moderate; antennae long, extending to middle of elytra, 11 segments, middle segments not broad or flat; interocular distance usually greater than ½ width of head.

Thorax: rectangular, glabrous; widest just anterior to base, front edge entire; very shallow anti-basal depression; immaculate or spotted. Scutellum triangular. Prosternum narrowed between coxae, procoxal cavities closed, procoxae narrowly separated; claws bifid. Elytra oval, glabrous; wider than thorax; punctations arranged in striae; spotted; no depressions.

Abdomen: abdominal sterna free; pubescence fine, pale, sparse.

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[1] Accepted for publication September 14, 1970.

[2] Department of Biology, St. Mary of the Plains College, Dodge City, Kansas 67801.

Key to the species of Acrocyum

1\. Pronotum immaculate 2
Pronotum spotted 3

2(1). Elytra with 7 or 8 black spots on each elytron . . . . sallaei Jacoby
Elytra with less than 6 dark fulvus spots on each elytron . . . . dorsalis Jacoby

3(1). Pronotum with 9 spots . . . . maculicollis Jacoby
Pronotum with 2 spots . . . . tarsata Jacoby

Acrocyum sallaei Jacoby

Acrocyum sallaei Jacoby, 1885. Biologia Centrali-Americana, Insecta, Coleoptera, 6(1): 381.

Type locality.–Yolotepec, Mexico [Lectotype: Yolotepec, Mexico, Sallé Coll., British Museum (Natural History), here designated.]

Description of lectotype.–Elongate oval, quite convex; testaceous except apical segments of antennae black and black spots on elytra; total length 5.8 mm, greatest width 3.0 mm.

Head: testaceous, very fine punctation; tubercles flattened; fovea very small, shallow near eyes; margin of labrum straight; right antenna missing, antennal segments 1-4 testaceous, 5-11 black, segments 3, 4, and 5 progressively longer; interocular distance 0.8 mm, greater than ½ width of head.

Thorax: shining; pronotum rectangular, testaceous, extremely narrowly margined; small projection at each corner, prolonged near eyes; anti-basal shallow transverse impression; immaculate; punctation very fine, scattered; pronotal length 1.1 mm, pronotal width 2.0 mm, width/length = 1.8. Scutellum triangular, testaceous, shining. Elytra oval, shining, narrowly margined, testaceous, rounded apex; distinct humeral prominences with short inter-humeral sulcus; punctation moderate, arranged in striae; each elytron with 8 black spots: 3 basal spots, 1 at suture at middle, 3 behind middle, and 1 at apex; elytral length 4.5 mm, elytral width 3.0 mm.

Legs: metatibiae and tarsi missing; tibiae and femora with black spots, tarsi black.

Abdomen: first visible sternum as long as 2 + 3.

Literature Cited

Jacoby, M. 1885. Biologia Centrali-Americana, Insecta, Coleoptera, Galerucidae. 6(1): 337-408.

2.0057 **A lectotype designation and a key to the species of *Acrocyum* (Coleoptera, Chrysomelidae, Alticinae).**–The species *Acrocyum sallaei* Jacoby has as its lectotype a specimen from Yolotepec, Mexico, from the original series in the Sallé Collection at the British Museum (Natural History). The species known for the genus are keyed on the basis of coloration.–**Edward C. Mignot,** *Department of Biology, St. Mary of the Plains College, Dodge City, KS 67801.*

Descriptors: Coleoptera; Chrysomelidae; Alticinae; *Acrocyum*; lectotype for *Acrocyum sallaei*; key to species; Mexico; Arizona; Guatemala.

(Entomologist's Record, continued from p. 188)

3.0053 Type-species designation for the subgenus Utacapnia (Plecoptera: Capniidae).– In Nebeker and Gaufin (1965. Trans. American Ent. Soc., 91: 467-487), the *Capnia columbiana* complex was described containing ten species. This species complex was raised to subgeneric status by Nebeker and Gaufin (1967. Trans. American Ent. Soc., 93: 235-247), but a type-species was not designated. The purpose of this note is to designate one of the originally included species as the type-species for the subgenus *Utacapnia: Capnia (Utacapnia) lemoniana* Nebeker and Gaufin, 1965, (Present designation). The males of this species have supra-anal process bipartite, upper portion bifurcate and enlarged at tip. The females have the subgenital plate on eighth sternite produced, bound on either side by a lateral sclerotized patch; subgenital plate with variable median and anterior sclerotization. The species occurs in western and Arctic North America.–**Arden R. Gaufin,** *Department of Biology, University of Utah, Salt Lake City, Utah 84112.* Accepted for publication: July 31, 1970.

Descriptors: Plecoptera; Capniidae; *Capnia (Utacapnia) lemoniana*; type-species.

NOTICE

The new printing method and other changes recently made in the processing of the issues of **ENTOMOLOGICAL NEWS** have required clarification on the masthead. Prospective authors in particular should refer to this information. This is found on the inside covers beginning with this issue.

At the same time, it should be noted that very prompt publication can be given to suitable articles, without page charges, and with very modest fees for illustrations.

Some difficulty in mail deliveries prompts us to publish the mailing dates of the issues for 1970. This information is included with the table of contents of each volume. Because mailings have been delayed in recent months, subscribers are advised that the issues for 1970 have been mailed as follows:

Vol. 81, no. 1, January 1970, mailed from Lancaster, Pa., March 10, 1970.
Vol. 81, no. 2, February 1970, mailed from Lancaster, Pa., May 15, 1970.
Vol. 81, no. 3, March 1970, mailed from Lancaster, Pa., June 2, 1970.
Vol. 81, no. 4, April 1970, mailed from Lafayette, Ind., August 11, 1970.
Vol. 81, no. 5, May 1970, mailed from Lafayette, Ind., August 21, 1970.
Vol. 81, no. 6, June 1970, mailed from Lafayette, Ind., August 25, 1970.

The July, 1970 issue will be mailed about September 25th. The exact date will be published in the next issue.–**Editor.**

3.0055 New records of European woodlice in New York.–In recent years there have been reported from Rochester, New York, a number of exotic arthropods (see Muchmore, 1969, Ent. News, 80: 66). Apparently these have been imported from Europe on botanical nursery stock and have succeeded in establishing themselves in favorable situations here. The most hospitable area has proved to be a railroad embankment between the Genesee River and Mt. Hope Cemetery in the southern part of the city, near the former site of a large, prosperous nursery.

Previously (Muchmore, 1957, Jour. Washington Acad. Sci., 47: 78-83), a number of European woodlice, or terrestrial isopods, were reported as living in this habitat. These included such rare forms (for the United States) as *Trichoniscus pygmaeus, Hyloniscus riparius,* and *Platyarthrus hoffmannseggi.* I now wish to report the occurrence here of two other introduced species, namely *Androniscus dentiger* Verhoeff and *Philoscia muscorum* (Scopoli).

Androniscus dentiger has been reported only once previously from North America, from greenhouses in the vicinity of London and Toronto, Ontario (Medcof, 1939, Canadian Field-Natur., 53:115). In Rochester, this species has been found living outdoors in two widely separated localities; one is the railroad embankment near Mt. Hope Cemetery mentioned above, the other is in Ellison Park, about six miles northeast of the first. The latter location is within half a mile of the site where the European opilionid, *Trogulus tricarinatus,* was found (see Muchmore, 1963, Ent. News 74: 208-210). On the embankment *A. dentiger* lives, in company with *Trichoniscus demivirgo* (probably = *T. pusillus*), *T. pygmaeus* and *Hyloniscus riparius*, in the loose cinders along the roadbed or under old ties or rocks nearby. In the park they were found under leaves in the loose soil of a damp stream bank, along with *T. demivirgo, H. riparius, Haplophthalmus danicus,* and *Oniscus asellus.* In both cases, it is evident that these small arthropods can easily travel far enough down into the loose soil in the winter to escape freezing. Both populations are thriving; they have been observed in different seasons over a period of several years and are still present.

Philoscia muscorum (=*P. vittata*; see Schultz, 1965, Crustaceana 8: 107-108) has been reported extensively from the coasts of northeastern and northwestern United States, but it has not heretofore been reported from any inland locality. On 15 November, 1956, a single specimen (fortunately a male) of *Philoscia muscorum* was taken by Tullgren extraction from litter at the base of a stone wall along the railroad embankment mentioned above. It was accompanied by the other isopods, *Trichoniscus demivirgo, T. pygmaeus, Hyloniscus riparius, Haplophthalmus danicus* and *Trachelipus rathkei.* The specimen has been compared carefully with authoritative descriptions of *P. muscorum* and against specimens of that species from England. There is no doubt as to its identity. In spite of repeated subsequent collections in the same area, however, no additional specimens have turned up. Possibly the population was quite restricted and its exact location has not been visited again, or else it may have become extinct. In this connection, it may be noted also that the population of *Platyarthrus hoffmannseggi* reported earlier (1957) has not been encountered again since 1957. Extensive reconstruction, weed-killing and general clean-up campaigns along the railroad right-of-way may well have extirpated these two species by destroying their special niches.

Recently (9 August 1970) another population of *P. muscorum* has been discovered in Durand-Eastman Park, at the northern edge of Rochester near Lake Ontario. The isopods were found under leaves on wet mud at the edge of a small pond, in company with *Trichoniscus demivirgo* and *Oniscus asellus.* That this is a stable population is evidenced by the occurrence of large numbers of adults (including gravid females) and of juveniles of various sizes. Inasmuch as this park has served for many years as a city arboretum, with many introduced trees and shrubs, it is not unexpected to find yet another exotic animal here. It is, perhaps, more interesting to wonder why *P. muscorum* is not more widely distributed around Rochester and in other parts of the country, as many other introduced European species are.—**William B. Muchmore,** *Department of Biology, University of Rochester, Rochester, NY 14627.* Accepted for publication August 22, 1970.

Descriptors: Woodlice; Isopods; introduced species; Rochester, New York; United States.

Prof. Travis appointed entomology chairman at Cornell.—The appointment of Prof. Bernard V. Travis, a noted medical entomologist and parasitologist, as chairman of the Department of Entomology and Limnology at the New York State College of Agriculture at Cornell University, has been announced by Charles E. Palm, dean of the College and former head of the Department.

Travis, who has been serving as acting chairman of the department since December 1969, replaced Prof. David Pimentel who has returned to full-time teaching and research, effective July 1. A member of the Cornell faculty since 1949, Travis will serve in his new position for a term of two years, Palm said.

A specialist in the control of insects that affect the health and welfare of man, Travis played a prominent role in research and development of a series of insect repellents for military use during World War II. In addition to his current research interests in the control of blackflies, Travis has compiled a six-volume reference guide on insects throughout the world that transmit disease. The 3,000-page publication, which took 17 years to complete, describes more than 17,000 insects of medical importance, representing the most comprehensive work of its kind ever published.

A research entomologist of the U. S. Department of Agriculture from 1935 to 1949, Travis worked on insect repellents at a World War II federal insect research laboratory in Orlando, Fla. Assigned to the Navy from 1944 to 1946, Travis tested a number of insect repellents in the Central and South Pacific areas for military use under field conditions. Travis and one of his fellow USDA scientists jointly hold several patents on repellents effective against such blood-sucking insects as mosquitoes, blackflies, punkies, and fleas. Travis also helped develop a formula for an aerosol bomb that has since found wide commerical use. Later, as leader of a joint USDA-military research team, Travis spent 12 months in Alaska over a four-year period from 1947 to 1950, investigating the biology and control of biting insects in the arctic region.

Down through the years, special assignments also took the Cornell scientist to many parts of the world, including Panama, Costa Rica, and 18 countries in Asia and Europe. From 1957 to 1959, Travis served as a visiting professor at the University of the Philippines' College of Agriculture at Los Banos under the sponsorship of the joint Cornell-U. P. Graduate Education Program. In 1964, he went to the Philippines again as a consultant for three months to help strengthen teaching, research, and extension programs in the animal sciences. While on sabbatical leaves in 1968, Travis set up a research project on blackflies under the joint sponsorship of the University of Costa Rica and the Louisiana State Medical School.

A native of Uncompahgre, Colo., Travis was graduated from the Colorado State University in 1930 with a B.S. degree. He received the M.S. degree in 1934 and Ph.D. in 1937, both from Iowa State University. He is author of more than 100 research and technical papers dealing with the biology and control of insects of medical significance, insect taxonomy, parasitic protozoa, and wildlife. For his outstanding professional achievements, Travis was elected an Honorary Fellow of the Entomological Society of America in 1950 and a Fellow of the American Association for the Advancement of Science in 1951. In addition to these organizations, he holds membership in the American Mosquito Control Association, the American Society of Parasitologists, and the Society of American Tropical Medicine and Hygiene. He also is a member of the American Society of Protozoologists, the American Microscopical Society, the American Society of Medical Entomology, Phi Kappa Phi, Alpha Zeta, Sigma Xi, and Gamma Sigma Delta.–**New York State College of Agriculture, Cornell University, Ithaca, NY 14850.**

The Entomologist's Library

In this section is published each month titles of books, monographs, and articles received and of special interest to entomologists. The contents of each is noted by the editor or invited reviewers. Brief analytical reviews may be submitted for possible publication even if the work has been previously noted here.—Ed.

Arachnida

Weygoldt, Peter. 1969. The biology of Pseudoscorpions. Harvard University Press, Cambridge. vii + 145 p. Cloth $ 6.00.

This small volume is a translation by the author of the 1966 German edition with the additions of recent research and new material on ecology, reproductive and developmental biology. The eleven chapters cover external morphology, internal anatomy and physiology, locomotion, reproduction, post embryonic development, longevity, senility, teratology, ecology, evolution and systematics, and collection, culture, and preservation of pseudoscorpions. There is a bibliography and species and subject indices. Though small this work is readable, well illustrated and contains a tremendous amount of interesting data on these little known arthropods.–S. S. Roback.

Evans, Owen (ed.). 1969. Proceedings of the 2nd International Congress of Acarology. Akademiai Kaido, Budapest. 652 p.

The papers presented give the results of recent research on the morphology, biology, and economic importance of mites and ticks. There are overall 102 contributions divided into 12 sections–soil mites, marine and freshwater Acari, plant mites, general and experimental taxonomy, mites of stored products, parasitic mites, ticks, biological control, physiology and genetics, chemical control techniques and Acari and diseases of medical and veterinary importance. The majority of the papers are in English though a few are in French or German.–**S. S. Roback.**

Siphonaptera

Stark, Harold E. 1970. A revision of the flea genus *Thrassis* Jordan 1933 (Siphonaptera: Ceratophyllidae) with observations on ecology and relationship to plague. Univ. of California Publ. in Ent. 53: 1-184. Univ. California Press. Paper $ 5.00.

Members of the flea genus *Thrassis* are suspected of playing an important role in the transmission and perpetuation of plague. The author has written an excellent and extensive paper covering the morphology, systematics, ecology, and host relations of the genus. The illustrations are well done and the bibliography appears quite complete.

The principal objectives of this study are to determine the taxonomic categories which best apply to groups within the genus; to present the morphology of adult *Thrassis* making comparisons within the genus and to higher taxonomic categories; to determine geographic distribution of the species, and to discuss the ecology, host relations, and plague importance of the genus.–**Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, MD 21228.*

Pest Management

Avidov, Zvi and **Isaac Harpaz.** 1969. Plant pests of Israel. Israel Univ. Press, Jerusalem. ix + 549 p. Cloth, $ 18.00

This book deals with 630 species of Mollusca, Acarina, and Insecta which are pests of cultivated and forest plants or are parasites or predators of these fomrs. The overall arrangement is taxonomic and under each pest are included data on morphology, host range and geographical distribution, life history, bionomics and ecology, nature of damage and control measures. There is an extensive bibliography, subject index and host plant index. This is the only text covering all crops of the Eastern Mediterranean area and as such should be very useful to all concerned with agriculture in this area.–**S. S. Roback.**

Miller, Morton W. and **George R. Berg (eds.).** 1969. Chemical fallout–current research on persistent pesticides. Charles D. Thomas, Publ., Springfield. xvii + 531 p. Cloth, $ 22.50.

This volume reports the results of a conference held at the University of Rochester. There were, in all, 33 contributers, mostly from the United States. The presentations are arranged in five groups which follow the pesticides from their entry into the ecosystem to their effect on man. The effects in aquatic, terrestrial and aerial environments are covered with the effects on birds being especially well covered. Of great interest are the discussions of the papers and a general discussion–all of which are fully recorded. These illustrate the points of agreement and disagreement among the participants.

The picture painted is not an encouraging one and the extent to which politics and the almighty dollar enters the situation is most dismaying.–**S. S. Roback.**

Lever, R. J. A. W. 1969. Pests of the coconut palm. FAO Agric. Studies no. 77. UNIPUB, Inc., 650 First Ave., N. Y., NY 10016. 190 p. $ 3.50.

The Food and Agriculture Organization is producing a series of publications on the pests and diseases of economically important plants and plant products, primarily to fill the gap in currently available entomological and phytopathological literature and so to assist developing nations. The first of these is the "Pests of the coconut palm (*Cocos nucifera*)" and is intended for the use of research workers, plant protection personnel and growers. The principal pests, both invertebrate and vertebrate that are harmful to the coconut palm are briefly described. Casual feeders on coconut or those that cause minor or occasional injury have been omitted. In this work 110 species of insects which attack the palm in the field are dealt with; in addition to the stored product pests attacking copra, as well as the various pests that are not insects.

The title of this publication is somewhat misleading as the text discusses only invertebrate and vertebrate pests and does not include plant diseases or weed pests. For those interested in tropical agriculture or tropical entomology this is a fine handbook for the common insect pests of the coconut. Though the publication is fairly well illustrated, it is hoped that future publications of the series will illustrate all pests, and perhaps examples of damage, that are discussed in the text.–**Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, MD 21228.*

Environment

Insect ecology and the sterile-male technique. Proceedings of Panal FAO/IAEA Division of Atomic Energy in Food and Agriculture, 1967, Vienna, 1969. 102 p. UNIPUB, Inc. P.O. Box 433, N. Y., N.Y. Paper $ 4.00.

The papers presented at an international panel on studies of the practical ecology of noxious insects have been published in an economical form. Studies on population dynamics, demographic models of population response to sterile male release, competition between sterile and normal males, estimating size of populations and the regulatory aspects of insect population dynamics are included. This series of panels organized and published by the International Atomic Energy Agency contains much valuable information.– **Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, Md. 21228.*

Technique

Bethke, Emil G. 1969. Basic drawing for biology students. Charles C. Thomas, Publ., Springfield. 86 pp. Cloth, $ 7.00

For those beginning biologists who have never attempted to illustrate a paramecium or a grasshopper leg, this book may be of some value–for others the techniques are too simple and too condensed. The illustrative material is somewhat poor and in some cases has not been labeled correctly, e.g., a photo and drawing of a pseudoscorpion, labeled–"*Stenocephalus Felis* (Cat Flea)". There is a need for a good text on scientific illustrating; unfortunately this text does not satisfy that need.–**Eugene J. Gerberg,** *Insect Control and Research, Inc., Baltimore, MD 21228.*

[3.0049]

A NEW SUBSPECIES OF *Plebejus (Icaricia) shasta)* FROM WYOMING (LEPIDOPTERA, LYCAENIDAE)[1]

Clifford D. Ferris[2]

Three subspecies of *Plebejus (Icaricia) shasta* (Edwards) are currently recognized (dos Passos, 1964): *shasta* (Edwards), *comsrocki* Fox, and *minnehaha* (Scudder). These three subspecies may be separated by the color, and width of the outer margin of the dorsal surface. Males are best used for comparison as the differences are more distinct than in the females. The subspecies *minnehaha* exhibits a bright blue-violet color with relatively narrow brown or gray-brown margins; *shasta* is a darker violet with brown margins approximately double the width of those found in *minnehaha; comstocki,* which should probably be considered as a local race of *shasta* rather than a separate subspecies, is distinguished by its very wide borders and generally darker colors (Fox, 1924). The subspecies *shasta* and *comstocki* (types) are figured by Comstock (1927, Plate 54).

Scudder (1874) described *minnehaha* from a series of four specimens (2♂♂, 2♀♀), while Fox described *comstocki* from a series of thirty-five specimens (26 ♂♂, 9♀♀). It is not known by this author the number of specimens in the type series for the nominate species *shasta*. From specimens examined in various collections, it does not appear to be scarce.

The morphologic differences among the three subspecies rest in the dorsal surface color and width of the outer margin, as described above, and in the distal end of the valvae as shown in Figure 1. *Plebejus (Icaricia) shasta comstocki* has not been figured as it appears to be really a local race or altitudinal variation of *Plebejus (Icaricia) shasta shasta.*

Geographically, *Plebejus (Icaricia) shasta shasta* is recorded from the Sierras of California north through Oregon and Washington; *shasta comstocki* is re-

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[2] Department of Electrical Engineering and Bioengineering, University of Wyoming, Laramie, Wyoming 82070.

corded from the type locality: Glacier Point, Yosemite National Park, California, and *shasta minnehaha* is found in North Dakota and Wyoming.

In the past, there has been some confusion concerning *Plebejus (Icaricia) shasta* in the Rocky Mountain region. Holland (1931) in the Butterfly book, page 268 has made the statement: "A rather small variety called *minnehaha* by Scudder is found on the high mountains of Colorado." This statement is the source of confusion. If one refers to Scudder's original description (1874) of *Agriades minnehaha*, now placed in *Plebejus,* Holland's error becomes apparent. First, there is no appreciable difference in size among the subspecies of this insect. Second, Scudder's butterfly was collected by J. A. Allen, a zoologist, who accompanied the Yellowstone Expedition of 1873. The collection locality was the Heart River Crossing, Dakotah [*sic*] Territory approximately fifty miles west of the Missouri River. This would place the type locality most probably in Grant Co., North Dakota where the present State Road 49 (between Glen Ullin and Elgin) crosses the Heart River. The elevation of the collection site is given as 1800′ above sea level, hardly a high mountain area. The type series was collected in the river valley on 26 June, 1873.

Thus the name *Plebejus (Icaricia) shasta minnehaha* applies to a low altitude prairie insect, whose distinguishing morphology is noted above, rather than to an arctic-alpine subspecies. In the Intermountain Region there is found an insect which is distinct from the presently named subspecies. A new name for this form is proposed below.

In Wyoming, *P.(I.)s. minnehaha* is found on the prairies in the eastern portion of the state, usually in association with washes or stream beds. Records exist from Albany Co. (East of Laramie, 7500′; Sybille Canyon, 5400′) and Converse Co. (4800′). It probably occurs in other prairie locations within the state, but has not been recorded simply because most collectors ignore the arid regions for the more inviting looking mountains. To date *P. (I.) s. minnehaha* has not been recorded from Colorado.

In July of 1953, F. Martin Brown collected a series of montane *Plebejus (Icaricia) shasta* on Powder River Pass, Johnson Co., Wyoming. He had intended to name the insect, but was diverted by more pressing matters and recently turned the series over to the author of this paper, who now takes pleasure in naming the insect after its collector.

Plebejus (Icaricia) shasta browni Ferris, NEW SUBSPECIES

(Figures 1 and 2)

Male.—Dorsal surface: blue-violet; marginal fringes white; outer margin narrow (slightly wider on forewing than on hindwing) and brown to gray-brown in color; on hindwing the margin is partially broken suggesting between-the-vein spots on a grayish background; there is a cell-end dark bar on both wings, but it is quite faint on the secondaries. Ventral surface:

pale gray-brown (slightly darker in the males than in the females); the spots are brown narrowly ringed with pale gray to white; on the secondaries there is a marginal row of metallic green spots, often with dark centers, which are capped basally with orange and then brown; the region just basad from the spots is lighter in color than the remainder of the wing. Expanse (costal margin length): 1 cm.

Female.—Dorsal surface: brown with basal blue flush of the same hue as in the male, extending in some examples over half of the wings; on the secondaries there is a marginal row of dark spots capped basad with orange and forming a lunule pattern; cell-end dark bars are present as in the male with the forewing bar about double the width of that of the male. Ventral surface similar to male but paler in color. Expanse: 1.1 cm (length of costa).

High altitude specimens (above 10,000′) are generally paler with more subdued markings than specimens from lower elevations.

The type series consists of eighty specimens, F. Martin Brown collector.

Holotype.—♂, Powder River Pass, 9700′, Johnson Co., Wyoming, 28 July, 1953.

Allotype.—♀, same data and location as male.

Paratypes.—46 ♂♂, 32 ♀♀, same data and location as holotype.

It is interesting to note that there is remarkable uniformity in facies within the type series. Only four specimens (two pairs) are significantly different from the others. One pair resembles the high altitude subdued marking form, while the other pair resembles the prairie *minnehaha.*

The new subspecies is intermediate between the subspecies *shasta* and *minnehaha*. The width of the outer margin on the dorsal surface of the males is midway between that on *shasta* and *minnehaha*. The color and male genitalia are closer to *shasta* than to *minnehaha*, although *browni* appears brighter in color than *shasta.*

The differences between the high alpine form of *browni* and the lower montane form are not considered sufficient to warrant any nomenclatural distinction as in the case of *P. (I.) shasta shasta* (Edwards) and *P. (I.) s. comstocki* Fox. Occassionally rather small specimens of *browni* are taken at high altitude. As one collects from treeline to high mountain tops, a cline is observed with respect to color and size. This is typical of other montane species found in the Intermountain Region.

This author has not attempted to make a detailed range study of *shasta shasta, shasta comstocki, shasta minnehaha,* and *shasta browni.* Such a study has been undertaken by J. F. Emmel and O. Shields and will be published at a later date. Presently *Plebejus (Icaricia) shasta browni* is recorded from several locations in Johnson Co., Wyoming and in Colorado from Boulder, Chaffee, Clear Creek, Costilla, Gilpin, Gunnison, Hinsdale, Lake, Larimer, Mineral, Pitkin, San Juan, San Miguel, and Summit Cos. at suitable elevations. Both Comstock (1927) and Holland (1931) allude to the occurrence of *Plebejus shasta* in Idaho and Montana. If the insect does occur in these states, one would expect to find subspecies *browni* in Idaho and the mountains of western Montana and *minnehaha* in eastern Montana.

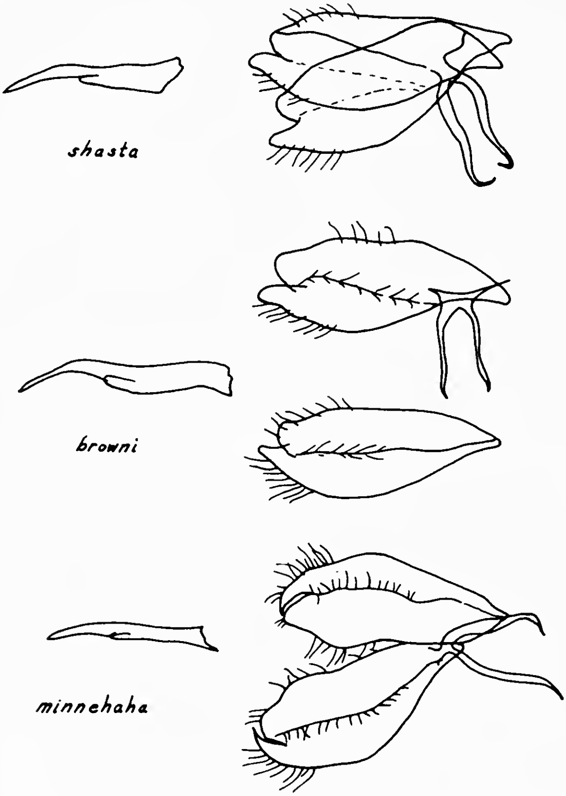

Figure 1. Male genitalia (aedeagus and valvae structures from slides) of *Plebejus (Icaricia) shasta shasta* (Yosemite National Park, California), *Plebejus (Icaricia) shasta browni* (Powder River Pass, Johnson Co., Wyoming), and *Plebejus (Icaricia) shasta minnehaha* (East of Laramie, Albany Co., Wyoming).

Paratype specimens of the new subspecies have been distributed as follows: Allyn Museum of Entomology: 1 pair; American Museum of Natural History: 2 pairs; Carnegie Museum: 2 pairs; United States National Museum: 1 pair; University of Wyoming Collection: 2 pairs; F. Martin Brown: 5 pairs; John F. Emmel: 4 pairs. The holotype, allotype, and remaining paratypes are presently placed in the author's collection.

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Scudder, S. H. 1874. Report on the butterflies collected by Mr. J. A. Allen on the Yellowstone Expedition of 1873. Proc. Boston Soc. Nat. Hist. 17: 86-91.

Figure 2. Dorsal and ventral surfaces of holotype male (left) and allotype female (right) of *Plebejus (Icaricia) shasta browni* Ferris.

2.0049 A new subspecies of *Plebejus (Icaricia) shasta* from Wyoming (Lepidoptera, Lycaenidae). *Abstract.*—The subspecific name *minnehaha* Scudder has been applied to one of the subspecies of *Plebejus (Icaricia) shasta* (Edwards) found in the Rocky Mountain region. Recent investigations have shown that the name *minnehaha* applies to a prairie subspecies from North Dakota. A new subspecific name *browni* Ferris is proposed for the montane insect found in the Rocky Mountains.

Descriptors: Lepidoptera; Lycaenidae; *Plebejus; Plebejus (Icaricia) shasta shasta; Plebejus (Icaricia) shasta comstocki; Plebejus (Icaricia) shasta minnehaha; Plebejus (Icaricia) shasta browni.*

Data Documents for Systematic Entomology

The following articles are available to specialists in complete form or as abstracts from The Institute for the Study of Natural Species (ISNS), 550 Elston Road, Lafayette, Indiana 47905, U. S. A. Copies are deposited in other Data Document centers as well. These documents are in addition to Data Document numbered articles and abstracts published in other sections of Entomological News.

Data Document comments, continued.—Very few questions have been sent in at this time. The editor is preparing for a discussion of the DDSE system at the annual meeting of the Entomological Society of America at Miami. Questions and comments will be welcome in advance of this meeting.

COMMENT: I would prefer to set up this . . . paper in the old fashion way rather than by the Data Document system. One reason for this is a desire to get reprints of the full article in the hands of European and Japanese workers who will be confused by the Data Document system.

REPLY: Full reprints are available, immediately, for these workers. But, these reprints should be exchanged only with those interested in the subject and currently doing research that requires the use of the data presented by the DDSE method. These reprints are free!

COMMENT: The February issue of Ent. News arrived and I congratulate you on putting Data Documents into practice. I think the system is a good one, but I wonder how much acceptance or support it will get.

COMMENT: If I were just beginning my work on the . . ., I would feel much more willing to switch over to a plan such as you have described, and very probably you will hear from numerous such young workers who are favorable to the new plans.

COMMENT: I have read your paper on SDI with great interest and foresee some real advantages in the system. However, I would prefer that my present manuscript be published under the old method. I am hesitant about SDI for several reasons. The [name of group] are small in number and worked over by very few people at erratic intervals. At present the classic method of publication suffices for the group although it may not for other larger and more frequently worked taxa.

REPLY: This is like saying that news of a trash fire in a neighbors garage should be published in *Newsweek*. Modern technology permits a suitable method of communication for each kind of information package.

COMMENT: Another thing that bothers me very much is the fact that these more detailed bits of information are not going to be present in libraries. This is going to do great disservice to international work, which is basic it seems to me in taxonomy, since many European and other colleagues certainly are not going to be able to stand the expense of buying descriptions which you admit will be reasonably expensive and this will lead to greater and greater provincialism in exchange of information. Furthermore, if I am unable to have reprints to exchange with foreign colleagues, I can hardly expect foreign colleagues to exchange their reprints with me and, since this is a major method in keeping up with literature, I think this is going to be very disadvantageous also.

REPLY: The reprint system should be replaced by current awareness publications and by photocopies. This will enable journals to survive, and cut down on the crates of useless reprints moved each year by our peripatetic entomologists.

The library problem could be solved by having interested libraries take over as Data Document centers. It seems reasonable to believe that such a union between information disseminators and consumers would be extremely beneficial.

COMMENT: . . . the title and descriptors . . . leave me cold . . . I pity the poor fellow in Akademia . . . writing a paper . . . who sees a reference to a paper [in Ent. News], borrows the journal from a . . . library or orders a xerox copy of the journal, and find only this much. He can order a copy from Data Document Center, but this involves months of government's red tape, restrictions on sending money out of the country, etc. Have you blocked much international communication?

REPLY: Is this the fault of the DDSE system, or an international problem? How far do our obligations extend to provide means for information dissemination? The problems mentioned here exist in this country, e.g., postal delivery problems; purchase order problems; budget restrictions, etc., or we could send it free—that is not unprecedent!

COMMENT: I can see need for your type of publication plan for many of the articles that are cluttering up the literature today. They are masses of data tables with a paragraph of summary conclusion. I have noticed that a goodly number of articles are essentially the same thing slightly abridged and rehashed and published under different titles in different journals. I suppose as a response to the spread of "publish or die" in so many universities, or, to pump up a thin result from work under N.S.F. . . . Since the papers I submitted are not of archival nature please return them and I will have them published elsewhere.

COMMENT: I am particularly concerned about your feeling that the Code cannot possibly rule out [publication of new taxa by DDSE system] because there are several thousand authors involved. It seems to me that the really responsible way to go about this would have been to have initiated an action by the International Commission on Zoological Nomenclature asking them to give you a ruling on this.

COMMENT: I object to anything that makes a journal obsolete!

REPLY: Data Documents does not make a journal obsolete, but it does make them useful. If they cannot survive by serving a useful purpose, why continue an expensive, time consuming project?

NOTE: The article that follows was submitted with the statement that it could be used for DDSE if desired. The journal article 2.0058 publishes 59% of the material. There is a space saving of 41%. Consider this saving in terms of printing costs and storage space in today's inflated economy!

[2.0058]

NEW CAVERNICOLOUS *Kleptochthonius* spp. FROM VIRGINIA (Arachnida, Pseudoscorpionida, Chthoniidae)[1]

William B. Muchmore[2]

Through the courtesy of Dr. John R. Holsinger, I have received for study a number of specimens of pseudoscorpions from caves in eastern United States. Here I wish to report on one previously described and two previously undescribed species of *Kleptochthonius (Chamberlinochthonius)* from these collections. Types of the new species are deposited in the American Museum of Natural History. This work has been supported in part by a grant (GB 17964) from the National Science Foundation.

Kleptochthonius (Chamberlinochthonius) henroti (Vachon)

Two female specimens were taken in Blue Springs Cave, ½ mile northwest of Mill Point, Pocahontas County, West Virginia, 2 September 1967, by J. R. Holsinger and R. Baroody. They appear to conform in major characteristics with specimens of *K. henroti*, which has heretofore been known only from caves in Greenbriar County (see Muchmore, 1965). This represents, therefore, an extension of the known range of the species about 20 miles to the northeast.

K. henroti has been found also in the following additional caves in Greenbriar County:

Grapevine Cave, two miles north of Lewisburg; one male, collected by J. Holsinger and D. Newson.

The Hole, near Frankford; one male, collected by J. M. Rutherford.

Benedict's Cave, 1.5 miles southeast of Maxwelton; two deutonymphs, collected by J. M. Rutherford.

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[1] Accepted for publication, September 12, 1970.

[2] Department of Biology, University of Rochester, Rochester, NY 14627.

Ent. News, 81: 210-212; Data Documents, 5 pp.; American Ent. Soc.

Kleptochthonius (Chamberlinochthonius) anophthalmus NEW SPECIES

(Figures 1 and 2) [Omitted in journal article]

Material: Holotype female (WM 467.01001) found by J. R. Holsinger in Porter's Cave, about 7.5 miles WSW of Millboro, Bath County, Virginia on 30 December 1960.

Description of female: A moderate-sized species, similar in general facies to others of the subgenus, but without eyes or eyespots.

[The journal article omits here the detailed description and measurements.]

Male: Unknown.

Remarks: This species is readily distinguished from most others in the genus by the complete absence of eyes or eyespots. It shares this characteristic with *K. (C.) gertschi* Malcolm and Chamberlin (1961), the only known specimen of which is from Gilley Cave, Pennington Gap, Lee County, Virginia. *K. anophthalmus* may be separated from *K. gertschi* on the basis of its smaller size (palpal femur 0.90 mm *vs.* 1.082 mm long), less attenuated appendages (l/w ratio of palpal femur 6.0 *vs.* 7.2), and fewer setae on the cheliceral palm (7 *vs.* 9).

Also at hand is a tritonymph from Madison Cave, Augusta County, Virginia (collector, T. C. Barr, Jr.) which may represent another new species of *Kleptochthonius (Chamberlinochthonius)*; however, because it is not in perfect condition, I refrain from describing it at the present time. Suffice it to mention here that it has a short, bilobed process on the movable chelal finger and appears to be without eyes, but that other characters preclude its being the nymph of *K. anophthalmus.*

Kleptochthonius (Chamberlinochthonius) regulus NEW SPECIES

(Figures 3 and 4) [Omitted in journal article]

Material: Holotype male (WM 1613.01001) and two paratypes, a female and a deutonymph, collected by J. R. Holsinger in Fallen Rock Cave, about two miles SW of Pounding Mill, Tazewell County, Virginia on 9 November 1968.

Description of male: A large, slender species, similar in general facies to others of the subgenus.

[The journal article omits here the detailed description and measurements.]

Female: Very similar to male in most particulars, but slightly larger.

[The journal article omits here the detailed description and measurements.]

Deutonymph: This specimen bears the same general relation to the adults described here as the deutonymph of *K. charon* does to adults of its species (see Muchmore, 1965, p. 18).

[The journal articles here omits the measurements.]

Remarks: As pointed out in an earlier publication (Muchmore, 1965), the species of *Kleptochthonius (Chamberlinochthonius)* can be grouped according to the size and shape of the process on the dorsal edge of the proximal end of the movable chelal finger. Thus, the two species known from Greenbriar County, West Virginia, namely *K. henroti* and *K. proserpinae*, have large, bifurcated processes on the movable fingers, while the two species known from Monroe County, West Virginia, and eastern Kentucky, namely *K. orpheus* and *K. krekeleri*, have processes which are long and simple. On the other hand the large number of species from extreme southwestern Virginia, central Kentucky and Tennessee have very short, slightly bilobed processes. Remarkably, the two new species described above resemble in this respect, not their nearest neighbors in West Virginia, but the short-processed forms, the closest of which are from Lee County, Virginia. As a matter of fact, the present species, *K. regulus*, seems morphologically most like *K. rex* Malcolm and Chamberlin (1961) which is known only from Bunkum Cave, Byrdstown, Pickett County, Tennessee. It can be separated from that species by its slightly smaller size (palpal femur 1.30 mm *vs.* 1.47 mm long), greater number of setae at the posterior margin of the carapace (four *vs.* two), and stronger development of the microdenticles on the chelal fingers.

The explanation of the distribution mentioned above is not yet known. As Dr. Holsinger has pointed out to me (in litt.), theoretical dispersal barriers are much greater between the caves of central Tennessee-Kentucky and the Virginia Appalachians than between those of the Virginia and West Virginia parts of the Appalachians. However, if pseudoscorpions do not often move from one cave to another, but rather the populations in individual caves have been derived independently from locally endemic, surface populations, then the distribution of cave forms may simply reflect the occurrence on the surface of diverse ancestral forms at some time(s) in the past. Since practically nothing is yet known about the distribution of present day, epigean forms of the genus (that is, those placed in the nominate subgenus), there is no other information available about the relationships of the cavernicolous species.

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Descriptors: Arachnida; Pseudoscorpionida; Chthoniidae; *Kleptochthonius (Chamberlinochthonius) anophthalmus; Kleptochthonius (Chamberlinochthonius) regulus; Kleptochthonius (Chamberlinochthonius) henroti;* Cavernicoles; Virginia; West Virginia.

examined, and long, detailed descriptions, discussions of nomenclatural problems will be recommended for **Data Documents for Systematic Entomology**. Instructions for this will be furnished on request (see Vol. 81, pp. 1-11 and recent issues). Short notes will be promptly published in **The Entomologist's Record.** Literature notices, short reviews, and books received will be published in **The Entomologist's Library.** Study notices, want items, and for sale notices are published in **The Entomologist's Market Place.** All manuscripts should follow the format recommended in the CBE "Style Manual".

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Insects

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ENTOMOLOGICAL NEWS

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THE AMERICAN ENTOMOLOGICAL SOCIETY

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(Continued on back inside cover.)

SECOND-CLASS POSTAGE PAID AT LAFAYETTE, INDIANA

[3.0064]

THE HOSTS OF *Neurocolpus nubilus* (Say), THE CLOUDED PLANT BUG (Hemiptera, Miridae)[1]

Richard L. Lipsey[2]

Introduction

Neurocolpus nubilus, the clouded plant bug, was described by Thomas Say in 1832, from a specimen collected in Indiana (LeConte, 1883). While Say placed it in the genus *Capsus*, Reuter, in 1876, used *N. nubilus* as the type species when he named the genus *Neurocolpus*. *Capsus hirsutulus* in Britian is considered synonymous to *N. nubilus* (Distant, 1904), but distinct from *N. mexicanus* and *C. affinis* (Knight, 1934).

N. nubilus has been recorded from Canada to Panama and from Maine to California on button bush growing in eastern swamps to mesquite growing in the desert in the southwest (Van Duzee, 1889; Crawford, 1916; Knight, 1941; Needham, 1908). A list of 42 known hosts from the literature appears in Table 1. Bibby, 1946, reported *N. nubilus* caused economic damage in cotton in Mississippi, while Crawford, 1916, found apple damage by *N. nubilus*. This insect did more to lower yield in the cotton crop in Mississippi in 1946 than did any other insect pest (Bibby, 1946). *N. nubilus* has been reported to spread the twig blight, *Bacillus amylovorus*, to apples (Caesar, 1913).

Crawford wrote on certain aspects of the biology of the clouded plant in 1916. The life history is described in a paper in press.

N. nubilus was first collected in Arkansas in 1924, in Lee County. The Entomology Department Museum at the University of Arkansas contains a total of 26 specimens collected from seven counties during May, June, and July from 1924 to 1965. Recent specimens have been collected in August and September as well as the months mentioned above. Extension personnel

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[1] Accepted for publication September 24, 1970.

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began finding *N. nubilus* in cotton in ever increasing numbers in northeast Arkansas from 1958, through 1966, with the peak appearing in 1965.

This study on the hosts of the clouded plant bug was done during the summers of 1966, and 1967, at the Northeast Branch Experiment Station in Keiser, Arkansas.

Table 1. A list of all hosts of *N. nubilus* found in the literature.

1. Alsike clover*
2. Apple*
3. Alternate-leaved dogwood
4. Burdock*
5. Button bush*
6. Canadian blue grass
7. Catnip
8. Cone flower
9. Cotton
10. Cottonwood
11. *Croton capitatus*
12. Curled dock*
13. Elder*
14. Evening primrose*
15. False indigo
16. Golden rod
17. Ground cherry*
18. Hairy vetch
19. Horseweed
20. Hungarian millet
21. Kentucky Coffee tree
22. Mesquite
23. Mullein
24. Old witch grass
25. Orange milkweed
26. Peach trees*
27. Peppermint
28. Pigweed
29. Poison sumac
30. Ragweed
31. Raspberry
32. Red clover
33. Round-leaved mallow
34. Rye*
35. Spearmint
36. Spy apple*
37. Staghorn sumac
38. Stinking milkweed
39. Sumac*
40. Teasel
41. Timothy*
42. Willow

*Designates those hosts on which nymphs were found also.

Materials and methods

Selected field crops and ditches in northeast Arkansas were sampled with 15 inch sweep nets and a D-Vac vacum apparatus, from June to September, in 1966 and 1967. Techniques of sampling had to vary with the host plants sampled. For example, blooming button bush could not be swept without crushing the insects under a mass of buttons, and a D-Vac could not be carried into ditches where the vegetation was too thick. Also, valid comparisons could not be made between populations of *N. nubilus* on various host plants for the same reason, so we could not quantatively determine which were the most important hosts. Also, since we could collect only during the summer, a complete seasonal history study was not possible.

One thousand sweeps were taken in cotton, soybeans, corn, wheat, and alfalfa fields during June and half of July in 1966, but this was reduced to 100 sweeps for the remainder of the summer. There were 16 cotton fields, 8 soybean fields, 3 alfalfa fields, 1 corn, and 2 wheat fields involved in the survey in 1966. The following summer the same fields were swept except that no corn or wheat fields were involved since no *N. nubilus* were collected from these two hosts in 1966. In 1967, only 100 sweeps were taken in each of the fields.

These fields were swept regularly, about every three weeks in 1966, and about every two weeks in 1967. But in 1967, 6 cotton, 6 soybean, and 3 alfalfa fields were swept weekly to determine population build-up in these three field crops. Ten sweeps were taken in 10 widely separated places in each field in an attempt to cover as much of each field as possible. The ditches were swept as frequently as the field crops, but the number of sweeps depended on the extent of a pure stand of a particular host.

The D-Vac was used in 1966 in all crops except wheat, in an attempt to suck the nymphs out of flowering parts. It was every Tuesday in the same 3 cotton fields, 3 soybean fields, and 1 alfalfa field. The funnel had a one-half square foot opening and was operated for one to five minute periods for an average of 157 row feet covered in one minute.

The host plants were identified by Drs. E. E. Dale and E. B. Smith of the Botany and Bacteriology Department of the University of Arkansas. The confirmation of the identification of *N. nubilus* was made by Dr. H. H. Knight of Iowa State University and Dr. J. L. Herring of the Entomological Research Division, Systematic Entomology Laboratory, Beltsville, Maryland.

Results

Adult and nymphal *N. nubilus* were collected from three field crops: cotton, soybeans, and alfalfa. None were found in corn or wheat, using a sweep net for a total of 3,600 sweeps in June, July, and August of 1966. In addition, this mirid was collected from a total of 13 wild hosts during 1966 and 1967 (Table 2). Ten of these wild plant species are previously unrecorded as hosts in addition to soybeans and alfalfa.

Nymphs were collected from: cotton, soybeans, alfalfa, button bush, black willow, smart weed, ladies' eardrop, and daisy fleabane.

Adults were first collected in early June on button bush, black willow, and soybeans, and the last adults were collected in the last week of September on late blooming and fruiting hosts: cotton, golden rod, smart weed, stink weed, and wild pepper. Small isolated populations of the clouded plant bug were seen in cotton well up into October. The populations in cotton during both summers averaged 2.65 individuals per 100 sweeps. The population peaks occurred in August with a total of 187 bugs per 190 row feet.

In soybeans the populations were low during 1966 and 1967, but they were fairly consistent all summer long.

Button bush and black willow supported the highest populations. The peaks appeared in July when a total of 50 adults and 150 nymphs were counted on 21 button bush plants in 2½ hours, and 27 adults and 3 nymphs were collected in 400 sweeps. But more *N. nubilus* was taken from button bush during the two summers than from any other host. More nymphs were found in button bush than from all other hosts combined. Nymphs appeared on button bush with the appearance of flower buds or buttons in June. These numbers reached as high as 6 nymphs per button and 23 nymphs per plant in July at the peak. Nymphs were still present throughout August but in very low numbers. Black willow supported clouded plant bug populations throughout the summer, from the first week of June to the last week of August, but no nymphs were collected on this host after mid-July during either summer.

The other hosts supported low populations at particular times during the summer. Nymphs were found on the major hosts mentioned above, as well as smart weed, ladies' eardrop, and daisy fleabane only at the time of blooming.

Discussion

Neurocolpus nubilus is a polyphagous mirid. A total of 16 host plants were recorded in northeast Arkansas during the summers of 1966 and 1967. A literature search revealed 42 hosts for this insect, while this study found ten new hosts, for a total of 52 host plants. Six hosts had previously been recorded in the literature. The 16 hosts of *N. nubilus* in northeast Arkansas include 3 field crops: cotton, soybeans, and alfalfa, and 13 wild hosts mainly in wet ditches and at or near the time of blooming.

Adults were collected from 64% of all cotton fields sampled in 1967, and averaged 2.65 individuals per 100 sweeps. *N. nubilus* adults were first found in cotton about the time of squaring, the last week of June, and disappeared in October. We don't know if *N. nubilus* actually does damage in cotton until present experiments are concluded.

The most important hosts appear to be button bush and black willow since they supported the highest numbers. The peaks appeared in July at the

Table 2. Host plants of *Neurocolpus nubilus* in Mississippi County, Arkansas, with combined data from 1966 and 1967.

Hosts	June				July				August				September			
Weeks:	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Alfalfa*		X	—	—	—	—	—	—	—	—	—	X				
2. Black willow (*Salix niger*)*	X	—	—	—	—	—	—	—	—	—	—	X				
3. Button bush (*Cephalanthus occidentalis*)	X	—	—	—	—	—	—	—	—	—	—	X				
4. Cotton				X	—	—	—	—	—	—	—	—	—	—	—	—
5. Daisy fleabane (*Erigeron* spp.)*											X					
6. Evening primrose (*Denathera biennis*)											X					
7. Golden rod (*Salidago altissima*)															X	
8. Honeysuckle (*Lonicera* sp.)*		X														
9. Johnson grass (*Sorghum halenpense*)*		X														
10. Ladies' eardrop (*Brunniehia cirrhosa*)*								X								
11. Morning glory (*Ipomoea pandurata*)*										X						
12. River locust (*Amorpha fruticosa*)*		X	—	—	—	—	—	—	—	X						
13. Smart weed (*Polygonum pennsylvanicum*)*										X	—	—	—	—	—	—
14. Soybean*	X	—	—	—	—	—	—	—	—	—	—	X				
15. Stink weed (*Pluchea camphorata*)*																X
16. Wild pepper (*Ampelopsis arborea*)*						X	—	—	—	—	—	—	—	—	—	—

*Previously unrecorded hosts

peak of reproduction for both hosts. In fact, I believe that there is a strong correlation between time of flowering of the various hosts and the presence of *N. nubilus.* The insect was found on all hosts when flower buds, blooms, or fruit were present. It was collected on smart weed, golden rod and other later blooming hosts only when it was blooming in late August and early September.

Since nymphs were collected from 8 hosts, then *N. nubilus* can probably pass its life cycle on these hosts. They are: cotton, soybeans, alfalfa, button bush, black willow, smart weed, ladies' eardrop, and daisy fleabane. Previously recorded hosts, such as staghorn sumac, cottonwood, apple, and pigweed, which are common to northeast Arkansas were swept extensively, but no clouded plant bug was ever taken from these hosts.

I believe this insect over-winters in the egg stage from diapausing eggs laid in late August. About 30 eggs brought back to the laboratory at this time imbedded in the nodes of button bush failed to hatch. Also, in live button bush in the field, eggs stayed imbedded in the stems up until the time observations ceased in October and no nymphs were found on this host after the last week of August. Experiments in the laboratory where temperature, humidity, and especially photoperiod are controlled, I hope, will confirm this opinion.

Since it takes about 40 days to pass one generation in the laboratory (Lipsey, in preparation) and the first nymphs hatch in May, then from 2-3 generations may be possible in the field each summer in northeast Arkansas. Crawford (1916) also reported that nymphs first appeared on May 27 in an apple orchard in Ontario, Canada, and the population completely disappeared by September 7.

The wide distribution of this species, together with the large number of host plants, some of them field crops, make *Neurocolpus nubilus* an important species in North America. Bibby (1946) reported that it damaged cotton; Crawford (1916) found that it damaged spy apples. Since it occurs also in such crops as clover, vetch, millet, peaches, peppermint, spearmint, raspberries, rye, timothy, soybeans, and alfalfa, as well as in various economically important shade trees, *N. nubilus* could be of economic importance. It also has the capacity for producing high numbers of individuals. Therefore, research continues on the possibility that this plant bug may become an economic pest of cotton in northeast Arkansas.

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2.0064. The hosts of *Neurocolpus nubilus* (Say), the clouded plant bug (Hemiptera, Miridae). Abstract.–*Neurocolpus nubilus,* the clouded plant bug, was collected from three field crops and 13 wild hosts during the summers of 1966 and 1967, in the northeast corner of Arkansas. Nymphs first appeared in May on button bush, black willow, and other wild hosts in ditches, with the adults appearing in June and moving into cotton, soybeans, and alfalfa. Two to three generations are possible and diapausing eggs are probably laid in August and September.–**Richard L. Lipsey,** *Department of Entomology, University of Illinois, Urbana, IL 61801.*

Descriptors.–Hemiptera; Miridae; *Neurocolpus nubilus*; clouded plant bug; Arkansas; hosts; season.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

3.0066 New collection records for *Sporothrips amplus* and *Atractothrips bradleyi* **(Thysanoptera: Phlaeothripidae).**–*Sporothrips amplus* (Hood) and *Atractothrips bradleyi* Hood have been known only from the peninsula of Florida and the Florida Keys (Stannard, 1968). *S. amplus* was described by Hood (1925) on the basis of specimens collected from Bradenton, Florida, and *A. bradleyi* described by Hood (1938) from material from Clearwater, Florida. Both species have been taken only from dead branches and dead leaves of palms or palmenttos.

The following collections should be recorded because the collection of these 2 species extends the range into south Georgia and includes a new host for *A. bradleyi.*

S. amplus was taken from dead *Sabal palmetto* (Walt.) Lodd. leaves in Echols Co., Georgia, on January 31 and February 7, 1970. Thirty-six adult males and 34 females of *S. amplus* were collected by beating dead leaves remaining on the palm and dead branches that had fallen on the ground near the base of the tree over a 36 square inch white sheet. Numerous larvae were taken on both collection dates. Four adult females and 1 adult male were collected on dead *S. palmetto* leaves, March 19, 1970 from Cumberland Island, Georgia.

Eight adult brachypterous females, 1 macropterous female and 1 brachypterous male of *A. bradleyi* were collected from *Mariscus* sp., Cumberland Island, Georgia, September 9, 1969. Additional unmounted material collected from the same host on June 11, 1970 is at hand. One brachypterous female was collected from dead *S. palmetto* leaves in Echols Co., Georgia, on February 8, 1970.

Appreciation is expressed to Dr. L. J. Stannard, Illinois Natural History Survey, Urbana, for confirmation of the identifications. Examples of both species are deposited in the Illinois Natural History Survey collection at Urbana and the University of Georgia at Experiment, Georgia.

Literature cited.–Hood, J. D. 1925. Four new Phlaeothripidae from the United States (Thysanoptera). Canadian Ent., 57(9): 218-222; 1938. A new genus and species of Phlaeothripidae (Thysanoptera) from palmetto. Proc. Biol. Soc. Washington, 51: 27-32. Stannard, L. J. 1968. The thrips, or Thysanoptera, of Illinois. Illinois Nat. Hist. Surv. Bull., vol. 29, art. 4, pp. 215-552.–**Ramona J. Beshear,** *University of Georgia College of Agriculture Experiment Stations, Georgia Station, Experiment, GA 30212.*
Accepted for publication: October 9, 1970.

Descriptors: Thysanoptera; Phlaeothripidae; *Sporothrips amplus; Atractothrips bradleyi*; Florida; Georgia.

(Continued on p. 224.)

[3.0059]

AN UNUSUAL NEW *Pseudochthonius* FROM BRAZIL (Arachnida, Pseudoscorpionida, Chthoniidae)[1]

William B. Muchmore[2]

In the collections of the American Museum of Natural History was discovered a single specimen of a remarkable species of pseudoscorpion. Resembling *Pseudochthonius* in many details, it nevertheless differs from all known species of that genus in some very important features, so that it is desirable to present a formal description. This work was supported in part by a grant (GB 17964) from the National Science Foundation.

Pseudochthonius orthodactylus, NEW SPECIES

Material: Holotype male (WM 634.01001) from Belem, Brazil, 8 February 1959 (A. M. Nadler).

Description: Male: Generally similar to other members of the genus except that the chelal fingers are shorter and lack the distinctive curves seen in most species. Body quite small and all parts weakly sclerotized and pale in color. Carapace slightly longer than broad; epistome broad and strongly serrate; surface nearly smooth; two weak eyes present, about one ocular diameter from the anterior margin. Carapace with 14 long, slender setae and a microseta in front of each eye: m3m-3-4-2=16 (normal total is probably 18). Coxal area typical; chaetotaxy 2-2-1:m-2-1-cs:2-3-cs:2-5:2-6; with three finely pinnate spines (Fig. 1) on each coxa I and five similar spines on each coxa II; no intercoxal tubercle present.

Abdomen typical. Tergal chaetotaxy 4:4:4:4:6:6:6:6:6:3:4:0. Sternal chaetotaxy 4-4:[4-4]:$(3)\frac{7\text{-}7}{5}(3)$:(3)10(3):8:8:8:8:6:4:0:2; spiracles oriented transversely and without distinct guard sclerites. Pleural membranes with very small granules.

Chelicera about twice as long as broad and 0.6 as long as carapace. Palm with five setae; fixed finger with nine teeth, the distalmost the largest; movable finger with one large distal tooth, plus a row of ten smaller ones; galea represented by a low elevation; serrula exterior of 15 blades, flagellum of seven or eight pinnate setae.

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[1] Accepted for publication September 17, 1970.

[2] Department of Biology, University of Rochester, Rochester, NY 14627.

Ent. News, 81: 221-223.

Palps moderately long and slender; femur 1.14 and chela 1.61 times as long as carapace. Proportions of segments shown in Fig. 2; especially noteworthy are the relatively short and straight fingers of chela. Trochanter 1.65, femur 5.25, tibia 2.0 and chela 7.4 times as long as broad; hand 2.95 times as long as deep; movable finger 1.35 times as long as hand. Surfaces smooth except for femur, which is weakly reticulated. Trichobothria of chela as shown in Fig. 3. Fixed finger of chela with two small distal denticles, followed by 13 large, sharp, spaced teeth, then by three low, rounded contiguous teeth; movable finger with one, seven and twelve similar teeth. Movable finger with a conspicuous, large apodeme projecting from dorsal side of basal end; this process provides a surface for the attachment of some, but not all, of the fibers of the adductor muscle.

Legs moderately slender. Leg IV with entire femur 2.25 and tibia 3.4 times as long as deep; trichobothria on metatarsus 0.36 and on telotarsus 0.12 length of segment from proximal end.

Female: Unknown.

Measurements (in mm): Body length 1.07. Carapace 0.39 long and 0.315 broad across eyes. Chelicera 0.24 by 0.125; movable finger 0.125 long. Palpal trochanter 0.14 by 0.085; femur 0.445 by 0.085; tibia 0.16 by 0.08; chela 0.63 by 0.085; hand 0.265 by 0.09; movable finger 0.36 long. Leg IV: entire femur 0.385 long; basifemur 0.23 by 0.17; telofemur 0.24 by 0.15; tibia 0.34 by 0.07; metatarsus 0.14 by 0.05; telotarsus 0.26 by 0.03.

Remarks: The pseudoscorpion described above is placed in the genus *Pseudochthonius* for the present, although strong arguments could be made for placing it in a separate, new genus. It appears to belong to *Pseudochthonius* because of the nature of the coxal area, including the shape and placement of the coxal spines, the nature of the spiracular areas, the structure and the chaetotaxy of the carapace, the placement of the trichobothria on the palpal chela, and most details of the genital area (see Chamberlin, 1929; Hummelinck, 1948; Hoff, 1963). However, it differs markedly from all other known members of the genus in the structure of the palpal chela, which is as a whole unique. While most other species of *Pseudochthonius* have long, gracefully curved chelal fingers with the fixed finger strongly hooked terminally and the movable finger meeting the fixed finger far proximad of the tip, *P. orthodactylus* has relatively short, straight chelal fingers which meet with their tips nearly in contact. Further, in most other *Pseudochthonius* the teeth on the two chelal fingers are distinctly different, the fixed finger having alternating large and small, spaced, acute teeth (except in *P. homodentatus*) and the movable finger having more or less contiguous and uniform, small, retrocuneate teeth; in *P. orthodactylus*, on the other hand, the teeth are similar in shape and nearly equally developed on the two fingers, nowhere being alternately large and small. Also, the apodeme for the attachment of the adductor muscle to the base of the movable finger is long and heavy in *P. orthodactylus*, but is small, or entirely absent in other members of the genus. The condition of the chela in *P. orthodactylus* can be viewed reasonably as more primitive, i.e., less highly modified, than the corresponding features in other species. If it can be accepted that *P. orthodactylus* is indeed more primitive in these respects than other members of the genus, then comparison of *Pseudochthonius* with other genera of the Chthonioidea is made much easier. In fact, a consideration of the relationship between *Pseudochthonius* and the unusual, cave-restricted genus *Aphrastochthonius*, based upon this point of view, will appear shortly in another paper.

Literature cited

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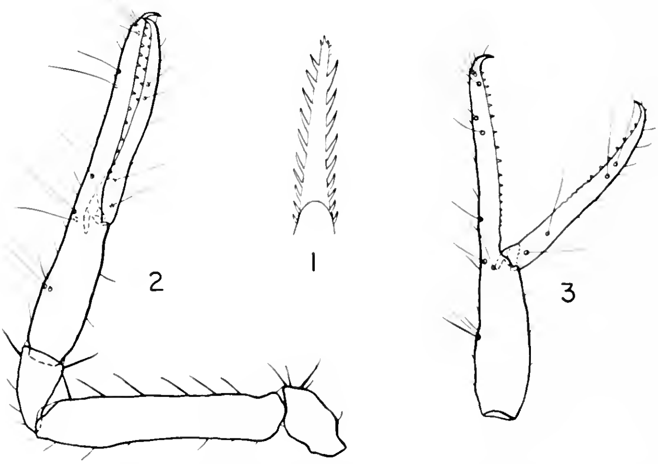
Hummelinck, P. W. 1948. Pseudoscorpions of the genera *Garypus, Pseudochthonius, Tyrannochthonius,* and *Pachychitra.* Studies Fauna Curacao, Aruba, Bonaire and Venezuelan Is. 3: 29-77.



Pseudochthonius orthodactylus, new species, holotype male. Fig. 1. Single coxal spine from pedal coxa II. Fig. 2. Dorsal view of left palp. Fig. 3. Lateral view of right chela.

2.0059. An unusual new *Pseudochthonius* from Brazil (Arachnida, Pseudoscorpionida, Chthoniidae). Abstract.–The new species, *Pseudochthonius orthodactylus*, differs from others in the genus in certain characters which suggest that it is a primitive member of the group.–**William B. Muchmore**, *Department of Biology, University of Rochester, Rochester, NY 14627.*

Descriptors: Arachnida, Pseudoscorpionida, Chthoniidae, *Pseudochthonius orthodactylus*, Brazil.

Edward Avery Richmond (1887-1970).—Dr. E. A. Richmond was born June 10, 1887 at Brockton, Massachusetts, of a very old Massachusetts family. He died July 14, 1970 in the Burlington County Hospital, Mt. Holly, New Jersey. He is buried in the old family plot at Brockton, Massachusetts.

He obtained his B. S. degree at Dartmouth College in 1912, his M. S. at Cornell University in 1924 and the Ph. D. at the University of Massachusetts in 1930. He had a long and active career of such a varied nature that it is difficult to summarize adequately his many activities and accomplishments.

Richmond was a member of the staff of the Japanese Beetle Laboratory, Bureau of Entomology, United States Department of Agriculture at Moorestown, New Jersey, 1924 to 1929 where he contributed to the development of chemical attractants and of traps for catching Japanese beetles. He then did research on the development of chemicals of possible value as insecticides for Rohn & Haas Co. and the Crop Protection Institute. He was one of the first to use pyrethrum for cranberry insects.

He was Plant Quarantine Inspector, United States Department of Agriculture at Westover Air Force Base near Springfield, Massachusetts June 12, 1946 to June 1, 1955 and Supervisory Plant Quarantine Inspector United States Department of Agriculture, McGuire Air Force Base, Wrightstown, New Jersey, June 1, 1955 to June 30, 1957 on which date he reached the compulsory retirement age of 70.

Dr. Richmond's two principal papers on entomology, both considered as basic in their field are: *Studies on the biology of the aquatic Hydrophilidae* (Bull. American Mus. Nat. Hist., 42(1):1-94, September 27, 1920) and *The external morphology of* Hydrophilus obtusatus *Say (Coleop: Hydrophilidae)* (J. New York Ent. Soc., 39: 191-251, June 1931).

Horn Island is situated in the Gulf of Mexico just off-shore from Gulfport, Mississippi. For some time during 1944 and 1945 Ned was stationed on and near the Island. He became interested in its natural history, an interest which continued during all of the ensuring years and he made many trips there to collect plants and animals. His results, combined with those of others, culminated in the following two papers authored by him: *The fauna and flora of Horn Island, Mississippi* (Gulf Research Reports 1(2): 59-106, figs. 1-27, maps 1, 3, 13, 1962). In November 1968 he published a supplement (same title) in volume 2, no. 3 (pp. 213-254) of the series. During 1944 through 1966 the impressive totals of 1364 species of animals and 204 plants were listed in these papers.

Richmond was a member of the American Entomological Society, Entomological Society of America, Phi Kappa Psi, Acacia, Sigma Xi, Moorestown Stamp and Camera Clubs, Masonry (Blue Lodge Chapter, Council, Commandery, Consistory). He was also Life Deacon of the South Congregational Church of Springfield, Massachusetts.

His military record was as follows: 1st Lt. QMC and Sn. Corps 1917-1919 and 1921; Captain and Major, CWS, U. S. Army, 1942-1945.

Ned Richmond was broadly interested in natural history; he was an excellent field botanist and his extensive garden at his home in Moorestown, New Jersey contained many kinds of flowers and ornamental shrubs and trees. He was a thorough extrovert and had hosts of friends. To this writer, who knew him intimately for over 50 years, his loss is great. He is survived by his wife, Leona, at the Moorestown home.—**Mortimer D. Leonard,** *2480 16th St., N. W., Washington, DC 20009.*

[3.0056]

REVISION OF THE GENUS *Physorhinus* (COLEOPTERA, ELATERIDAE) IN NORTH, CENTRAL, AND SOUTH AMERICA[1, 2]

PART I: Introduction and Key to the Species

Dietrich Schaaf[3]

The genus *Physorhinus* as it is presently known occurs only in the New World, primarily in the Neotropics. This revision deals with the known species of North, Central, and South America, exclusive of the Galápagos Islands. The species treated here are alike in having a yellowish color on the frons, a character which was until recently considered distinctive for the genus, if not definitive. Seventeen such species from the southwestern United States, Central America, and South America were described between 1801 and 1903. Until now, no all-inclusive revision of their taxonomy has been undertaken.

HISTORICAL REVIEW

The genus *Physorhinus* was noted in 1833 in the third edition of the Dejean Catalogue and again in 1836 in Sibermann's Revue Entomologique, but in both cases, no validly described species were assigned to it. In 1840 Germar published descriptions first of *P. xanthocephalus* and later of *P. sturmii.* He mentions the morphology of the pleurosternal sutures, the second and third antennal segments and the metacoxal plates which in combination with the yellow frons became the hallmarks of the genus. Candèze revised *Physorhinus* in 1859, bringing together Fabricius' *Elater erythrocephalus*, described in 1801, Germar's two species, *P. galapagoensis* described by Waterhouse in 1845, and 6 new species

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[2] A thesis submitted in partial fulfillment of the requirement for a Master of Science degree from Purdue University; approved by the Agricultural Experiment Station, as journal paper no. 4207.

[3] Department of Fisheries & Wildlife, Michigan State Univ., E. Lansing, MI 48823.

first described at that time. *P. galapagoensis*, distinguished in his key by a prothorax which is only slightly narrowed and by a frons which has only the anterior border yellow, was placed in *Anchastus* in 1895 by Champion on the basis of its narrowly separated pleurosternal sutures. The remainder of the species Candèze separated on the basis of elytral maculation, pronotal punctation and the comparative widths of the prothorax and elytra; the latter character being of doubtful value for this purpose.

Several additional species were described in the ensuing years (Steinheil, 1875; Candèze, 1881, 1893). In 1895 Champion reviewed the Central American species and described 4 new ones. Two additional yellow-headed *Physorhinus* species were later described, one from Peru by Schwarz in 1902, the other from the United States by Wickham in 1903. More recently, Van Dyke in 1953 treated the *Physorhinus* species of the Galápagos Islands. He described 6 new species and included one formerly placed in *Anchastus.* This was the first work to include within the genus beetles which do not have the classical yellow frons.

Physorhinus Germar, 1840

Dejean, 1833. Catalogue des Coléoptères . . . de M. le comte Dejean, ed. 3, p. 86 (2 manuscript species).
Eschscholtz, 1836. [Table of] Classification des elatérides . . . Rev. Ent., 4:4. (In table without species.)
Germar, 1840. Zeitschr. Ent., 2: 245. (Type species of the genus: *P. xanthocephalus*, Monobasic.)
Lacordaire, 1857. Gen. Col., 4: 167, 175.
Candèze, 1859. Mon. Elater., 2: 387.
Candèze, 1891. Cat. Elat., p. 103.
Champion, 1895. Biol. Centrali-Americana, Insecta, Coleopt., 3: 385.
Schwarz, 1906. *In* Wytsman, Gen. Ins., fasc., 46, Elater., p. 131.
VanDyke, 1953. Occ. Papers California Acad. Sci., no. 22, p. 46.

It is not clear which characters separate *Physorhinus* from the closely related genus *Anchastus* (LeConte, 1893). In the past these two genera were separated by the yellowish color of the frons (present in *Physorhinus*, absent in *Anchastus*), the relative lengths of antennal segments 2 and 3 (equal or subequal in *Physorhinus*, 3 longer than 2 in *Anchastus*), the extent of the caudal expansion of the metacoxal plates (reaching to or just short of the second abdominal segment in *Physorhinus*, considerably shorter in *Anchastus*) and the extent and nature of the separation between the pleurosternal sutures (most widely separated toward the center of their length in *Physorhinus*, evenly and rather narrowly separated throughout in *Anchastus*). On the basis of studies conducted in the preparation of this work, I believe that none of these characters is completely reliable.

I have examined *A. digitatus* LeConte, the type species of *Anchastus*, and find that it differs in several respects from *P. xanthocephalus* Germar, the type of *Physorhinus*. In *A. digitatus* the pronotum is longer than wide, the anterior edge of the prosternal lobe is sculptured to give a scalloped effect, the pleurosternal sutures are narrowly and evenly separated throughout their length, the male genitalia are short and broad, with the apices of the parameres blunt or subquadrate in form, the female bursa bears two bulbous colleterial glands, and the spermatheca is greatly elongated and contorted. *P. xanthocephalus* differs in that the pronotum is wider than long, the prosternal lobe is not sculptured, the pleurosternal sutures are most widely separated in the middle of their length, the parameres are slender with pointed apices, the bursa is bulbous or roughly pyriform with two sclerites near the vaginal canal opening, and the spermatheca is shorter and less contorted. The other species of *Physorhinus* here treated agree well with these characters shown by *P. xanthocephalus*, but there are exceptions. Examination of 12 additional species assigned to *Anchastus* showed that one of these, *A. fumicollis* Fall agrees closely with *A. digitatus.* Ten others, including two exotic species, one from Africa, the other from Asia, differ from the type of both *Anchastus* and *Physorhinus* in genital characters, width and morphology of the pleurosternal sutures, lack of prosternal sculpturing, morphology and size of antennal segments 2 and 3, and total body size, some of the species being very much smaller than others. One species, *A. subdepressus* Fall belongs in the genus *Physorhinus*, since it displays characters which agree with those given above for *P. xanthocephalus*, differing only in that the pleurosternal sutures are narrower than usual. However, it does not exhibit the yellow frons and greatly extended metacoxal plates which were until now considered important characters in separating *Physorhinus* from *Anchastus.*

Seven *Physorhinus* species were recently named from the Galápagos Islands (Van Dyke, 1953). They further prove the unreliability of the characters used in the past to separate *Physorhinus* and *Anchastus*, in that they all lack the yellow frons. I was able to examine two of these species and found also that the metacoxal plates are not extended caudally as they are among the yellow-headed species from the mainland. These exceptions led to further analysis, and it was found that the *Physorhinus* and *Anchastus* species examined here differ in the mode of articulation of antennal segments 1 and 2. In *Physorhinus* segment 2 joins 1 on the inner side of 1, leaving the distal end of segment 1 to form a rounded cap over the end of segment 2. In *Anchastus*, segment 2 joins 1 on its distal end (figure 1). This difference in the manner of antennal segment articulation and the differences in the genitalia described before appear to be more fundamental and universal than the characters heretofore used in separating the two genera. It is important to point out that this analysis of generic differences is far from exhaustive and will have to be used with care until further research tests its validity.

In addition, the examination of *Anchastus* showed that several species have antennal segment 3 similar in size and morphology to segment 4, while only segment 2 is small and cylindrical. In the *Physorhinus* species here examined and in the type species of *Anchastus*, both segments 2 and 3 are small and cylindrical or subcylindrical. This and other differences within the genus suggests that *Anchastus*, as it is now constituted, may contain more than one genus.

Nothing is known about the biology of the *Physorhinus* species, and there are no data on life histories or food preferences which might be used to delimit species. Although some label data give the names of plants on which specimens were taken, this information is not proof of host plant relationships since the insects may simply have alighted before being caught, and the data are so sketchy that no tentative correlations may be made. Adults appear to be active the year around in the tropics, but here again data are not sufficient to indicate peaks of activity.

No sexual dimorphism was observed. Champion (1895) believed that the antennae of the males were longer than those of the females in several species, but his conclusions are based on few specimens, and no such conclusions can be drawn from the present study.

Locality data are cited under the listings of specimens examined. Distribution is sometimes indicative of specific differences, as in the case of *P. cruciatus* and *P. insularis.*

Material for the revision was borrowed from a number of individuals, museums and universities both in the United States and Europe (abbreviations used later in the text are given after the name of the individual or institution, following the system proposed by Arnett and Samuelson, 1969): American Museum of Natural History, New York (AMNH); Academy of Natural Sciences of Philadelphia (ANSP); British Museum (Natural History), London (BMNH); California Academy of Sciences, San Francisco (CASC); Cornell University, Ithaca (CUIC); Deutsches Entomologisches Institut, Eberswalde (DEIC); Canadian National Collection of Insects, Ottawa (CNCI); Field Museum of Natural History, Chicago (FMNH); Mr. Gerard E. Flory, Lincoln Memorial University, Harrogate, Tennessee (GEFC); Institute Royal des Sciences Naturalles de Belgique, Brussells (IRSN); Institute for the Study of Natural Species, Lafayette, Indiana (ISNS); Dr. J. N. L. Stibick (JNLS); Museum of Comparative Zoology, Cambridge (MCZC); Museum fur Naturkunde, Berlin (MFNC); Museum G. Frey, Tutzing (MGFC); Museum National d'Histoire Naturelle, Paris (MNHN); Mr. M. W. Stone, Riverside, California (MWSC), Naturhistoriska Riksmuseet, Stockholm (NRIC); Ohio State University, Columbus (OSUC); University of Kansas, Snow Entomological Museum, Lawrence (SEMC); University of California, Berkeley (UCBC); University of California, Davis (UCDC); United States National Museum, Washington, D. C. (USNM); and the Universitetets Zoologiske Museum, Copenhagen (UZMC).

DIAGNOSTIC CHARACTERS

Many characters were examined for usefulness in separating the various *Physorhinus* species. Those which were found of value are discussed below.

Head.—A triangular brownish macula is found at the base of the head in several species, and it occurs most consistantly in *P. erythrocephalus*; only a few specimens of this species were seen in which it is lacking. The characteristic brown border around the frons which often occurs in *P. frontalis* has not been discovered in any of the other species described here. The nasale is almost always more or less flat and rectangular or subrectangular. Only in *P. sexnotatus* it is consistantly concave, with the lateral anterior edges raised into distinct ridges.

Antennae.—The following antennal characters are common to all the species examined here: segments 2 and 3 smaller than all the others, segments 4-11 compressed and similar to each other in morphology, almost always each of segments 4-11 has a more or less distinct median longitudinal dark brown streak; this is rarely lacking, sometimes it is probably masked by the dark brown color of the antennal segments themselves. *P. sexnotatus, P. xanthocephalus,* and *P. marginatus* all have these dark streaks raised into more or less distinct carinae, usually on segments 4-8. In these species segment 1 also bears a median carina. Antennal length varies considerably intraspecifically, but the extraordinarily long antennae of *P. longicornis* are useful in distinguishing this species.

Pronotum.—The shape, color and punctation of the pronotum vary somewhat intraspecifically, yet the pronotum offers several useful characters for the separation of species. Color is useful in separating *P. marginatus* from all other species because of its flavous pronotal borders. Both *P. marginatus* and *P. insularis* have a distinctly broad, almost flat pronotum, while in *P. frontalis, P. fusculus,* and *P. lateralis* the pronotum tends to be more distinctly convex. In almost all cases pronotal punctation increases in size and density on the anterior sides of the pronotum, and the extent of coarse, deep pronotal punctation onto the hind angles is important in separating *P. fusculus* from similar species. The density of pronotal punctation on the disc and sides is quite noticably greater on such species as *P. fusculus, P. frontalis,* and *P. sturmii* than on *P. erythrocephalus, P. distigma* and others. The hind angles of the pronotum are as a rule bicarinate with the carinae well developed, except in *P. longicornis* and *P. sellatus* where the supramarginal carinae are very weakly developed or lacking altogether. In *P. fusculus, P. frontalis,* and *P. sturmii* the area between the carinae is flat or even slightly concave, making the hind angles appear not to blend smoothly into the contour of the pronotal disc, as they do for example in *P. distigma,* where the space between the carinae is convex.

Elytra.—The most useful feature of the elytra is the presence or absence of maculae and the pattern of maculation, which is constant in all the species except *P. distigma* where there is considerable variation in size, shape, and intensity, but not in number of maculae. Also in *P. sexnotatus*, the second pair of elytral maculae is much smaller in several specimens from Costa Rica than in those specimens from further south. Elytral striation, though variable, can be helpful in identifying several species. For example, in *P. quadrinotatus* only the sutural stria is distinct, while in *P. boliviensis* 9 striae can be distinguished. In *P. stellatus* elytral striation is absent except for the sutural stria, while in *P. fusculus* and *P. frontalis* striation is well developed and distinct. Elytral apices are distinctly serrate in most of the species, but in *P. fusculus, P. frontalis, P. lateralis* and *P. sturmii* serration is absent or at most very fine.

Metacoxal plates.—The extent of development and the shape of the metacoxal plates is of limited use in separating some of the species. In *P. xanthocephalus* and *P. stellatus* the metacoxal plates are triangularly produced to acute apices which generally do not reach the second abdominal segment. *P. erythrocephalus* has the metacoxal plates more bluntly rounded and almost always reaching the second abdominal segment. *P. sexnotatus* has metacoxal plates which are narrowly and acutely produced, often reaching beyond the anterior edge of the second abdominal segment.

Male genitalia.—The genitalia of the species examined here are all very similar in appearance, with simple, acutely pointed parameres, each paramere bearing 3 setae near its apex, 2 ventrally and 1 dorsally placed. These setae are common to all the species and are not shown in the illustrations.

The genitalia differ chiefly in the length of the parameres and the amount of curvature of their outer margins, when viewed from the venter. There is a good deal of intraspecific variation, and the examples described and illustrated were chosen because they appear to best represent the species in question. In general, male genitalia should not be used to separate species, with the exception of those of *P. frontalis* which have a minute but distinct notch at the apex of each paramere where its inner margin is drawn out into a fine point. One or two additional differences can be mentioned. For example, *P. longicornis* has a long, slender genital apparatus in comparison with the other species. The parameres of *P. erythrocephalus* are quite strongly curved in comparison to those of *P. stellatus* or *P. xanthocephalus* and others. In *P. marginatus* the basal ends of the parameres join to form a more rounded arch than in any of the other species.

Female genitalia.—The female genitalia are much more distinctive than the male genitalia, and they can be used to separate groups of species or single species. This will be apparent from an examination of the illustrations and descriptions. In all cases the spermatheca has a row of fine scales which sometimes has the appearance of a zipper along the side of the spermatheca, and sometimes forms a wide band along the spermathecal wall. The individual scales examined under high magnification may show specific differences; however, they were not examined in this manner since the more obvious features of the female genitalia provide suitable diagnostic characters. Size, shape and number of bursal sclerites, spermathecal shape and accessory gland position are important diagnostic features. The illustrations show only the bursa and bursal sclerites, spermatheca with scales and the bulbous or sausage-like accessory gland attached to the spermatheca.

KEY TO THE *Physorhinus* SPECIES OF NORTH, CENTRAL, AND SOUTH AMERICA

1. Flavous maculae present on elytra 2
Maculae absent or so large as to cover most of elytra, or elytra with lateral flavous bands 8

2(1). Elytra yellow brown to piceous red brown with 2 subapical variable maculae. **distigma**
Maculae more than 2 3

3(2). Maculae 4 4
Maculae 6 7

4(3). Basal elytral maculae as large or larger than apical maculae 5
Basal elytral maculae smaller than apical maculae 6

5(4). Elytra piceous to red brown with 4 subapical maculae, 2 toward bases, 2 toward apices; pronotum with lateral flavous bands . . . . **marginatus**
Elytra red brown to yellow brown; 2 slightly oblong maculae toward bases, 2 smaller and rounder toward apices; pronotum without lateral flavous bands . . . . **erythrocephalus**

6(4). Elytra red brown to brown, 2 small round maculae at outer margins just below bases, 2 larger subapical round maculae; sutural striae alone distinct (Central America) . . . . **quadrinotatus**
Elytra red brown; each elytron with small round macula centrally placed below base, and larger, oblong macula toward apex; 9 elytral striae distinguishable (Bolivia) . . . . **boliviensis**

7(3). Elytra yellow brown to brown, 2 small basal maculae distinct or obscure, 2 oval and laterally placed, large or small, 2 before apices; antennal segments 1 and 4-9 or 10 with median longitudinal carinae . . . . **sexnotatus**
Elytra shiny yellow brown to brown, 4 small maculae slightly beyond base, 2 much larger, laterally placed beyond middle; antennal segments without carinae . . . . **stellatus**

8(1). Hind angles or prothorax unicarinate or with supramarginal carina very weakly developed; antennae long, half of body length or more, antennal segments 3-5 times as long as broad; prothorax dark, elytra light yellow brown and narrowly tapered. . . . . **longicornis**

Hind angles of prothorax bicarinate; antennae half of body length or less, antennal segments at most 4 times as long as broad; prothorax dark, elytra yellow brown or darker, narrowly tapered or not 9

9(8). Elytra brown with 4 large subequal maculae covering most of surface; pronotum subtriangular, not strongly convex; lateral anterior pronotal punctation coarse and deep (Caribbean island of Guadeloupe) . . . . **insularis**

Elytra as in *P. insularis*; pronotum more squared and convex; anterior lateral pronotal punctation shallow, large but not coarse (Pacific coast of southern Mexico). . . . . **cruciatus**

Elytra more or less unicolorous and without maculation, or with flavous lateral bands; pronotum subtriangular or not 10

10(9). Lateral elytral bands with conspicuous emarginations toward sutural line near bases; antennal segments 1 and 4-8 or 9 with more or less distinct median longitudinal carinae . . . . **xanthocephalus**

Lateral elytral bands, when present, without emarginations; antennal segments without carinae 11

11(10). Elytra with lateral bands 12

Elytra without lateral bands, unicolorous 13

12(11). Pronotum convex, densely punctate; elytral apices without serrations (Peru). . . . . **lateralis**

Pronotum not strongly convex, moderately punctate; elytral apices at least finely serrate (Caribbean, Mexico, northern Central America) . . . . . **distigma**

13(11). Elytra brown to piceous brown; pronotal punctation distinctly extending onto hind angles . . . . **fusculus**

Elytra piceous red brown to yellow brown; pronotal punctation obscure or obsolete on hind angles 14

14(13). Elytra brown to piceous red brown; pronotal punctation dense, but obscure on hind angles; elytral apices with very fine serration at most; male genitalia with inner margins of parameres produced into a fine point, creating a small notch at apex of paramere; female genitalia with slender, toothed bursal sclerites . . . **frontalis**

Elytra light brown to yellow brown; pronotum dark, densely punctate, but punctation obscure on hind angles, elytral apices without serration; or elytra and pronotum uniformly dark; male parameres without apical notch, female bursal sclerites rounded, each with 2 large conical teeth . . . . **sturmii**

Elytra brown to piceous brown; pronotal punctation moderate, obscure well before hind angles; elytral apices finely serrate; male parameres without apical notch, female bursal sclerites slender and toothed . . . . **distigma**

(To be continued: Part 2, descriptions of the species.)

[3.0060]

NEW EXOTIC CRANE-FLIES (TIPULIDAE: DIPTERA) PART XX[1]

Charles P. Alexander[2]

The preceding part under this general title was published in Entomological News, vol. 81 (4): 79-84. At this time I am considering further Hexatomine crane-flies that were collected by Dr. Fernand Schmid in various parts of India. Additional to the new species herein described and figured I am including drawings of four others that had been described in earlier parts of this series of papers but not previously illustrated. All species discussed at this time belong to the genus *Limnophila* Macquart. Types of the new species are preserved in the Alexander Collection.

Limnophila (Afrolimnophila) euglena, NEW SPECIES

Size relatively large (wing of female to 10 mm); head and thorax olive gray, praescutum with scarcely evident more yellowed stripes; halteres yellow; legs yellow, femora with a faintly indicated darker subterminal ring, tips of tibiae narrowly darkened; wings light yellow with scattered pale brown dots and large open ocelli at origin and fork of *Rs* and at near midlength of vein R_5.

Female.–Length about 11 mm; wing 9.5-10 mm.

Head, including rostrum, olive gray, mouthparts and palpi black, the latter with long conspicuous setae. Antennae brown, flagellar segments oval.

Thorax almost uniformly olive gray, praescutum with scarcely evident more yellowed stripes; dorsopleural membrane yellow. Halteres yellow. Legs with coxae and trochanters yellow; remainder of legs yellow, femora with a scarcely evident subterminal darkening, tips of tibiae and basitarsi narrowly darkened, remainder of tarsi brownish black. Wings (Fig. 1) light yellow, including the slightly darker veins; an abundant pale brown pattern that includes dots in all cells, and larger ocelliform rings, the largest and most

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[1] Accepted for publication: September 17, 1970.

[2] Contribution from the Entomological Laboratory, University of Massachusetts, Amherst, MA 01002.

evident of these at origin and fork of *Rs* and in outer radial field, the center of the last just beyond midlength of vein R_5; ocelli large, the darkened borders much narrower than the enclosed yellow rings; dots in cells small and scattered, less conspicuous than in *pterosticta*. Venation: Cell M_1 about one-half longer than its petiole; *m-cu* shortly beyond midlength of M_{3+4}.

Abdomen light brown, genital shield and bases of valves of ovipositor dark orange.

Habitat.—Sikkim. Holotype: ♀, Namnasa, 9,500 feet, July 13, 1959 (Schmid). Paratopotype, broken, sex doubtful.

The most similar species is *Limnophila (Afrolimnophila) pterosticta* Alexander, of Manipur, which shows slight distinctions in the leg pattern and marked differences in wing pattern, the darkened dots being more abundant, equalling or exceeding the yellow ground, and with the borders of the ocelliform areas broader, subequal to the enclosed yellow ring.

Limnophila (Indolimnophila) adicia Alexander

Limnophila (Indolimnophila) adicia Alexander; Ent. News, 75: 62; 1964.

Type from Leimatak, Manipur, Assam. Fig. 2 (venation), Fig. 6 (male hypopygium).

Limnophila (Indolimnophila) dravidica, NEW SPECIES

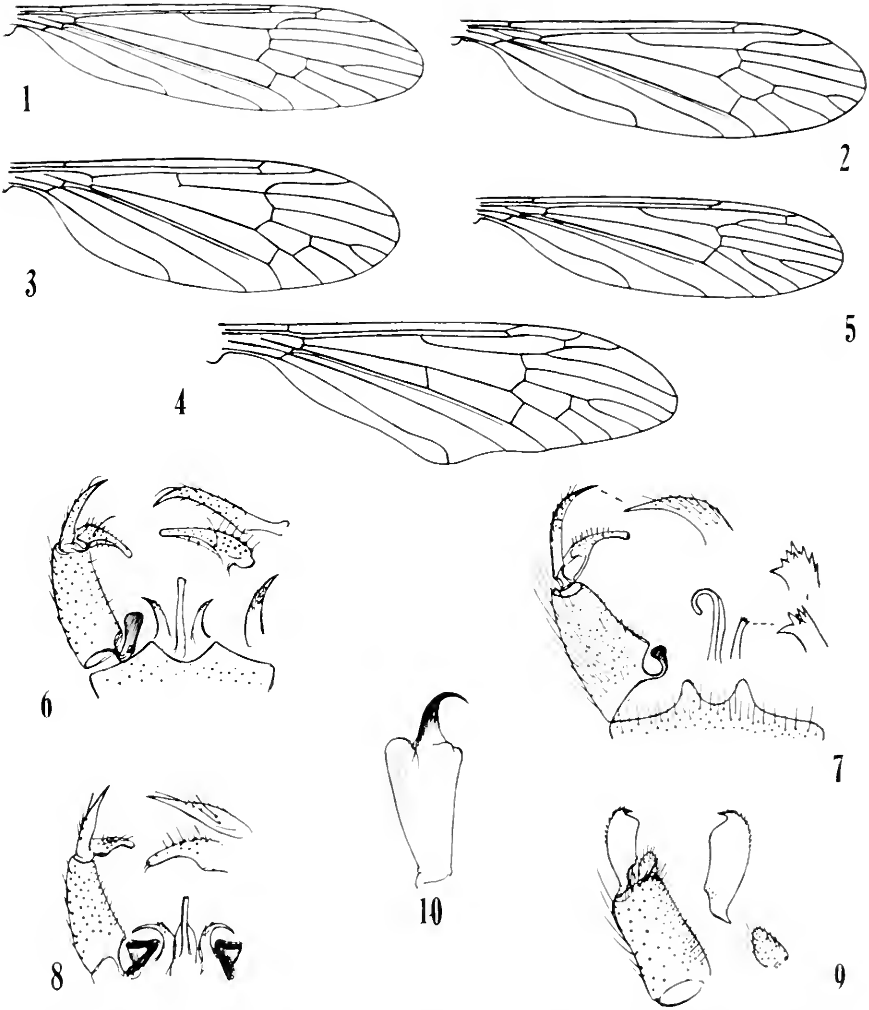
General coloration of mesonotum gray, praescutum irregularly patterned with brown; halteres light yellow; femora and tibiae yellow, tips conspicuously blackened; wings light yellow with abundant brown dots in all cells; male hypopygium with outer dististyle terminating in a long spine; gonapophysis slender, yellow, with a crown of from about six to nine spines at apex; outer end of aedeagus strongly recurved.

Male.—Length about 6-7 mm; wing 6.5-7.5 mm; antenna about 1.1-1.3 mm.

Female.—Length about 8.5-9 mm; wing 8-8.5 mm.

Rostrum brownish black, palpi black. Antennae with scape dark brown, remaining segments paler brown, oval, progressively smaller outwardly; in male outer segments longer. Head brownish gray, vertex with a narrow brown central line.

Pronotum large, brownish gray, patterned with darker. Mesonotal praescutum light gray, patterned irregularly with brown, central darkening very narrow in front, widened posteriorly, at near midlength subtended by a short lateral streak on either side, lateral stripes broader and more conspicuous. psuedosutural area darkened; posterior sclerites of notum dark gray, scutal lobes dark brown; a continuous brown central line on scutum and scutellum, mediotergite darkened posteriorly. Pleura dark gray, variegated by darker. Halteres light yellow. Legs with coxae dark gray, trochanters obscure yellow; femora yellow, tips conspicuously blackened, on fore pair including about the outer seventh; tibiae and basitarsi yellow, tips more narrowly blackened, outer tarsal segments brownish black. Wings light yellow, with abundant brown dots in all cells, largest areas at tip of *Sc* and in stigmal region, united posteriorly to form a major spot over the anterior cord, in some specimens solidly darkened at costa; veins brownish yellow, clearer yellow in pre-



Figures 1-10.–Fig. 1, *Limnophila (Afrolimnophila) euglena,* new species; venation. Fig. 2, *Limnophila (Indolimnophila) adicia* Alexander; venation. Fig. 3, *Limnophila (Indolimnophila) iota* Alexander; venation. Fig. 4, *Limnophila (Eloeophila) perdilata* Alexander; venation. Fig. 5, *Limnophila pectinifera* Alexander; venation. Fig. 6, *Limnophila (Indolimnophila) adicia* Alexander; male hypopygium. Fig. 7, *Limnophila (Indolimnophila) dravidica,* n. sp.; male hypopygium. Fig. 8, *Limnophila (Indolimnophila) iota* Alexander; male hypopygium. Fig. 9, *Limnophila (Eloeophila) dravidiana,* new species; male hypopygium. Fig. 10, *Limnophila (Eloeophila) perdilata* Alexander; male hypopygium.

(Symbols: *a,* aedeagus; *b,* basistyle; *d,* dististyle; *g,* gonapophysis; *p,* phallosome; *t,* 9th tergite.)

arcular and costal fields, not evidently darker in the patterned areas. Longitudinal veins beyond cord with abundant trichia, lacking on M_{3+4}. Venation: Sc_1 extending beyond fork of *Rs*, Sc_2 at its tip; cell 1st M_2 long-rectangular, with *m-cu* at or just beyond mid-length; cell M_1 small, approximately one-third to one-half its petiole.

Abdomen, including hypogium, brownish black. Male hypopygium (Fig. 7) with tergal lobes, *t*, relatively slender, the emargination broad. Outer dististyle, *d*, gradually narrowed outwardly, gently curved to a long terminal spine, outer two-thirds with long setae; inner style with numerous short erect setae, apex obtuse. Phallosome with gonapophysis, *g*, yellow, slender, apex with a crown of from about six to nine spines; aedeagus, *a*, with outer third strongly recurved to form a crook.

Habitat.—South India. Holotype: ♂, Periyakanal, Kerala, 5,000-5,500 feet, December 17, 1958 (Schmid). Allotype, ♀, Kodaikanal, Madras, 6,500-7,200 feet, December 5, 1958 (Schmid). Paratopotypes, 2 males, pinned with holotype, 5 females on three pins. Paratypes, ♂, Fort Hamilton, Madras, 7,200-7,500 feet, December 12, 1958; males, Ootacamund, Madras, 7,200-7,300 feet, December 25, 1958; 4 males, 1 female, Senbaganur, Madras, 5,500-6,500 feet, December 7-8, 1958; 1 male, Swamp Hill, Madras, 7,500 feet, December 13, 1958 (all Schmid).

Other allied regional species include *Limnophila (Indolimnophila) adicia* Alexander and *L. (I.) iota* Alexander, all species being most readily separated by hypopygial characters, especially the dististyles, aedeagus, and gonapophyses.

Limnophila (Indolimnophila) iota Alexander

Limnophila (Indolimnophila) iota Alexander; Ent. News, 75: 60; 1964.

Type from Telca, Cachar District, Assam. Fig. 3 (venation), Fig. 8 (male hypopygium).

Limnophila (Eloeophila) dravidiana, NEW SPECIES

General coloration brownish gray, pronotum and praescutum with a dark central stripe; antennae brown; femora yellow, tips dark brown, tibiae and basitarsi yellowed, tips narrowly darkened; wings obscure yellow, patterned with large brown costal areas, with smaller markings elsewhere, without spots or dots in the cells; male hypopygium with outer dististyle terminating in a small subappressed spine, with relatively few smaller spicules on outer margin, inner style oval, with yellow setae.

Male.-Length about 6.5 mm; wing 6.8 mm.

Female.—Length about 7 mm; wing 8 mm.

Rostrum dark brown, palpi black. Antennae with scape dark drown, pedicel paler, proximal flagellar segments light brown, the outer ones brownish black, elongate. Head dark brown, laterally yellowish pollinose; anterior vertex broad.

Pronotal scutum brownish gray with a darker central stripe, scutellum light yellow. Mesonotal praescutum brownish gray, the interspaces clearer yellow, anterior fourth of sclerite with a more blackened central streak; posterior sclerites of notum brownish gray.

Pleura brownish black, variegated by paler gray areas, dorsopleural region obscure yellow. Halteres with stem obscure yellow, knob brownish black. Legs with coxae dark brown, trochanters obscure yellow; femora yellow, tips conspicuously dark brown, including about the outer seventh; tibiae and basitarsi yellow, tips narrowly darkened, remainder of tarsi brownish yellow. Wings with ground obscure yellow, clearest on anterior half, posterior cells more infuscated, especially before cord; a heavy brown costal pattern, including about seven major areas, the largest at origin of *Rs*, end of *Sc* and the stigma, the two latter more or less interconnected posteriorly over the anterior cord, last major costal darkening near outer ends of cells R_3 and R_4; other conspicuous darkenings over posterior cord, outer end of cell *1st* M_2, fork of M_{1+2}, supernumerary crossvein in cell *M* and in base of this cell; further spots at ends of longitudinal veins and less evidently along the margins, especially in the holotype; veins brown, darker in the infuscated parts, clear yellow in the costal interspaces of veins *C*, *Sc* and *R*; no spots or dots in the wing cells. Venation: Cell M_1 variable in length, from subequal to longer than its petiole; *m-cu* at near midlength of cell *1st* M_2; supernumerary crossvein in cell *M* about opposite one-third the length of *Rs*.

Abdomen dark brown. Male hypopygium (Fig. 9) with outer dististyle, *d*, terminating in a small subappressed spine, with seven or eight smaller spicules more basad, these progressively smaller on outer margin, inner margin rounded just below the terminal spine; inner style unusually short, oval, with yellow setae.

Habitat.—South India. Holotype: ♂, Avalanche, Madras, 6,900-7,500 feet, December 29, 1958 (Schmid). Allotopotype: ♀, pinned with type.

Limnophila (Eloeophila) dravidiana is most similar to species such as *L. (E.) paraprilina* Alexander, of eastern China, and less evidently to *L. (E.) fumigata* Alexander, of Assam. The last species and virtually all other regional forms have darkened dots and spots in the wing cells, lacking in the present fly.

Limnophila (Eloeophila) fuscoanalis, NEW SPECIES

General coloration of head and thorax gray, conspicuously patterned with brown; femora yellow with a narrow brown subterminal ring, the actual apex paler brown; wings yellowed, with a heavy brown pattern that includes a series of transverse dashes in cell *C* and small darkened areas along all veins, posterior border of cell *2nd A* with confluent spots along posterior border.

Female.—Length about 9 mm; wing 9.3 mm.

Rostrum brownish black, palpi black. Antennae with scape and pedicel brownish black, pruinose; proximal flagellar segments obscure yellow, outer segments more bicolored, darkened beyond bases. Head yellowish gray, vertex extensively dark brown.

Pronotal scutum yellowish gray, with a narrow dark brown central stripe, lobes of scutellum more yellowed. Mesonotal praescutum yellowish gray, conspicuously patterned with brown, including three stripes on anterior half, with paler brown marks at posterior ends of the intermediate areas; margins and sublateral stripes paler brown, interspaces with about five brown setigerous punctures, pseudosutural foveae black; posterior sclerites of notum yellowish gray, each scutal lobe with three brown areas, the innermost larger. Pleura variegated gray and brown, dorsopleural membrane more yellowed. Halteres with stem obscure yellow, knob brown. Legs with coxae dark brown, pruinose; trochanters brownish yellow; femora yellow with a narrow brown subterminal ring, the actual tip paler brown; remainder of legs yellow, outer tarsal segments brown. Wings yellowed, with a heavy brown pattern, involving all cells excepting *1st* M_2; major darkenings in radial and medial fields, including origin of *Rs* and the supernumerary crossvein in cell *M*; other large marks in stigmal area, continued caudad to *r-m* and a subterminal blotch with center over cell M_1; small darkened spots along all veins, including a series of transverse dashes in cell *C*; veins *M, Cu* and the Anals with series of brown marks on their cephalic margins; posterior border of cell *2nd A* almost continuously darkened by confluent brown spots; veins in the very restricted interspaces yellow, brown in the patterned areas. Venation: *Rs* square at origin; supernumerary crossvein in cell *M* oblique, its posterior end more distal; apex of vein *2nd A* conspicuously arched.

Abdomen dark brown; genital shield and valves of ovipositor brownish yellow. Cerci long and very slender.

Habitat.—India. Holotype: ♀, Jhum La, Kameng, North East Frontier Agency, Assam, 7,800 feet, June 2, 1961 (Schmid).

7,800 feet, June 2, 1961 (Schmid).

The most similar regional species is *Limnophila (Eloeophila) perdilata* Alexander, which is virtually of the same large size, in the female sex differing especially in the wing pattern, including the distribution of dark pattern in the Anal cells.

Limnophila (Eloeophila) oxyacantha, NEW SPECIES

General coloration of thorax gray, patterned with brown; antennae relatively long, proximal flagellar segments weakly bicolored; legs yellow, femora with a pale brown subterminal ring; wings yellowed, with a heavy brown costal pattern, posterior two-thirds with smaller brown clouds in all cells; male hypopygium with outer dististyle long-oval, apex produced into a long slender spine.

Male.—Length about 5.5 mm; wing 5.2 mm; antenna about 1.4 mm.

Rostrum brownish gray, palpi brownish black. Antennae of male relatively long; scape and pedicel brownish black, proximal flagellar segments weakly bicolored, brown basally, outer third or less obscure yellow, distal five or six segments uniformly darkened; segments subequal in length to their longest verticils. Head grayish brown.

Pronotum gray. Mesonotal praescutum gray, with four dark brown discal stripes, the intermediate pair narrow, subequal in width to the median interspace more confluent posteriorly; lateral borders behind the humeral region more broadly darkened, pseudosutural foveae and adjacent margin blackened; posterior sclerites of notum brownish gray, scutal lobes with darker centers, parascutella and pleurotergite darkened. Pleura dark brown. Halteres with stem yellow, knob brownish black. Legs with coxae dark brown, trochanters yellowed; femora brownish yellow with a narrow pale brown subterminal ring; tibiae and tarsi clearer yellow, especially the latter. Wings with the restricted ground yellowed, with a heavy brown pattern that includes seven larger costal areas, the fourth at tip of Sc_1, fifth at stigma, the two broadly confluent posteriorly in cell R_1; posterior two-thirds of wing with relatively sparse smaller and slightly paler brown marks and clouds in all cells, the total amount subequal to the ground areas; veins brown. Venation: Cell M_1 slightly longer than its petiole.

Abdomen brownish yellow, segments with lateral and posterior borders brown, subterminal segments more uniformly darker brown. Male hypopygium with outer dististyle long-oval, apex extended into a long slender spine; outer margin without projections, lower margin at base of spine microscopically tuberculate, inner style gently arcuated.

Habitat.—India. Holotype: ♂, Amatulla, Kameng, North East Frontier Agency, Assam, 1,250-2,000 feet, March 11, 1961 (Schmid).

Limnophila (Eloeophila) oxyacantha is most readily distinguished from other generally similar regional species by the conformation of the outer dististyle of the hypopygium. Other regional species, including *L. (E.) fascipennis* Brunetti, with numerous brown markings in the wing cells have these smaller and more numerous.

Limnophila (Eloeophila) perdilata Alexander

Limnophila (Eloeophila) perdilata Alexander; Ent. News, 77: 221; 1966.

Type from Yagtang, Sikkim. Fig. 4 (venation), Fig. 10 (male hypopygium).

*Limnophila (*subgenus uncertain*) pectinifera* Alexander

Limnophila pectinifera Alexander; Ent. News, 75: 59; 1964.

Type from Tairenpokpi, Manipur, Assam. Fig. 5 (venation).

2.0060 New exotic crane-flies (Tipulidae: Diptera) Part XX. *Abstract.*—Further Hexatomines were collected in various parts of India. Additional to the new species described and figured drawings of four others described in earlier parts of this series are illustrated. Types of the new species are preserved in the Alexander Collection.

Limnophila (Afrolimnophila) euglena, NEW SPECIES: Size relatively large (wing of female to 10 mm); head and thorax olive gray, praescutum with scarcely evident more yellowed stripes; halteres yellow; legs yellow, femora with a faintly indicated darker subterminal ring, tips of tibiae narrowly darkened; wings light yellow with scattered pale brown dots and large open ocelli at origin and fork of *Rs* and at near midlength of vein R_5. Type locality: Sikkim, Namnasa, 9,500 feet.

Limnophila (Indolimnophila) adicia Alexander: venation and male hypopygium illustrated; type locality, Leimatak, Manipur, Assam.

Limnophila (Indolimnophila) dravidica, NEW SPECIES: General coloration of mesonotum gray, praescutum irregularly patterned with brown; halteres light yellow; femora and tibiae yellow, tips conspicuously blackened; wings light yellow with abundant brown dots in all cells; male hypopygium with outer dististyle terminating in a long spine; gonapophysis slender, yellow, with a crown of from about six to nine spines at apex; outer end of aedeagus strongly recurved. Type locality: South India, Periyakanal, Kerala, 5,000-5,500 feet.

Limnophila (Indolimnophila) iota Alexander: venation and male hypopygium illustrated. Type locality: Telca, Cachar District, Assam.

Limnophila (Eloeophila) dravidiana, NEW SPECIES: General coloration brownish gray, pronotum and praescutum with a dark central stripe; antennae brown; femora yellow, tips dark brown, tibiae and basitarsi yellowed, tips narrowly darkened; wings obscure yellow, patterned with large brown costal areas, with smaller markings elsewhere, without spots or dots in the cells; male hypopygium with outer dististyle terminaing in a small subappressed spine, with relatively few smaller spicules on outer margin, inner style oval, with yellow setae. Type locality: South India, Avalanche, Madres, 6,900-7,500 feet.

Limnophila (Eloeophila) fuscoanalis, NEW SPECIES: General coloration of head and thorax gray, conspicuously patterned with brown; femora yellow with a narrow brown subterminal ring, the actual apex paler brown; wings yellowed, with a heavy brown pattern that includes a series of transverse dashes in cell *C* and small darkened areas along all veins, posterior border of cell *2nd A* with confluent spots along posterior border. Type locality: Jhum La, Kameng, North East Frontier Agency, Assam, 7,800 feet.

Limnophila (Eloeophila) oxyacantha, NEW SPECIES: General coloration of thorax gray, patterned with brown; antennae relatively long, proximal flagellar segments weakly bicolored; legs yellow, femora with a pale brown subterminal ring; wings yellowed, with a heavy brown costal pattern, posterior two-thirds with smaller brown clouds in all cells; male hypopygium with outer dististyle long-oval, apex produced into a long slender spine. Type locality: Amatulla, Kameng, North East Frontier Agency, Assam, 1,250-2,000 ft.

Limnophila (Eloeophila) perdilata Alexander: venation and male hypopygium illustrated. Type locality: Yagtang, Sikkim.

Limnophila (subgenus uncertain) *pectinifera* Alexander: venation illustrated. Type locality: Tairenpokpi, Manipur, Assam.–**Charles P. Alexander,** *Entomological Laboratory, University of Massachusetts, Amherst, MA 01002.*

Descriptors: Diptera; Tipulidae; Crane-flies; India; *Limnophila (Afrolimnophila) euglena; Limnophila (Indolimnophila) adicia; Limnophila (Indolimnophila) dravidica; Limnophila (Indolimnophila) iota; Limnophila (Eloeophila) dravidiana; Limnophila (Eloeophila) fuscoanalis; Limnophila (Eloeophila) oxyacantha; Limnophila (Eloeophila) perdilata; Limnophila* (subgenus uncertain) *pectinifera.*

examined, and long, detailed descriptions, discussions of nomenclatural problems will be recommended for **Data Documents for Systematic Entomology.** Instructions for this will be furnished on request (see Vol. 81, pp. 1-11 and recent issues). Short notes will be promptly published in **The Entomologist's Record.** Literature notices, short reviews, and books received will be published in **The Entomologist's Library.** Study notices, want items, and for sale notices are published in **The Entomologist's Market Place.** All manuscripts should follow the format recommended in the CBE "Style Manual".

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(Continued on back inside cover.)

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LSD: CHROMOSOMAL BREAKS IN *Antheraea eucalypti* (Scott) (Lepidoptera: Saturniidae)[1]

Norvall C. Quinn[2]

Entomogenetic studies with lysergic acid diethylamide have been scarce and inconclusive. Browning (1968) reported augmentation of X chromosome damage in *Drosophila* sp. males exposed to LSD. However, massive doses equivalent to 4000 μg per gram of fly body weight were utilized. Working with both low and high tissue saturations, D. Grace (1968) found no evidence of chromosomal or mutagenic aberrations in Drosophila.

The present research investigated the *in vitro* effects of LSD on the chromosomal structure of *Antheraea eucalypti* (Scott) tissue cells.

Entomogenetic Technique

Cultures of *A. eucalypti* cells from ovaries of diapausing pupae were reared and sustained in T. D. C. Grace's (1962) insect tissue medium supplemented with 10% *Bombyx mori* plasma. Experimental suspension cultures in 25 ml medium containing 10^6 cells/ml were treated with an aqueous solution of LSD (Sandoz, 20 μg/ml) at 27° C for five hours. After a five hour recovery period, cells were given a one hour subjection to 7×10^{-7} M colchicine and then bathed for 15 minutes with distilled water. Following fixation with 60 per cent acetic acid–0.1 N hydrochlorid acid and staining with acetic orcein, squash preparations were examined for structural defects. For purposes of this analysis, a lesion produced by a shift in alignment of the distal end of the centric fragment with respect to the proximal end of the acentric fragment was classified as a break. Achromatic lesions not fitting this definition were scored as gaps.

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[1] Accepted for publication October 20, 1970.

[2] Baker Research Center, 710 Bowdoin Street, Stanford, CA 94305.

Ent. News, 81: 241-242

Control cultures underwent identical test conditions excepting substitution for LSD of an equal quantity of control solution.

Results

Structural aberrations, the majority of which were chromosome breaks, were observed within many cells. Most breaks occurred near primary constriction thus accounting for an increase in acentric fragments. A summary of the mean values noted during metaphase scoring is presented in Table 1. All differences significant at 0.001.

Table 1. Effects of LSD on *in vitro A. eucalypti* culture cells.

Dosage µg/ml	Cells Analysed N.	Aberrant Metaphase %	Chromosome Breaks/Cell N.	Chromatid Breaks/Cell N.	Achromatic Gaps/Cell N.
0	300	.01	.01	.00	.00
20	300	47.99	4.41	.79	.06

In addition to chromosomal breakage, scattered incidents of mitotic ruffling were detected. The author knows of no other study in which LSD induced ruffling has been reported.

Literature cited

Browning, Luolin S. 1968. Lysergic acid diethylamide: mutagenic effects on Drosophila. Science, 161: 1022-1023.

Grace, D. *et al.* 1968. *Drosophila melanogaster* treated with LSD: Absence of mutation and chromosome breakage. Science, 161: 694.

Grace, T. D. C. 1962. Establishment of four strains of cells from insect tissues grown *in vitro.* Nature, 195: 788.

2.0069. **LSD: Chromosomal breaks in *Antheraea eucalypti* (Scott) (Lepidoptera: Saturniidae). Abstract.**–Cultures of *A. eucalypti* cells from ovaries of diapausing pupae were treated with an aqueous solution of lysergic acid diethylamide (20 µg/ml) for five hours. After a five hour recovery period, significant increases in chromosomal aberrations were detected. Most were chromosome breaks occuring near primary constriction. Scattered examples of mitotic ruffling were noted.–**Norvall C. Quinn**, *Director, Entomogenetic Research, Baker Research Center, 710 Bowdoin Street, Stanford, CA 94305.*

Descriptors: Lepidoptera; Saturniidae; *Antheraea eucalypti;* chromosome aberrations; LSD; lysergic acid diethylamide.

[3.0062]

A NEW SPECIES OF *Psilotreta* FROM NORTH CAROLINA (Trichoptera: Odontoceridae)[1]

J. B. Wallace[2]

A survey of the Trichoptera of the Coweeta Hydrological Laboratory in Macon Co., North Carolina, has resulted in the discovery of a new species of *Psilotreta* Banks from the southern Appalachians. The following description is offered to give workers in aquatic biology, especially those concerned with rearing and use of the metamorphotype technique, a more accurate determination of species in this genus in the eastern United States.

The author is pleased to name this species for H. H. Ross, who has contributed so much to our knowledge of the North American Trichoptera fauna.

Psilotreta rossi NEW SPECIES

Male.–Length from head to tip of wings 10 mm; head, thorax, and legs yellowish brown; forelegs appearing darker at tibia and tarsi due to heavy brush of dark brown hair. Abdomen black dorsally, slightly lighter ventrally. Maxillary palpi with first two segments short, bearing a mesal brush of hair that extends from midway on the first segment to the tip of the third; third and fourth segments each about the same length as the first and second combined; fifth segment about one-fourth longer than the fourth. Genitalia as in Figs. 1-3. Ninth segment rather sinuous and narrowed above at point of insertion of cerci. Ninth tergite long and narrowed in middle (in dorsal view) slightly bulbous at apex with a small apical notch. Basal hooks of tenth tergite curled with pointed tip projecting posteriodorsally (Figs. 1-2). From the lower side of the apex of the tenth tergite arise a pair of sclerotized, elongate, slightly sinuate, robust plates which are rather pointed at their apices (visible only as rather blunt plates in dorsal view, Fig. 2). Cerci rather elongate and slightly pointed at their apices, widest at a point about one-fourth distance from base. Claspers each with basal segment widest near base; second segment about one-fourth length of the first, each with two heavily sclerotized teeth, one

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[1] This work was supported by U.S.D.I., F.W.P.C.A., Grant no. 18050 DFQ. Accepted for publication: September 21, 1970.

[2] Department of Entomology, University of Georgia, Athens, GA 30601.

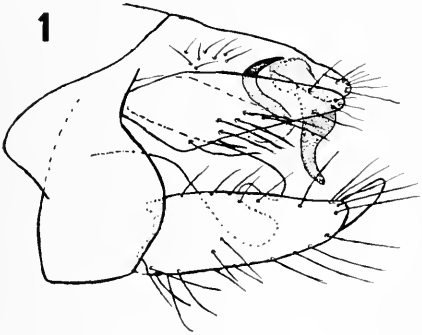
mesally near base and another at the dorso-mesally curved apex (Figs. 1, 3). Adeagus with a slender, tubular base and a sclerotized U-shaped process at apex which is surrounded by a membranous sheath (surrounding sheath not shown on drawing, Fig. 1).

Female.–Unknown.

Habitat–A small spring seep at 3800 feet elevation in the southern Appalachians.

Holotype.–Male; Coweeta Hydrological Laboratory, Macon Co., North Carolina, 15 June 1970; J. B. Wallace.

1



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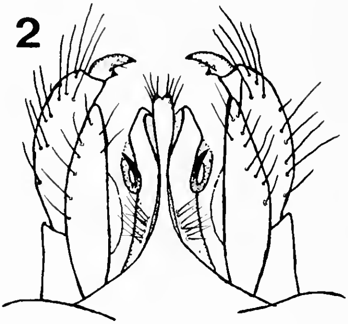

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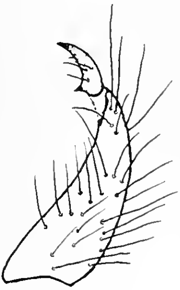

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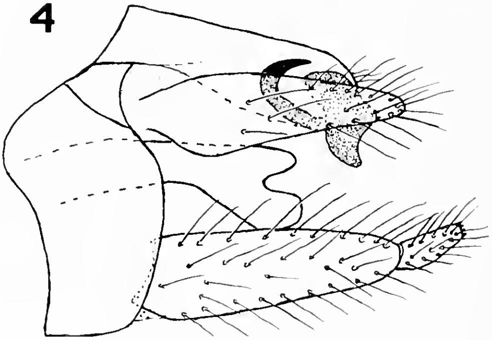

Figs. 1-3. Psilotreta rossi new species, male genitalia. *Fig 1*, lateral view; *Fig. 2,*dorsal view; *Fig. 3,* clasper, ventral view; *Fig. 4, Psilotretra rufa* (Hagen), male genitalia, lateral view.

Psilotreta rossi will not key to any species in Ross 1944 (p. 286). This species appears closest to *rufa* (Hagen). *P. rossi* can be separated from *rufa* by the following features. The apical sclerotized plates of the tenth tergite are longer and slender in *rossi* compared to the shorter, more robust apical processes in *rufa* (*cf* Figs. 1 and 4). The posterior extension of the ninth tergite slightly surpasses the sclerotized apical plates (in dorsal view) in *rossi* (Fig. 2) whereas in *rufa* the extension of the ninth tergite does not surpass the apical plates. In addition, the second segment of the claspers has two teeth (Fig. 3) in *rossi* and 5-6 teeth in *rufa.*

The holotype specimen is deposited in the University of Georgia collection.

Literature cited

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2.0062. A new species of *Psilotreta* from North Carolina (Trichoptera: Odontoceridae). Abstract.—A new species of *Psilotreta* (Trichoptera: Odontoceridae) is described from the southern Appalachians. The species, *P. rossi,* is closest related to *P. rufa* (Hagen). —**J. B. Wallace,** *Dep't. Entomology, Univ. of Georgia, Athens, GA 30601.*

Descriptors: Trichoptera; Odontoceridae; *Psilotreta rossi,* n. sp.; North Carolina.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

3.0075 Two new records for North Carolina faunal list.—Through oversight, records for the Japanese Weevil, *Pseudocneorhinus bifasciatus* Roelofs (Curculionidae) were omitted from the third supplement to "Insects of North Carolina" (1967). Since this marks the southern limit of this introduced weevil, the following records are significant. First record for North Carolina was at Charlotte, August 7, 1961, when several adults were collected at night feeding on privet hedge. Another recent record is for Raleigh, May 12, 1969, when one adult was found feeding on privet.

Another record for the North Carolina faunal list is the Brown Recluse Spider (*Loxoceles reclusa* Gertsch and Malaik), family Scytodidae, which was first found in North Carolina at Reynolda May 5, 1968, by A. T. Olive, Wake Forest University Biology Department. Three specimens were found in a Children's Science Museum in a room where packing material had been removed from shipped-in stuffed animal and bird specimens from the Midwest. Since then six specimens have been found on several later visits. The museum is situated in an old dairy building with many crevices and out-of-the-way corners. This is very conducive for this spider to survive and become established. The identity of the first spider specimen was confirmed by Dr. W. J. Gertsch.—**David L. Wray,** *Systematic Entomologist, Entomology Division, N. C. Department of Agriculture, Raleigh, NC 27611.*

Accepted for publication: October 19, 1970.

Descriptors: Coleoptera; Curculionidae; Japanese Weevil; *Pseudocneorhinus bifasciatus*; Arachnida; Scytodidae; Brown recluse spider; *Loxoceles reclusa*; distribution; North Carolina.

3.0067 ***Erebia disa*** **(Lepidoptera: Satyridae) in the continental United States.**—I predicted the presence of *Erebia disa* (Thunberg) in northern Minnesota (Masters, 1969. J. Res. Lepidoptera, 7: 19-22) but personal attempts to locate it here have failed. I recently had the opportunity, however, to confirm the identification of a fresh male specimen collected 21 June, 1970 by Ronald L. Huber of St. Paul in a black spruce area about 30 miles north of Two Harbors, Lake County, Minnesota. *Erebia disa*, a circumpolar species inhabiting mature black spruce bogs, had been taken in Alaska and Canada, east to Smoky Falls, Ontario, but the Huber specimen is the first authentic record for the adjacent 48 states. The Minnesota specimen belongs to the geographical subspecies *mancinus* Doubleday.—**John H. Masters,** *P. O. Box 7511, Saint Paul, MN 55119.*

Accepted for publication: October 15, 1970.

Descriptors: Lepidoptera; Satyridae; *Erebia disa mancinus*; Minnesota.

(The Entomologists' Record is continued on page 252)

[3.0063]

Pteromicra melanothrix MELANDER, NEW SYNONYM OF *Antichaeta melanosome* MELANDER, WITH A KEY TO THE NEARCTIC SPECIES OF *Pteromicra* LIOY (Diptera: Sciomyzidae)[1]

L. V. Knutson[2]

Pteromicra melanothrix Melander, 1920 (page 313), was described from 1 male collected at Yellowstone Lake, Wyoming, August 9, 1918, and *Antichaeta melanosoma* Melander, 1920 (page 318), was described from 1 female collected during July in Polk County, Wisconsin. Comparison of the holotypes of *P. melanothrix* and *A. melanosoma*, which are now in the United States National Museum of Natural History, Washington, has revealed that these represent 1 species of the genus *Antichaeta* Haliday. Furthermore, the male genitalia of the holotype of *P. melanothrix* compare exactly with published figures of the genitalia of *A. melanosoma* (Steyskal, 1960), with genitalia of specimens associated with females and obtained during rearings in Ithaca, New York, and with other specimens of *A. melanosoma* from Quebec, Ontario, New York, Ohio, Michigan, Wisconsin, North Dakota, Nebraska, Idaho, Utah, and Wyoming. *Antichaeta melanothrix* (Melander), 1920, new combination, is placed as a junior synonym of *Antichaeta melanosoma* Melander, 1920.

Species of *Antichaeta* lack a propleural bristle and belong to the Tetanocerini; species of *Pteromicra* Lioy have a propleural bristle and are placed in the Sciomyzini. Many species of *Antichaeta* are very similar in size and color pattern to *Pteromicra*, but they may be further distinguished from *Pteromicra* by the following characters: arista with black hairs; midfrontal stripe broad, shiny and complete; hind tibia with 2 dorsal pre-apical bristles; epandrium of the male postabdomen strongly asymmetrical; fifth abdominal sternum projecting under the postabdomen in the male; anterior surstylus of the male

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[1] Accepted for publication: September 23, 1970.

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postabdomen rudimentary. In *Pteromicra*, the arista is black- or white-haired, the frons is entirely shiny; the hind tibia has only 1 dorsal pre-apical bristle; the epandrium is symmetrical; the fifth sternum does not project under the postabdomen, and both the anterior and posterior surstyli are well developed.

The genus *Pteromicra* is known exclusively from the northern hemisphere. The world species were reviewed by Steyskal (1954); additional Nearctic species were described by Fisher and Orth (1966), Foote (1959), Knutson and Zuska (1968), and Steyskal (1956, 1958), and a key to the Nearctic species was presented by Foote (1959). A study of the biology, morphology of immature stages, and classification of adults of European *Pteromicra* entailed changes of names of 2 Holarctic species (Rozkošný and Knutson, 1970).

A revised key to the Nearctic species is presented below. I have not been able to recognize *P. apicata* (Loew, 1876), and I have found no characters in the description of the female holotype of *P. apicata* that will distinguish this species from all specimens of *P. pectorosa* (Hendel). The type material of *P. pectorosa* was examined recently (Rozkošný and Knutson, 1970); the genitalia of North American and European specimens compare exactly, although there are minor differences in coloration. Study of additional material of *Pteromicra inermis* Steyskal may show this species to be better placed in the genus *Sciomyza* Fallén. The holotype of *P. inermis* has 1 dorsal pre-apical bristle on 1 of the front tibia and 1 strong bristle and 1 weaker bristle on the other front tibia; other specimens show 2 well developed bristles.

The food snails, where known, are included as the last entry in each couplet of the key. Information on geographical distribution (based on the above papers and on Steyskal, 1965; T. W. Fisher, B. A. Foote, and R. E. Orth, personal communication, and specimens in the U. S. N. M. and Cornell University) also is included in the key. The distribution of the closely related and common *P. pleuralis* and *P. siskiyouensis* are shown in Fig. 1. I thank T. W. Fisher, B. A. Foote, and R. E. Orth for helpful criticism of the key.

KEY TO THE NEARCTIC SPECIES OF *Pteromicra* LIOY

1. Front femur without pecten (series of short, closely-spaced spinules located apically on anteroventral margin); pteropleuron with 2 or 3 long bristles in addition to several shorter bristly hairs; 2 pairs of fronto-orbital bristles 2

Front femur with pecten; pteropleuron with small patch of short hairs only 5

2(1). Antenna entirely black; palpus black; front femur mostly yellowish (Mich., Kans., Sask.) (Succinea sp.) . . . . **anopla** Steyskal

Antenna yellowish to brownish; palpus yellowish or black; front femur entirely black or black on apical 1/2 to 2/3 3

3(2). Palpus yellow in male, black in female; front femur black on apical 1/2 to 2/3 in male, entirely black in female (N. Y.) (Lymnaea spp.) . . . . **inermis** Steyskal

Palpus yellow in both sexes; front femur completely black in both sexes 4

4(3). Front tarsus pale basally; wing not patterned; posterior surstylus without process on anterior margin (Colo.) (Pupilla sp.) . . . . **perissa** Steyskal

Front tarsus black basally; wing patterned; posterior surstylus with process on anterior margin (Mont., Colo.) **rudis** Knutson and Zuska

5(1). Palpus completely yellow 6

Palpus black, at least apically 11

6(5). Two pairs of fronto-orbital bristles, anterior pair often much shorter 7

One pair of fronto-orbital bristles. 9

7(6). Front tarsus usually completely black, at most last segment in male sometimes yellowish to brown; wings brownish to black with whitish tomentum (Alaska, Popoff Is. and Amchitka Is.; Europe) (small Planorbidae, Lymnaeidae, Succineidae). . . . . **angustipennis** (Staeger) (=**glabricula** authors)

Front tarsus with last 1-3 segments whitish; wings broader; hypopleuron yellowish, rarely with faint whitish tomentum . . . 8

8(7). Dorsum of thorax shiny black (B. C., Wash., Europe) (small Planorbidae) . . . . **leucopeza** (Meigen)

Dorsum of thorax mostly yellowish, blackish only anteriorly (N. H., Mass., N. Y., Iowa) (Discus cronkhitei (Newcomb)) . . . . **steyskali** Foote

9(6). Thoracic pleura entirely dark brown to black; hypopleuron and sternopleuron with dense whitish tomentum; head mostly black 10

Thoracic pleura mostly yellowish to light brown; hypopleuron yellow; hypopleuron and sternopleuron with sparse whitish tomentum; head extensively yellow (Alaska, B. C., Wash., Calif., Mont., S. D., Alta., Man., Mich., Ont., Que., N. Y., Europe) (many non-operculate aquatic and hygrophilous snails) . . . . **pectorosa** (Hendel)

10(9). Male posterior surstylus pointed apically, with anteriorly directed process located midway on anterior margin (distribution, Fig. 1). . . . . **siskiyouensis** Fisher and Orth

Male posterior surstylus rounded apically, with inwardly directed process on anterior margin near base (distribution, Fig. 1 (many non-operculate aquatic and hygrophilous snails) **pleuralis** (Cresson)

11(5). Two pairs of fronto-orbital bristles 12

One pair of fronto-orbital bristles 13

12(11). Metapleuron black; hind legs entirely yellow (Maine, N. H., Mass., Conn.) . . . . **albicalceata** (Cresson)

Metapleuron mostly yellowish; apex of hind femur blackish (Que., N. Y., N. J., Mich.) (Planorbula spp.) . . . . **similis** Steyskal

13(11). Frons yellowish apico-medially; arista brown, long plumose; third antennal segment usually darkened apico-dorsally (D. C., Mich., S. D.) (Physa spp.) . . . . **sphenura** Steyskal

Head entirely black (occasionally tomentose on facial orbits); arista white, short plumose; third antennal segment almost entirely black (Wash., Idaho, Wyo.) (Gyraulus spp.) **leucothrix** Melander

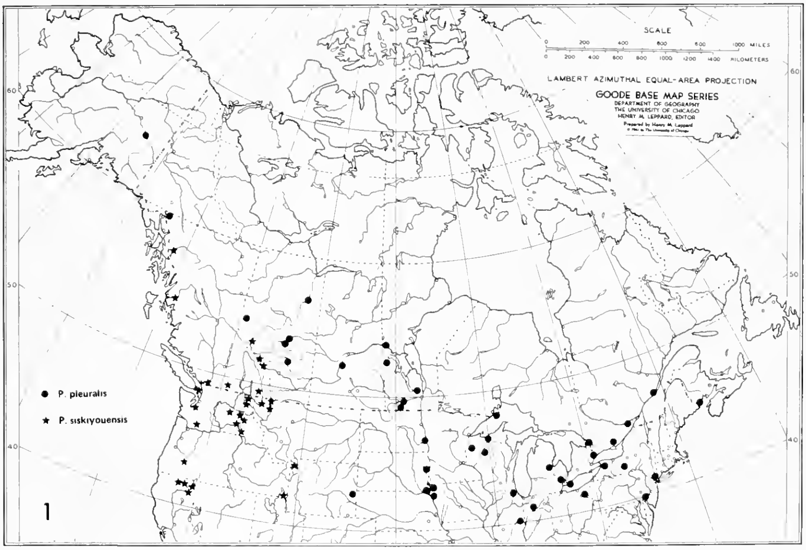

Fig. 1. Distribution of *Pteromicra siskiyouensis* Fisher & Orth and *P. pleuralis* (Cresson).

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Steyskal, G. C. 1954. The genus *Pteromicra* Lioy (Diptera, Sciomyzidae) with especial reference to the North American species. Papers Michigan Acad. Sci., 39: 257-269.

————. 1956. New species and taxonomic notes in the family Sciomyzidae (Diptera: Acalyptratae). Papers Michigan Acad. Sci., 41: 73-87.

————. 1958. A new species of the genus *Pteromicra* associated with snails (Diptera, Sciomyzidae). Proc. Ent. Soc. Washington, 59: 271-272.

————. 1960. The genus *Antichaeta* Holiday, with special reference to the American species (Diptera, Sciomyzidae). Papers Michigan Acad. Sci., 45: 17-26.

————. 1965. Family Sciomyzidae, in Stone, A., *et al.*, A catalog of the Diptera of America north of Mexico. United States Dept. Agric. Hndbk. 276.

2.0063. *Pteromicra melanothrix* **Melander, new synonym of** *Antichaeta melanosoma* **Melander, with a key to the Nearctic species of** *Pteromicra* **Lioy (Diptera: Sciomyzidae).** Abstract.–*Antichaeta melanothrix* (Melander), 1920 *(Pteromicra)*, **new combination**, is placed as a junior synonym of *Antichaeta melanosoma* Melander, 1920. A key to the 14 Nearctic species of *Pteromicra* Lioy serves to separate the species.–**L. V. Knutson,** *Systematic Entomology Laboratory, USDA, c/o [U.S.] National Museum of Natural History, Washington, DC 20560.*

Descriptors: Diptera; Sciomyzidae; *Pteromicra; Pteromicra melanothrix; Antichaeta melanosoma*; synonymy; key to species of *Pteromicra*; snail hosts.

(Continued from p. 246.)

International Commission on Zoological Nomenclature A. (n.s.) 86.–Announcement: Required six-month's notice is given on the possible use of plenary powers by the International Commission on Zoological Nomenclature in connection with the following insect names listed by case number (see Bull. Zool. Nomencl., 26, pt. 6, 7 April 1970):

1791, suppression of *Papilio aglaja* Linnaeus, 1758 (Lepidoptera); **1889**, suppression of *Culex albirostris* Macquart, 1851 (Diptera); **1892**, emendation to Sphaeridae of Sphaeriidae Erichson, 1845 (Coleoptera); **1897**, type-species for *Trepsichrois* Hübner, 1816 (Lepidoptera); **1898**, type-species for *Monroa* Warren, 1904, and *Hetererannis* Warren, 1904 (Lepidoptera); **1899**, suppression of *Hymenitis* [Illiger], 1807 (Lepidoptera). (See Bull. Zool. Nomencl., 27, pt. 2, 10 August 1970): **1916**, neotype for *Hyocephalus aprugnus* Bergroth, 1906 (Hemiptera); 1917, type-species for *Minecomutilla* Ashmead, 1903 (Hymenoptera); **1918**, suppression of *Zealandobates* Hammer, 1967 (Acari); **1919**, suppression of *Clavicera* Latreille, 1802 (Hymenoptera); **1921**, neotype for *Saperda inornata* Say, 1824 (Coleoptera).

Comments should be sent in duplicate, citing case number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London SW7, England. Those received early enough will be published in the Bulletin of Zoological Nomenclature.–**Margaret Doyle.**

Received for publication: November 2, 1970.

Jean Walker Fox (1914-1970).–Mrs. Jean Walker Fox died in Pittsburgh, Pennsylvania, of a coronary involvement March 10, 1970. She was the wife of the late Dr. Richard M. Fox. As his devoted and able assistant and co-worker she had participated in the preparation of much of her husband's work on the Ithomine butterflies. They were joint authors of a number of publications, including a text-book–"Introduction to Comparative Entomology" (Reinhold Publishing Corporation. 1964). With her husband Mrs. Fox served on the staff of the Liberian Institute, American Foundation for Tropical Medicine during 1955-1957, and in 1958 accompanied him on an expedition to the Liberian interior. It was during her residence in Africa that she became interested in the Strepsiptera; later (1964-1969) publishing six papers on this order.

Mrs. Fox was born at Bradford, Pennsylvania, April 23, 1914. She attended Swathmore College and Pennsylvania College for Women (now Chatham College) taking her A. B. degree at the latter institution in 1934. Her marriage to Richard M. Fox took place in June of 1942. In 1949 she received her M. S. degree from the University of Pittsburgh.

Her active and varied scientific career included the following posts: Instructor in the Department of Zoology, Colorado College 1949-1954; Laboratory Assistant in water purity research program, Colorado Springs Department of Public Works 1951-1954; Research Assistant and Staff Librarian at the Liberian Institute, American Foundation for Tropical Medicine, Harbel, Liberia 1955-1957; Research Assistant in the Section of Insects and Spiders, Carnegie Museum 1962-1969.

See was a member of Sigma Xi, Phi Sigma, American Association for the Advancement of Science, American Microscopical Society, Entomological Society of America, and Sweadner Entomological Society.–**George E. Wallace**, *Carnegie Museum, Pittsburgh, PA 15213.*

(Continued on p. 255.)

[3.0070]

A METHOD OF TAGGING LARGE AQUATIC BEETLES[1]

Chad M. Murvosh[2] and Bruce W. Miller[2]

Ecological studies of the desert pupfish, *Cyprinodon nevadensis* (Deacon, 1968), at Saratoga Springs, Death Valley National Monument, have led to ecological-ethological work on two similar species of predaceous diving beetles, *Cybister explanatus* LeC. and *C. ellipticus* LeC. Investigations of mating behavior, trophic ecology, and activity patterns led us to initiate a search for a suitable marking technique, enabling us to differentiate between males and females as well as between the species. A visible tag was practical since the water in one of the two habitats is remarkably clear, enabling observations under field conditions. Previous experience by the senior author in tagging flies (Murvosh and Thaggard, 1966), and a literature search suggested that an acceptable method was lacking. The following procedures were tried: 1) Painting dots on the elytra; 2) Spraying fluorescent paint; 3) Tying colored thread to the beetles, and 4) Applying dots of colored tape to the elytra.

Painting dots with various inks and paints was unsatisfactory except for limited success with Testors Dope applied with a toothpick or capillary tube. Dots begin to peel off after a couple of days and may be seen for up to a week. A method used in tagging fish (Jackson, 1959), with dry fluorescent pigments applied by compressed air, proved to be unsatisfactory, as the pigment did not penetrate the elytra as expected, adhering only to tarsal hairs. This method is expensive, difficult to apply, visible only under U-V light, and short lived (3-4 days).

An attempt was made to census the beetle population at Saratoga Springs by a tag, release, recapture procedure. One hundred adults were released after tying a short length of very brightly colored thread through a pinhole at the edge of an elytron. This marker lasted about a month in laboratory aquaria

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[1] Accepted for publication: October 20, 1970.

[2] Department of Biological Sciences, University of Nevada, Las Vegas, NV 89109.

but none of the field marked beetles were ever recaptured or sighted.

A more promising technique is the "Tape Dot" method in which tiny dots of colored tape are applied to the elytra. A dot about four mm in diameter was punched out of a roll of colored tape using a paper punch. The punched dot was picked up at the very extreme edge with the sharp tips of jewelers forceps and applied to the dry surface of an elytron. This method is tedious and time consuming and the dot must be applied correctly or it may flake off in a few days. Dots must be punched free of frayed edges and with as little disturbance to the adhesive as possible.

Several different tapes were tried. Scotch plastic tape was used with some success in preliminary studies, but most dots peeled off after a month in laboratory aquaria. We finally selected Time Laboratory Tape[3] after vigorous tests in aquaria. Dense cover (*Phragmites* sp. and *Ceratophyllum* sp.) and rocks in the aquaria provided surfaces which came in contact with the tape marker on the dorsum of the beetles. Longevity of the Time tape exceeded two months under these conditions. Preliminary field studies suggest that the method is also applicable under natural conditions. Tagged beetles were recovered in the field after four weeks and preliminary census and sex ratio data obtained using 50 marked beetles. Studies are in progress and another attempt will be made to census the population in one of the habitats at Saratoga Springs.

Individual beetles may be identified by varying the size and/or shape, location, number, and color of the dots on the beetles. The large size (30 mm) of the beetles is a boone to this technique. Time tape dots also were applied successfully to the large (40 mm) hydrophilid *Hydrophilus triangularis*, but was of little value when a half dot was placed on the elytra of the smaller (10 mm) *Tropisternus obscurus.*

Insect tagging techniques often work well for one investigator but poorly for another. This procedure, properly used, may prove of value for other workers. We have not tagged any terrestrial insects but the method seems applicable to that area.

Acknowledgments.–We wish to thank Dr. James Deacon for his assistance in and support of the work and Dr. Glen Bradley for criticizing the typescript. We also wish to acknowledge the work of James Lesser and Claude Whitmeyer, undergraduate biology students, who devised and field tested the thread tying method.

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[3] Professional Tape Co., Burlington Road, Riverside, IL 60546.

Murvosh, C. M. and C. W. Taggard. 1966. Ecological studies of the house fly. Ann Ent. Soc. America, 59(3):533-547.

2.0070. A method of tagging large aquatic beetles. Abstract.—Two dytiscids,*Cybister explanatus* and *C. ellipticus* were successfully marked in laboratory and field studies using a "Tape Dot" technique. Small dots of colored tape were punched from a roll of Time Laboratory Tape and put on the dry elytra of the beetles. Individual beetles were identified by altering the size, color, shape, and location of the dots.—**Chad M. Murvosh** and **Bruce W. Miller,** *Department of Biological Sciences, University of Nevada, Las Vegas, NV 89109.*

Descriptors: aquatic beetles; Coleoptera; *Cybister spp.;* marking technique.

(The Entomologists' Record, *continued from p. 252.)*

3.0061 Collecting slime flux feeding Coleoptera in Japan.—Sappy wounds of injured or diseased trees entice a wide variety of insects. Carter (1945) stated that when fluxing is prolific or long continued, air-borne bacteria, yeasts, and fungi contaminate the oozing sap, ferment it and produce the material called slime flux. Apparently the oozing flux is toxic to the flux site and so prevents callusing by the tree. Consequently, the same tree usually can be a good collecting site for insects from year to year.

My stay in Japan spanned four years, and collecting at flux sites was one of the most fruitful areas of endeavor. As soon as the vascular system of a tree became active in the spring the slime flux began to ooze out and attract insects. The best trees to visit were usually elms which possibly suffered from wetwood. April and May saw only a few insects feeding at the trees in the Tokyo area, but their numbers and kind greatly increased in June, July, and August; an abrupt decline in insect activity occurred in September.

During the day in the prime months, numerous species of nymphalid butterflies could be encountered and easily captured (species of *Hestina, Kaniska, Nymphalis, Vanessa, Polygonia, Neope*). Flies, wasps, and occasionally slugs were seen also feeding in very close proximity to one another and in apparent harmony. Only a new arrival or departure would send a nervous twitch through the group.

Beetles, however, were the most prevalent visitors to the sap flows. Nitidulids (*Librodor japonicus* Motschulsky) were always to be found buried in the slime flux or hiding in adjacent cracks and crevices. Helotids *(Helota gemmata* Gorham) were seen less commonly but were usually in the same surroundings as the nitidulids. Scarabs, especially the Cetoniinae (*Protaetia orientalis* Gory and Percheron, *Rhomborrhina japonica* Hope, *R. polita* Waterhouse) were very abundant during the day. The cetonines invariably kept to the higher or tree-top feeding areas and only rarely visited a lower flux site. An extendable 15 ft. net was an essential piece of equipment and enabled one to catch 20-30 of these swirling insects in one sweep. During the first two years of collecting, the rhinoceros beetle (*Allomyrina dichotoma* L.) could be found during the day, but after the second year they could be observed only at night.

Insect activity at the flux sites increased sharply with the advent of darkness. Wood roaches, long-horned grasshoppers and a variety of moths made their appearance. Carabids (*Damaster blaptoides* Koller, *Nebria* sp.) would venture near the sap flows, and the nitidulids and helotids remained active. Curculionids (*Ectatorrhinus adamsi* Pascoe, *Hylobius abietis* L.) occurred in considerable numbers on three or four trees in one very localized area. The most frequently encountered beetles, however, were the elaterids, lucanids, scarabs, and cerambycids.

The elaterids *Tetrigus lewsi* Candèze, *Spheniscosomus cete* Candèze, *Stenagostus umbratilis* Lewis, *Melanotus legatus* Candèze, and *Selatosomus onerosus* Lewis were collected with ease, there normally being several individuals at each of the 20 or so collecting trees.

Lucanids were very abundant and seemed to be climbing about nearly everywhere; it was not uncommon to see 10-20 individuals on just one flux site. Species taken were *Psalidoremus inclinatus* Motschulsky, *P. inclinatus* var. *inflexus* Harold, *Serrognathus titanus* Saunders, and *Macrodorcas rectus* Motschulsky. The beam of a flashlight would cause a number of them to start and maintain an alert or defensive posture while others, seemingly oblivious to the light, continued lapping up the flux. Even though all the individuals on a tree might be collected, returning a half hour later would reveal a host of replacements feeding at the flow.

Like the stag beetles, the rhinoceros beetle (*A. dichotoma* L.) came to feed at the flux sites in numbers, often flying in with a heavy droning of great wings, their eyes glowing in the flashlight beam like orange embers. Collecting 50 of these beetles a night was not an unreasonable goal. Another dynastine, *Eophileurus chinensis* Faldermann, was taken on less numerous occasions.

Among the cerambycids, *Mallambyx raddei* Blessig fed at the flow sites frequently as did the highly elusive, beautifully green *Chloridolum japonicum* Harold. The latter were wary and would rapidly run up the tree within a matter of seconds after a light was shown.

The optimum time for night collecting began at about 8:30 PM and lasted until about 2 AM. The majority of the beetles had retired after this time, leaving the slime flux to the moths and roaches. This method of collecting was a continual source of excellent material and personal pleasure because one never knew what new and unexpected creature could be waiting on the next tree.

Literature cited: Carter, J. C. 1945. Wetwood of elms. Bull. Illinois Nat. Hist. Survey, 23: 407-448.–**Brett C. Ratcliffe,** *2231 Griffith, Lincoln, NB 68503*

Accepted for publication: September 19, 1970.

Descriptors: Lepidoptera; Coleoptera. Orthoptera; Slime flux feeding; Japan.

NOTICE

Please send all correspondence of an editorial nature to the editor at the following address:

Dr. Ross H. Arnett, Jr., *Editor*
Entomological News
Route 1, Box 161
Tallahassee, FL 32303

The editor has left Purdue University permanently. He has been appointed a *Henry L. Beadel Fellow* at the Tall Timbers Research Station, Tallahassee, Florida.

[3.0065]

THE LIFE HISTORY OF *Neurocolpus nubilus* (Say), THE CLOUDED PLANT BUG (Hemiptera, Miridae)[1]

Richard L. Lipsey[2]

Introduction

Neurocolpus nubilus (Say, 1832), the clouded plant bug, is one of seven species in the genus: *N. arizonae* Knight, *jessiae* Knight, *johnstoni* Knight, *rubidus* Knight, *simplex* Van Duzee, and *tiliae* Knight. The species *N. nubilus* was originally described in the genus *Capsus* Fabricius, 1803 (LeConte, 1883). However, in 1876 Reuter described the genus *Neurocolpus* with *nubilus* as the only included species. This mirid occurs throughout the United States, Southern Canada, and Mexico (Crawford, 1916; Knight, 1941, and Van Duzee, 1889).

Crawford, 1916, wrote on certain aspects of the biology of this mirid when it became a pest on spy apples in Ontario, Canada, from 1912 to 1916. He reported that the eggs hatched about May 27 in 1915, and the nymphal period lasted for about a month. The population had almost disappeared by August 24 and was gone entirely by September 7.

A total of 42 hosts have been mentioned in the literature: Alsike clover, apple, alternate-leaved dogwood, burdock, button bush, Canadian blue grass, catnip, cone flower, cotton, cotton wood, *Croton capitatus*, curled dock, elder, evening primrose, false indigo, golden rod, ground cherry, hairy vetch, horseweed, Hungarian millet, Kentucky coffee tree, mesquite, mullein, old witch grass, orange milkweed, peach, peppermint, pigweed, poison sumac, ragweed, raspberry, red clover, round-leaved mallow, rye, spearmint, spy apple, staghorn sumac, stinking milkweed, sumac, teasel, timothy, and willow (Bibby, 1946; Crawford, 1916; Knight, 1941; Needham, 1903).

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[1] Accepted for publication September 24, 1970.

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The first specimen of the clouded plant bug, *N. nubilus*, collected in Arkansas was in 1924, with large populations found in northeast Arkansas beginning in 1958. This study on the life history of *N. nubilus* was carried out during the summers of 1966, and 1967, at the Northeast Branch Experiment Station in Keiser, Arkansas.

Methods and materials

N. nubilus were reared in the laboratory using as cages plastic Petri dishes with filter paper in the bottom. Fresh cut green beans, *Phaseolus vulgaris*, were picked daily and cut into two inch pieces. They served as food and oviposition sites. The eggs were left in the beans until hatching and the nymphs were placed in individual Petri dishes, and a record kept of their development. After they developed into adults, they were sexed, paired, and observed for mating and oviposition.

The temperature, humidity, and photoperiod in the laboratory was about ambiant. On rainy days, when the humidity was nearly 100%, the green beans containing eggs had to be placed in an air tight compartment with selica gel in the bottom to retard the growth of fungus. Otherwise, the tiny first instar nymphs would get tangled up in the mycelia.

Results

Adults.—A total of 468 *Neurocolpus nubilus* were reared to adults in the laboratory on green beans. There were 226 males and 242 females for an approximate 1:1 sex ratio. Adults lived an average of only 14.1 and 14.9 days respectively for males and females. The maximum longevity was 29 days for males and 34 days for females (Table 1).

The male is 6.5 mm by 2.5 mm. The rostrum is 2.7 mm and just reaches the posterior margin of the hind coxae. The first segment of the antennae is 1.3 mm and covered with heavy, flattened, black hairs with smaller white bristles intermixed. The second segment is 2.4 mm and enlarged apically on the terminal one-third. The third is .88 mm and the fourth is .86 mm. The pronotum is 1.4 mm long and 2.1 mm wide at the base. The pronotal disc has irregular brown marks. The scutellum is yellow with brown streaks. The hemelytra is brown to fuscous. The femora have brown markings with the hind pair with a brown band in the middle of the apical half. The tibia has a brown band in the middle.

The female is 7.0 by 2.6 mm and is more robust than the male. She has similar color and pubescence (Knight, 1941).

Mating was observed in the laboratory on seven occasions. The male usually flew frantically for several seconds upon being placed in the Petri dish of a receptive female. A typical courtship and mating behavior pattern follows: Coming to rest near the female, the male approached the female with antennae pointing toward her, he stopped short of her. The female assumed a calling position by spreading her hind legs and raised her abdomen. The male began scissoring her abdomen with his antennae by alternately raising and lowering each antennae over her abdomen while both moved into copulatory position. She backed into him while he spread his fore and then his middle legs. All the while his antennae were alternately moving up and down, touching the dorsum of the female. All of a sudden copulation occurred–lasting only 7 seconds, and then the two insects separated.

A non-receptive female kicks the male away with her hind legs. Receptive females were between 6 and 9 days old and males were 8 to 10 days old (Table 2).

Egg.–A total of 228 eggs were laid in green beans in the laboratory by 11 females (Table 2). Almost all of the eggs were laid in the seam of the bean. The range was 7-36 eggs and the mean was 10.0. The pre-oviposition period ranged from 12-16 days with a mean of 14.5 days.

The eggs are 1.75 mm long and 0.3 mm wide. They are hard and shiny with a white, claw-shaped cap on one end containing the micropyle. Eggs laid in June hatched in 12 days, and those in July hatched from 13-14 days. Eggs laid in August hatched in 14 days.

Nymphs.–A newborn nymph has the appearance of a tiny, hairy spider with long legs. The antennae average 1.2 mm in length and his hind legs are 1.2 mm long. The body is greenish and covered with small black hairs. There are red bands on the legs and antennae. The eyes are very large and bright red.

One hundred and seventy-two nymphs were reared to adults in the laboratory on green beans. They passed through 5 stadia in 12.6 days in June, 12.8 days in July, and 12.3 days in August. It took from 12-15 days to pass from egg to adult at an ambiant temperature (Table 1). The first three stadia lasted an average of only two days each while the last two stadia took three days each (Table 2).

Discussion

Green beans did not appear to be adequate food or oviposition sites in the laboratory for *Neurocolpus nubilus*, the clouded plant bug. Most adults only lived 14 or 15 days in the laboratory and the majority of the females died without laying eggs. Only 11 out of 351 females laid eggs, leaving 340 that died before laying. Other food was tried, like cotton squares, button bush buttons, sliced apples, and sumac flowers, since *N. nubilus* is known to reproduce on these in nature, but no eggs were ever found in any of these. Upon dissection, all of the females over 6 days old contained many mature eggs, so the females may not have been getting the proper ovipositing stimuli from the green beans.

The reproductive biology of this mirid should be studied further for the possibility of a sex attractant. Behavior in the field and in the laboratory indicate that the female does secrete a sex pheromone. Caged, virgin females were seen to attract males in the field. In the laboratory, males placed in female cages, especially with fecal material evident on the filter paper, remained still for several seconds and then flew frantically around the Petri dish. It did not appear as escape behavior because the male usually came to rest near the abdomen of the female and facing her. Olfactometer studies in the lab failed to show the presence of a sex attractant, but in the field, six times as many males were captured by sticky traps baited with virgin females as were caught by an empty sticky trap just 2-3 feet away. A total of 12 baited traps caught 19 males while the 12 control traps only had three stuck to them. Therefore, I suspect a sex pheromone is produced by virgin females.

From the 228 eggs laid in the lab by 11 females the eggs hatched in about 13 days; the nymphs passed through 5 stadia in 12.6 days. So, from egg to adult took about 25 days. Crawford (1916) reported that nymphal development took about a month at ambiant temperature in Ontario apple orchards. Adults mated at about 8 days of age and eggs were laid about 6 days later. Therefore, a generation takes about 40 days. Since the first adults appear in the field in late June and early July, then two to three generations may be possible in the field.

Diapausing eggs are probably laid in late August since 100% of the eggs collected from the field before this time hatched and almost none of the eggs collected from the field after the last week of August hatched. Crawford, in the only other study on the biology of *N. nubilus*, found that eggs hatched on May 27 in Ontario, Canada, and the population had almost disappeared by August 24 and was entirely gone by September 7. We cannot be sure that diapausing eggs are indeed laid in late August without controlled experiments in the laboratory monitoring various photoperiods and temperatures.

The wide distribution of this species, together with the large number of host plants (52), some of them field crops, makes *Neurocolpus nubilus* an important species in North America.

Table 1. Range and mean of life history data of *Neurocolpus nubilus* in the laboratory.

Event	Mean	Range	*n*
Incubation (in days)	13.1	11-14	228
Duration of nymphal development (in days)			
First stadia	2.1	1-3	172
Second stadia	2.4	2-3	172
Third stadia	2.4	1-3	172
Fourth stadia	2.6	2-4	172
fifth stadia	3.1	2-4	172
Age at mating			
Male	8.7	8-9	7
Female	8.0	6-9	7
Pre-oviposition (in days)	14.5	12-16	12
Number of eggs laid by 11 females	19.0	7-36	228
Longevity (in days)			
Male	14.1	1-29	80
Female	14.9	1-34	80

Table 2. Duration of nymphal development for 172 nymphs.

Days in	Numbers of individuals per stadium				
each stadia	1	2	3	4	5
1	8	0	4	0	0
2	136	108	104	80	20
3	28	64	64	84	100
4	0	0	0	8	52
5	0	0	0	0	0
Mean	2.1	2.4	2.4	2.6	3.1
Range	1-3	2-3	1-3	2.4	2-4

Literature cited

Bibby, F. F. 1946. *N. nubilus*, a cotton pest. J. Econ. Ent. 39(6):815.

Crawford, H. G. 1916. A capsid attacking apples (*N. nubilus*). Ann. Rep. Ent. Soc. Ontario 46:79-88.

Knight, H. H. 1941. The plant bugs or Miridae of Illinois. Bull. Illinois Nat. Hist. Surv. 22, Art. 1, p. 182.

LeConte, J. L. 1883. The complete writing of Thomas Say on the entomology of North America 1:341.

Needham, J. G. 1903. Button-bush insects. Psyche 10:22.

Reuter, O. M. 1876. Capsinae ex America Boreali in Museo Holmiensi asservatae descriptae. Ofv. Sv. Vet.-Ark. Forh. 32(9):59-92.

Van Duzee, E. P. 1917. Hemiptera of America north of Mexico. Vol. 2, Univ. California Pub. Ent. pp. 314-315.

3.0065 **The life history of *Neurocolpus nubilus* (Say), the clouded plant bug (Hemiptera, Miridae).** Abstract.–*Neurocolpus nubilus,* the clouded plant bug, was reared in the laboratory in Petri dishes on green beans at ambiant temperatures and photoperiod. The eggs hatched in 13.0 days and the nymphs passed through five stadia in 12.6 days. Mating occurred when the females were at least six days old and the males were eight days old. The pre-oviposition period was 14.5 days and the sex ratio was 1:1. **Richard L. Lipsey,** *Department of Entomology, University of Illinois, Urbana, IL 61801.*

Descriptors: Hemiptera; Miridae; *Neurocolpus nubilus*; clouded plant bug; Arkansas; life cycle.

(The Entomologists' Record, continued from p. 256)

3.0073. Notes and synonymy on Buprestidae (Coleoptera).—This paper contains biological notes and synonymy of North American Buprestidae. All collections were made by D. J. and J. N. Knull.

Agrilus arizonicus Obenberger, 1936. Casopis Cs. Spol. Ent. 33:139. Adults were abundant on foliage of *Desmodium batocaulon* Gray in Miller Canyon, Huachuca Mts., Az., Aug. 10, 1935; also on the same plant in Madera Canyon, Santa Rita Mts., Az., July 16 to Aug. 15, 1969. It would indicate that this is the host plant.

Agrilus auroguttatus Schaeffer, 1905. Bull. Brooklyn Inst. Mus. 1(7):149-150. Adults were taken on oak slash in Cave Creek Canyon, Chiricahua Mts., Az., July 29, 1953, July 17, 1957.

Agrilus chisosanus Knull, 1956. Ent. News 67:47-48. This is a female of *A. obscurilineatus* Vogt (1949), NEW SYNONYMY.

Agrilus cliftoni Knull, 1941. Ohio J. Sci. 41(5):382-384. Adults taken on foliage of black walnut (*Juglans nigra* L.) at Clifton, Greene Co., Ohio, June 5, 1957; July 6, 1962; Delaware Co., Ohio, June 22, 1947; Clear Creek, Hocking Co., Ohio, June 9, 1959. The species evidently breeds in walnut.

Agrilus duncani Knull, 1929. Ent. News 40:270-271. Adults were captured on the dead branches of *Baccharis* sp. in Florida Canyon, Santa Rita Mts., Az., Aug. 14, 1969. Nelson (1964) recorded it from *Chrysothamnus* sp. When this species was described it was placed in the group with prolonged elytra; however, it would fit better near *A. muticus* LeConte according to Fisher (1928).

Agrilus mimosae Fisher, 1928. United States Nat. Mus. Bull. 145:241-243. Adults were taken on catclaw (*Acacia greggii* Gray) in Cave Creek Canyon, Chiricahua Mts., Az., July 16 to 25, 1965; also on the same plant in the Davis Mts., Tex., July 23, 1946. I would conclude that this plant is the host.

Agrilus palmerleei Knull, 1944. Ann. Ent. Soc. America 37(1):76-77. Adults were collected from whiteleaf oak (*Quercus hypoleucoides* A. Camus) in the Chiricahua Mts., Az., at Herb Martyr Dam, Chiricahua Mts., Az., Aug. 4, 1970; Onion Saddle, July 24, 1955.

Agrilus parafloridanus Knull, 1929. Ent. News 49:270-273. This species is a green variety of *A. floridanus* Crotch (1873), NEW SYNONYMY.

Agrilus santarita Knull, 1937. Ent. News 48:39-40. Adults were taken on the foliage of *Desmodium batocaulon* Gray in Madera Canyon, Santa Rita Mts., Az., July 28 to Aug. 11, 1969, and on the same plant at Herb Martyr Dam, Chiricahua Mts., Az., July 23-30, 1968. The numbers taken would indicate that this plant is the host.

Brachys floccosus Mannerheim, 1837. Bull. Soc. Imp. Nat. Moscow 10(8):118. Adults were collected on the foliage of whiteleaf oak (*Quercus hypoleucoides* A. Camus) in the Chiricahua Mts., Az., at Onion Saddle, July 25, 1965.

Chrysobothris atrifasciata LeConte, 1859. Trans. American Philos. Soc. (n.s.) 11:240. One specimen collected along U. S. 80 about 10 miles north of Rodeo, N. M. on *Atriplex* sp., June 14, 1939.

Chrysobothris bicolor Horn, 1894. Proc. California Acad. Sci. (Ser. 2) 4:328, 366-367. Specimens of what I take to be this species were collected from catclaw (*Acacia greggii* Gray) at Cienega Lake, Hidalgo Co., N. M., June 27, 1967 and Cave Creek Canyon, Chiricahua Mts., Az., July 16-19, 1965.

Chrysobothris ephedrae vogti Knull, 1964. Ohio J. Sci. 64(5):367. A series of this subspecies is now available collected from *Ephedra* sp. in Starr Co., Tex., Mar. 28 to April 13, 1965. The dorsal surface varies to solid, brilliant metallic green.

Chrysobothris micromorpha Fall, 1907. Canadian Ent. 39:237-238. Adults were taken on foliage of catclaw (*Acacia greggii* Gray) in Cave Creek Canyon, Chiricahua Mts., Az., July 15 to 22, 1965. No doubt this species breeds in this plant.

Chrysobothris platti Cazier, 1938. Bull. Southern California Acad. Sci. 37:14-15. As pointed out by Nelson (1960), *C. santarosae* Knull (1947) is a dark colored male of the above species. Males vary in color from dark brown to metallic green; however, I have not seen any dark females. They were abundant on the tips of Mormon tea (*Ephedra* sp.) at Jacumba, San Diego Co., Calif., July 6, 1952, at sundown.

Cinyra cuprescens Knull, 1940. Ohio J. Sci. 40(6):363. Specimens were taken on foliage of desert honeysuckle (*Anisacanthus thurberi* (Torr.) near Portal in the Chiricahua Mts., Az., July 30, Aug. 7, 1959; Florida Can., Santa Rita Mts., Az., Aug. 3, 1962. This plant is undoubtedly the host.

Cinyra robusta Chamberlin, 1920. Ent. News 31:241. Nelson (1968) called attention to my misidentification of this species (1920). A check of material shows that all specimens are *robusta* and not *prosternalis* Schaeffer as I recorded.

Nanularia (Ampheremus) cylindricollis (Fall), 1917. Ent. News 28:69. Specimens were taken on the flowers of *Erigonium* sp. along U. S. 80 about two miles north of Rodeo, N. M., June 27, 1949. Also one specimen from Lordsburg, N. M., June 23, 1949.

Pachyschelus oculatus Schaeffer, 1909. Brooklyn Inst. Mus. Sci. Bull. 1:377-378. Adults were taken on foliage of *Desmodium batocaulon* Gray in Madera Can., Santa Rita Mts., Az., Aug. 8, 1968; Idlewilde Camp Ground, Cave Creek Can., Chiricahua Mts., Az., Sept. 5, 1947 and at Herb Martyr Dam, Chiricahua Mts., July 26-Aug. 2, 1952.

Ptosima gibbicollis schaefferi Chamberlin, 1926. Buprestidae of North America, Catalogue 235. Adults were abundant on redbud (*Ceris texansis* Sarg.) in Gillespie Co., Tex., April 5, 1935 and May 7, 1946. The species undoubtedly breeds in redbud.

Ptosima idolynae Frost, 1923. Canadian Ent. 55:279-281. Specimens were taken on *Gleditsia* sp. at Maud, Tex., April 29, 1941.

Literature cited.–Crotch, M. A. 1873. Notes on the species of Buprestidae found in the United States. Proc. Acad. Nat. Sci. Philadelphia 25:84-96. **Fisher, W. S.** 1928. A revision of the North American species of buprestid beetles belonging to the genus *Agrilus.* United States Nat. Mus. Bull. 145, 347 p. **Knull, J. N.** 1947. New North American Coleoptera (Buprestidae, Schizopodidae, and Cerambycidae). Ohio J. Sci. 47 (2):69-73; 1950. New Coleoptera with notes II (Buprestidae and Cerambycidae). Ent. News 61(4):89-92. **Nelson, G. H.** 1960. Notes on Buprestidae and Schizopoidae. Bull. Brooklyn Ent. Soc. 55(3):70-74; 1962. Notes on Buprestidae: Part III. Bull. Brooklyn Ent. Soc. 57(2):56-60; Notes on Buprestidae (Coleoptera): Part VI, Coleopt. Bull. 22(1): 28-30. **Vogt, George B.** 1949. Five new Buprestidae from southern Texas (Coleoptera). Ann. Ent. Soc. America 42:48-54.–**Josef N. Knull,** *Prof. Emeritus, Faculty of Entomology, The Ohio State University, Columbus, OH 43210.* Accepted for publication: October 26, 1970.

Descriptors: Coleoptera; Buprestidae; synonymy; biological notes.

The Entomologist's Library

This section contains titles of books, monographs, and articles received by the editor that may be of special interest to entomologists and biologists. A brief statement of contents and items of interest are noted. Brief analytical reviews may be submitted for possible publication. All correspondence for this section should be addressed to Dr. Eugene J. Gerberg, Book Review Editor, 6603 Johnnycake Road, Baltimore, MD 21207.

Publications received.—As soon as a publication is received, it is listed in this section. Short reviews follow as space permits. Certain publications of unusual interest to Entomologists may be critically reviewed at anytime. All publications are classified according to the following section headings: **1. General; 2. Invertebrates; 3. Textbooks; 4. Natural history; 5. Morphology; 6. Physiology; 7. Embryology; 8. Genetics; 9. Ecology; 10. Biogeography; 11. Environment; 12. Medical Entomology and Parasitology; 13. Pest management; 14. Field guides; 15. Regional guides; 16. Regional lists; 17. Identification aids,** listed by order; **18. Technique,** including nomenclature; **19. Information retrieval.**

Authors and publishers are urged to submit their publications for notation here. Current literature has long been a feature of **Entomological News.** *Note:* The publications listed in this section are only those that have come to the attention of the editor. Bibliographers are not to assume that this is a complete list of current publications on entomological subjects.

1. General

Eidmann, H. and F. Kuhlhorn. 1970. Lehrbuch der Entomologie. Verlag Paul Parey, Hamburg. 633 p. Cloth, 68 DM.

Krishna, K. and F. M. Weesner. 1970. Biology of termites, vol. 2. Academic Press, New York. xlv + 643 p. Cloth, $ 32.00.

3. Textbooks

Borror, Donald J. and Dwight M. DeLong. 1970. An introduction to the study of insects. 3rd ed. Holt, Rinehart, and Winston, New York. xiii + 812 p. Cloth, $ 18.75.

Chapman, R. F. 1969. The insects. American Elsevier Publ. Co., New York. xii + 819 p. Cloth, $ 13.75.

4. Natural History

Evans, Howard E. and Mary Jane West Eberhard. 1970. The Wasps. Ann Arbor Science Paperback, AAS 518, Univ. of Michigan Press, Ann Arbor. vi + 265 p. Paper, $ 3.45; cloth, $ 7.95.

Oldroyd, Harold. 1970. Elements of entomology. Universe Books, New York. x + 312 p. Cloth, $ 7.95.

Sauer, Jonathan D. 1967. Plants and man on the Seychelles Coast. Univ. Wisconsin Press, Madison. x + 132 p. Cloth, $ 5.00.

6. Physiology

Engelmann, F. 1970. The physiology of insect reproduction. Pergamon Press, New York. x + 307 p. Cloth, $ 18.75.

7. Environment

Benson, G. K. and J. G. Phillips. 1970. Hormones and the Environment. Cambridge Univ. Press, New York. xvi + 629 p. Cloth, $ 22.50.

UNESCO. 1970. Use and conservation of the biosphere. Proc. Intergovernmental Conf. on the scientific basis for rational use and conservation of the resources of the biosphere, 1968. UNIPUB, Inc., P. O. Box 433, New York, NY 10016. 272 p. Paper, $ 6.00.

11. Ecology

UNESCO. 1970. Ecology of the subarctic regions. UNIPUB, Inc. P. O. Box 433, New York, NY 10016. 354 p. Cloth, $ 19.00.

12. Medical Entomology and Parasitology

Dunn, Angus M. 1969. Veterinary helminthology. Lea and Fabiger, Philadelphia. xi + 302 p. Cloth, $ 17.00

Faust, E. C., P. C. Beaver, and R. C. Jung. 1968. Animal agents and vectors of human disease. 3rd ed. Lea and Febiger, Philadelphia. ix + 461 p. Cloth, $ 11.50.

Faust, E. C., P. F. Russell, and R. C. Jung. 1970. Craig and Faust's Clinical parasitology. 8th ed. Lea and Febiger, Philadelphia. viii + 890 p. Cloth, $ 25.50.

International Atomic Energy Commission. 1970. Isotopes and radiation in parasitology, 2. Proceedings of a research co-ordination meeting, Vienna. UNIPUB, P. O. Box 433, New York, NY 10016. p. 00. Paper, $ 4.00.

Sasa, M. [ed.]. 1970. Recent advances in researches on filariasis and schistosomiasis in Japan. University Park Press, Baltimore. 402 pp. Cloth, $ 20.00

Schmidt, Gerald E. [ed.]. 1969. Problems in systematics of parasites. University Park Press, Baltimore. 131 p. Cloth, $ 7.95.

13. Pest Management

Beroza, Morton [ed.]. 1970. Chemical controlling insect behavior. Academic Press, New York. xii + 170 p. Cloth, $ 10.00.

Komarek, Roy [ed.]. 1969. Proceedings Tall Timbers conference on ecological animal control by habitat management. Number 1. Tall Timbers Research Station, Talla-Hassee. v + 244 p.

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1. General

LEHRBUCH DER ENTOMOLOGIE, by H. Eidmann and F. Kuhlhorn. Verlag Paul Parey, Hamburg, 1970. 633 p. Cloth, 68 DM.

For those entomologists who are proficient in German, or who want to practice reading German, this is an excellent general textbook on entomology. This new edition is an updated version within the original framework of the text. The nine chapters cover the systematics; the characteristics of the organization of the insect body; the habitat magnitude and size of insects; the morphology of the insect body and its appendages; the organs and their functions; reproduction; the relationship of insects to their environment, and the classification of insects. Throughout the text, ecological and physiological problems are given due regard. The illustrations are well done and clear.

This book should be of interest to entomologists, naturalists, agriculturists, medical scientists, and others who desire to know more about the insect world, and who have a basic knowledge of German.–*Ed.*

BIOLOGY OF TERMITES, V. 2, by K. Krishna and F. M. Weesner [eds.]. Academic Press, New York. xlv + 643 p. Cloth, $ 32.00

The second volume of this treatise brings together a series of articles prepared by specialists. Laboratory and field studies are included in the chapters on: Protozoa associated with termites and their role in digestion; Embryology, nests, and taxonomy of termites, and Principles of termite control. This volume and its companion are invaluable sources of information and should be in the libraries of research workers, as well as pest control operators.–*Ed.*

3. Textbooks

THE INSECTS, by R. F. Chapman, American Elsevier Publishing Co., New York. 1969. xii + 819 p. Cloth, $ 13.75.

This book was announced and briefly described in an earlier issue (May, 1970, p. 113). While I consider it an important contribution to entomology and will use it as a text, I would be remiss if I did not take it to task for its shoddy treatment of luminescent insects. Perhaps others will report on the quality of the sections dealing with their specialties.

In male *Photuris* spp. there is *not* a *pair* of light organs on each . . . segment. In *Photuris* spp. females light organs do *not* occur only in one segment. Neural excitation of the light organ is *not* mediated by acetycholine. End cells are *not* merely poorly developed in some species–some don't even have them. In *Photinus* spp. each flash does *not* last a few hundred milliseconds–depending upon species and sex, a flash may last from less than 100 to more than 2,000 milliseconds. "The male *Photinus* [spp.]" does *not* necessarily flash at intervals of 5.8 sec and fly 50 cm above the ground–these factors depend upon species, temperature, surroundings, etc. (Chapman here is referring to the mean flash interval of *Photinus pyralis* at 24° C–why doesn't he say *P. pyralis*?). *Photinus* spp. females do not delay 2 sec and then answer male flashes–*Photinus pyralis* females do, at about 25° C (Chapman does note that delays are species-specific). Larval light organs do *not* necessarily disappear at metamorphosis. All luminescent Diptera are now placed in the family Mycetophilidae. Primary reference citations would have been most helpful but Chapman doesn't even cite E. N. Harvey's comprehensive book *Bioluminescence* (1952) which has a large section on insects that could have filled many of Chapman's omissions. None of the literature depended upon for the above non-taxonomic corrections is more recent than 1966.–**J. E. Lloyd,** *Department of Entomology, University of Florida, Gainesville, FL 32601.*

examined, and long, detailed descriptions, discussions of nomenclatural problems will be recommended for **Data Documents for Systematic Entomology.** Instructions for this will be furnished on request (see Vol. 81, pp. 1-11 and recent issues). Short notes will be promptly published in **The Entomologist's Record.** Literature notices, short reviews, and books received will be published in **The Entomologist's Library.** Study notices, want items, and for sale notices are published in **The Entomologist's Market Place.** All manuscripts should follow the format recommended in the CBE "Style Manual".

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No. 25. *Michael G. Emsley*—The Schizopteridae (Hemiptera: Heteroptera) with the description of new species from Trinidad. 154 pp. $6.50

No. 26. *James R. Zimmerman*—A taxonomic Revision of the Aquatic Beetle Genus *Laccophilus* (Dytiscidae) of North America, 275 pp. $12.00

Clarence E. Mickel—A Review of the Mutillid Genus *Chyphotes* Blake (Hymenoptera: Mutillidae, Apterogyninae). 110 pages, 10 plates, 26 maps. . . . $2.50

Arthur M. Shapiro—Butterflies of the Delaware Valley. 63 pages, 11 plates, 10 habitat photographs. $1.50

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Subantarctic entomology, *particularly of South Georgia and Heard Island, with biogeographical summary.* Ed. by J. L. Gressitt. Pacific Insects Monograph 23, 1970, 383 p, ill. incl. color pl. $ 9.50 hard binding; $ 8.50 wr., Bishop Museum Press, Box 6037, Honolulu. HI 96818.

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Wanted: Customers; I am trying to liquidate large stock of Lepidoptera as well as my own collection. Discounts on all orders–write for list. Russell L. Dunn, Sedona, AZ 86336.

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VOL. 81 NOVEMBER 1970 NO. 10

ENTOMOLOGICAL NEWS

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THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS

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(Continued on back inside cover.)

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[3.0071]

INSECT FLIGHT AND ENTOMOLOGISTS' INHERITANCE[1]

Brian Hocking[2]

Fifteen years after I published (Hocking, 1953) an hypothesis concerning insect flight behaviour in relation to land and sea breezes this was, in part, accorded a more factual status (Holzapfel and Harrell, 1968) than my evidence warranted. This paper results from a search for further evidence relevant to the hypothesis.

Methods

Two traps designed to catch insects flying with the wind separately from those flying against the wind were developed (Figs. 1-3), from the original design of Malaise (1937), with some of the Gressitt (1962) modifications. The larger traps intercept 10m^2 of air and are set up across the anticipated wind direction. They are thus of maximum usefulness if wind direction is predictable, which it usually is with well developed land and sea breezes. The smaller intercept 0.5m^2 of air, are free to rotate, and their orientation is maintained across the wind direction at all times by a vane.

The net material used in the traps was a pale green nylon monofilament tulle with openings approximately 0.8 mm wide. This was chosen for its high strength in relation to its permeability for air and in the hope that, by allowing the escape of very small insects, which are irrelevant to the proposed study because they have poor control of flight direction relative to wind, it would reduce the labour of counting and identification. The floor of the large trap and its 8 inch rim were made of a dark green 3 oz coated nylon, strips of which were used to reinforce all edges and seams in the net of both traps, except two main vertical seams in the diaphragm of the large traps; visual emphasis on the diaphragms was considered undesirable.

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[1] Accepted for publication: October 21, 1970.

[2] Department of Entomology, University of Alberta, Edmonton 7, Canada.

The trap frames were made of aluminum alloy tubing. The large traps had two central uprights, each of two telescoping sections (1 inch and 7/8 inch outside diameter), joined by a welded 3/4 inch cross piece with a central socket for a 1/2 inch vertical. This vertical was coupled by an X-block to a horizontal diagonal supporting the lucite catching bottles. The floor was pegged to the ground at the corners and centre line and supported by four, 40 foot guy lines of 3/16 inch nylon, two running from each end of the top cross-piece, each to a ring on one of the four eave corners, thence to a peg. For the small traps, two square frames each with two adjacent sides of 3/8 inch tubing, the other two sides of 1/4 inch tubing, were joined at the corners by shorter lengths of 1/4 inch tubing, except for the corner between the 3/8 inch pieces where 1/2 inch tubing was used. This, the bottom corner, was mounted on a bicycle pedal bearing, itself on a 30 x 1 inch tube held upright by 3 guys of 1/8 inch nylon. The three tubes at each corner were secured by tightening the single nylon screw in an appropriate size of lucite corner piece. These pieces were cut from half inch lucite stock (except the largest size, C, from 3/4 inch) and drilled, to the dimensions shown in figure 1. The single screw in the large hole, which is slotted out about 1/32 inch, bears on the tube in this hole to grip the other two tubes. The large hole is cut into the smaller holes between 0.01 and 1/64 inch. The catching bottles of the small traps were of acetate sheet, 2 1/2 or 3 inch diameter, supported by 3/16 inch alloy tubing from a modified size A lucite corner piece in the center of the top tube. The top tube also carried the acetate vane on 3/16 inch tubing, plugged into one end of it. Granular calcium cyanide was used in all catching bottles; the openings in the cones measured 12 mm diameter in the small traps and 16 mm in the large ones.

To reduce the likelihood of insect escape both traps had reflexed edges of net (large 6 inch; small 2 inch) held back at about 45° by nylon ties to the centre corners. It was assumed that insects landing on these edges had an even chance of going in or out, so that the intercept areas used are measured to the mid-lines of the reflex edges.

Two of the large traps and 4 of the small ones were operated over a period of about 12 summer months, 8 months in the southern hemisphere and 4 months in the northern. Sites were all within 10 km of the shores of lakes (L. Huron, Canada; L. Baikal, U.S.S.R.), islands (Western Samoa, Tahiti, Rangiroa, Oahu, Hawaii) or continents (Australia; California, N. America). Most of the work was done as close to the shore as possible in W. Samoa (13°30'-14°S), Hawaii (19°30'-21°30'N), and California (35°30'-36°30'N) where available sites were chosen with equal attention to their meteorological and biological (plants and insects) suitability. Traps were usually cleared at times of wind reversal or significant wind change. Since wind reversal was usually close to sunrise and sunset, most catches represent night or day flight activity. Catching was occasionally suspended in the daytime when the wind speed exceeded the tolerance of the traps (c. 10 m sec^{-1}); few insects flew at trap height (1 to 4 m) in winds of these speeds. Catches were rough-sorted, pinned, labelled with conventional data plus direction of travel relative to wind direction, and counted, usually before the succeeding trap clearance. Despite the rather large mesh net, insects small enough to pass readily through the mesh were caught in very large numbers. They were ignored in considering flight direction relative to wind since their direction of origin was questionable.

Results

About 70,000 insects were trapped in 22,000 m^2hr of operation. During 7 months in Western Samoa, where the most intensive work was done, the catch included about 1000 different species, a number of them not previously recorded from the islands and several undescribed. Since Buxton and Hopkins (1927-35) collected nearly 1600 species in two years' work and my catches were almost restricted to flying species, the fauna seems well represented. Spiders, lizards, nymphal grasshoppers, and even fish were, however, included in my catches. It was necessary to watch for, and remove the spiders and the lizards.

The mean numbers of insects caught per m^2hr of operation in the three main locations, the approximate areas of land, and other possibly relevant data are given in Table 1.

Because of the varying proportions of time devoted in the three locations to trapping at different distances from the shore line and at different times of the day and night, direct statistical comparison of catches in the three areas would not be appropriate. However, when for example mean shore line catches per m^2hr at night are compared, the following figures result: Hawaii 1.93±0.26 (14); W. Samoa 6.44±0.57 (25); N. America 0.41±0.08 (19); all differences are significant at the 0.001 probability level.

Analysis of the data in relation to wind direction, distance from shore line, day and night, taxa, and sex is in progress.

Discussion

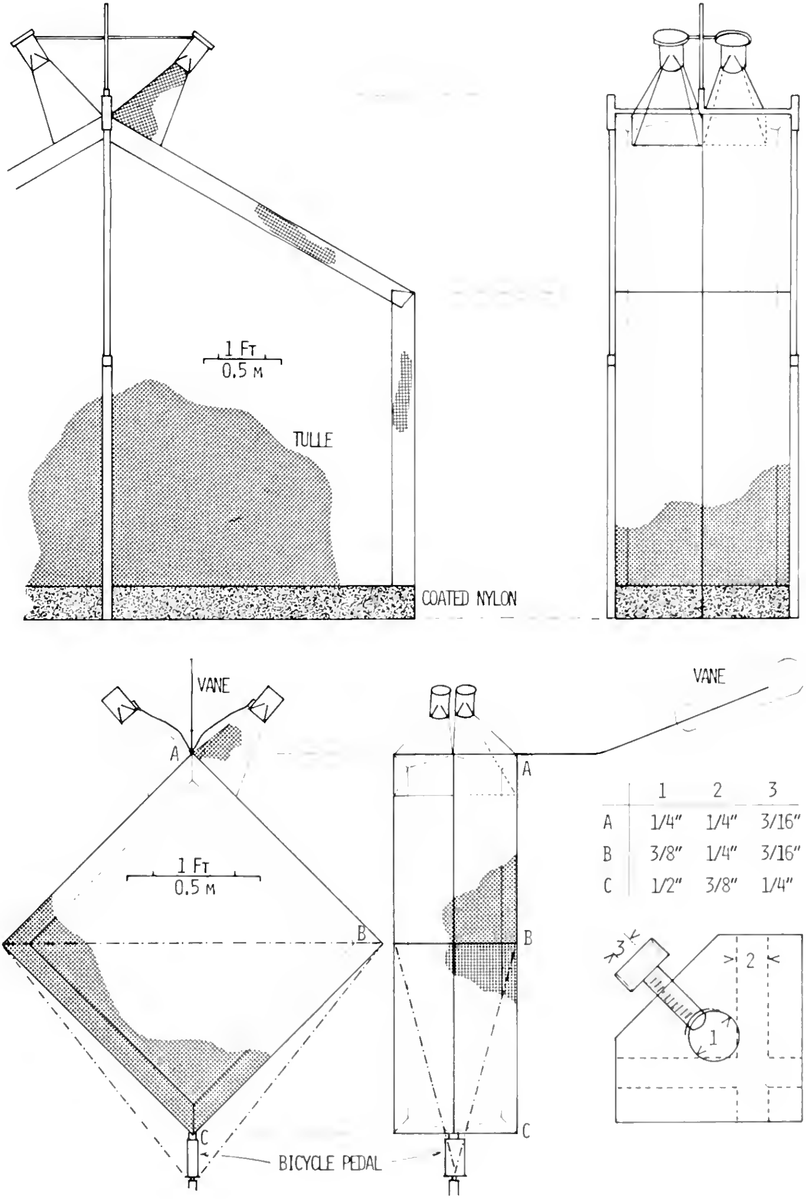
It is generally agreed (Carlquist, 1965; Darlington, 1957; McArthur and Wilson, 1967) that there is a direct relationship between the size of oceanic islands and the sizes of their faunas; this is perhaps most clearly expressed by the insects. Much less attention has been paid to the possible relationships

Table 1. Wind trap catches per m²hr on islands of various sizes and continental North America, with latitudes, human population densities, insecticide use, and trapping time. Pacific, 1968-69.

Area	Km^2	Latitude	$Persons/km^2$	Insecticide use–rank	m^2hr	Catch: Total insects/m^2hr
Savaii	1820	13°30′-14°S	48	2	12,150	4.2
Upolu	1114					
Oahu	1560	19°30′-21°30′N	55	4	3,600	2.1
Hawaii	10,040					
Tahiti	1040	17°40′S	53	3	66	5.7*
Rangiroa	49	15°S	16	1	79	1.4**
California (N. America)	4.12×10^5 (2.6×10^7)	35°30′-36°30′N	42(10)?	5	5,400	0.8
Hollins′ Is. (W. Samoa)	0.026	13°30′S	0	0	700	0.19**

* mostly inland

** all coastal; Rangiroa 320 km NE of Tahiti, Hollins' Is. 1 km off NW coast of Savaii.



	1	2	3
A	1/4"	1/4"	3/16"
B	3/8"	1/4"	3/16"
C	1/2"	3/8"	1/4"

FIGURE 1

(See captions, next page.)

②

③

Figure 1. (See p. 273). Above, large trap; below, small trap; below right, detail and dimensions of the three sizes of lucite corner pieces for the small traps. Dot-dash lines represent stranded stainless steel stays.

Figure 2. (above). Large trap in operation in a coconut plantation at Utumapu, *(Caption continued on next page.)*

between sizes of islands and their total insect population densities. A similar direct relationship, perhaps with a smaller slope, is to be expected, at least at the lower end of the size range of islands, if only for the geometrical reason that as the areas of islands increase the proportion of insect-inhospitable shore line to total area decreases. It is reasonable to expect the mean catch per m^2 hr of the traps used to be directly related to the population density of flying insects. The differences noted in mean catch per m^2 hr in Table 1 are in the opposite sense to those which might be anticipated on account of size of land area. The time spans of the catches were great enough that weather variations were unimportant, but climate, or latitude as determiner of climate, may account for part of the differences.

Again, data on relationships between latitude and insect population density are scarce and relate mostly to higher latitudes, but if the trend shown by these figures were extrapolated into the Canadian sub-arctic, one would expect to find it virtually insect-free. A further type of explanation suggests itself: the human population density, the degree of environmental alteration, and specifically the extent of insecticide use, especially of persistent compounds. The Hawaiian and Californian environments are in general much more altered than the Samoan; the immediate localities of traps were less different. Precise figures for insecticide use are not available, but the rank order in Table 1 is unequivocal and the spread is from zero to more than 120 lb active ingredient/mi^2/year.

An initial reaction from both economic and academic entomologists to the suggestion that these differences in populations could be attributable to insecticide use is one of incredulity that insecticides are that effective. Some simple calculations are illuminating: the amounts of DDT alone which have been used on the earth now add up to about 0.25 lb/acre of land or 2.4 lb/arable acre (Hocking, 1970). Mosquitoes can still be controlled in some areas with 0.03 lb/acre. Since insecticides are not used at all on a substantial part of the world's arable land, there must have now been, for many years, an average concentration of persistent toxic materials in land where they have been used, well above the level which many insect species can tolerate. Some species undoubtedly have been unable to develop resistance fast enough to survive. Of course since only perhaps one-fifth of the world's insect fauna has been described, many of these must be unknown and will now remain so. The populations of species in process of developing resistance must be lowered.

(Captions continued from p. 274.)

Western Samoa. Small trap at left margin.

Figure 3. (below). Small trap in operation at the edge of the forest near Utumapu, Western Samoa.

This is a factor which must be taken into account in quantitative ecological studies from now on. I do not think it can be discounted, as a contributing factor at least, in explanation of my figures.

Entomologists' inheritance

Between June 1968 when I left North America for this study and my return in August 1969 little information from the western world not directly related to this study reached me. Changes in matters of concern both to entomologists and to the general public were at once apparent on my return. Conspicuous among these changes were, firstly, a widespread concern over the deteriorating quality of our environment, previously expressed only by some academics and crackpots. This was much more striking than was the deterioration in the environment, which was nonetheless, apparent. Chlorinated hydrocarbons, and especially DDT, attracted a generous share of this concern. Second among these changes was the increased concern over human popula-growth; this must be regarded as a separate change since many people and groups are still concerned about one or the other problem only and if they do in fact recognize them as the same they do not express this recognition in their actions. Pollution control work appears, in fact, to serve as a displacement activity for population control.

As I have shown elsewhere (Hocking, 1965, 1968) history suggests a direct relationship between human population size and the severity of problems of applied entomology both in agriculture (1965:95) and in forestry as represented by reforestation, and also in medicine (1968:118). Applied entomology is largely a matter of insect population control, or should be so; the education of entomologists properly includes instruction in population dynamics. It might be expected that entomologists and especially economic entomologists would lead in awareness of the problems of human population, and be among the first to recognize the role played by insecticides in hastening the deterioration of the environment initiated by other more direct effects of growing human populations. Events have proved otherwise.

At a meeting of the Entomological Society of Alberta, held at Lethbridge in October 1969, the following motion was carried by a vote of 20 to 12:

> "Whereas the Entomological Society of Alberta recognizes its responsibility to man's welfare in protecting him and his crops from noxious or disease-carrying insects and Whereas production of food and fibre cannot be increased at a rate commensurate with human population growth, therefore Be it resolved that pesticide programs be carefully considered and that the long-term welfare of man, other species, and their environments be given over immediate economic gain and that the Governments of Alberta and Canada be urged to sponsor and support research on world population control."

Motions in a similar vein at the Chicago meetings of the Entomological Society of America in December 1969 were defeated by similar margins; but the support of such measures by the governing board of the American Institute of Biological Sciences and in August 1970 by the Entomological Society of Canada was almost unanimous. In no discussions did the conspicuous support for the motions come from primarily economic entomologists.* (See p. 278)

The short-sighted abuse of insecticides out of ignorance may be excused; part of the blame undoubtedly rests with commercial interests. Now that abuse has been so clearly established, however, surely entomologists of all kinds must forget their differences and cooperate in halting the damage as speedily as possible, in opposing insect slaughter for mere comfort or convenience, and in seeking more acceptable procedures for insect control, when this is essential. At the same time the common interests of both economic and academic entomologists are to be served by the reduction—not mere stabilization—of human populations and revision of so-called standards of human living. A revision which will put the quality of the environment first, and the quality and quantity of the consumables it is made to yield second. Entomologists as a whole then should support all procedures calculated to achieve these ends: the academics that they may have an abundance and diversity of insect species which rightly delight them and allow the illumination of so many basic problems in biology; the economic entomologists for divers reasons. For smaller populations will allow less intensive crop production, prerequisite to crop pest control, and will permit greater "nearest neighbour distance" among men, necessary to the control of vector borne diseases. And diversity of species is prerequisite to stability of species populations.

The image of entomology in the eyes of enlightened people has been tarnished somewhat by the events of the late sixties. When biologists of today and tomorrow are gathered together in discussion of tomorrow's problems, entomologists may well be reluctant to admit to their specialization; they are in the dog-house. Entomologists have been challenged and have not yet responded; they have all a responsibility to do so. This responsibility is also an opportunity, for no other large group of biologists is so well fitted by education, training, and experience, to speak and act on matters of population control. We must tackle this task that lies before the world; we must not wait for politicians to act, for monies to be allocated, for legislation to be passed. We must ourselves see that these things are done. Only thus can the reputation of entomology be redeemed and its future assured. We inherited a world fit for insects and entomologists, in reasonable numbers, to live in. What will our children and our students inherit? The answer lies more in our hands than in those of any other group.

Acknowledgement.–It is a pleasure to acknowledge the untiring assistance of my wife as field assistant and seamstress, financial assistance from the Defence Research Board (6801-39) and the National Research Council of Canada, and facilities provided by the Rhinoceros Beetle Project of the South Pacific Commission at Apia, the Institut de Recherche Médicale at Papeete, the Bishop Museum at Honolulu, and the Point Lobos State Park in California.

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3.0071. Insect flight and entomologists' inheritance. Abstract.–A study designed to test an hypothesis concerning insect flight behaviour in relation to land and sea breezes, mostly on oceanic islands, yielded a mass of data, mostly irrelevant to the hypothesis. The possible relevance of some of these data to problems of current concern to the general public and to entomologists is evident.–**Brian Hocking,** *Department of Entomology, University of Alberta, Edmonton 7, Canada.*

Descriptors: Insect flight behavior; modified Malaise trap; wind trap; insecticide misuse; population control.

**Note added in proof:* While a motion in this sense was carried by a substantial majority at the Miami meetings of the Entomological Society of America in December 1970, my point stands, namely: entomologists in general have not yet given the leadership the world has a right to expect from them in these matters.

[3.0078]

HARRY HOPKINS, MASTER SIPHONAPTERIST, AND HIS ASSOCIATES[1]

C. Andresen Hubbard[2]

Through the many years that I have known him he has always been Harry Hopkins to me but through these years his by-line has always been G. H. E. Hopkins. I never learned what the G. H. E. stood for and I am not sure that H stands for Harry. To me this dynamo of energy is just a disagreeable, but lovable cantancerous old Englishman.

During the 1960's while I was working the fleas of East Africa a new university was being established in Dar es Salaam. It was in need of teachers so I applied giving Harry as a reference. He wrote me back saying: "Why use me as a reference, all I know about you is that you are a good flea collector." And I thought, how true, how little we know about our specialist friends. That is why I am penning this paper on the world's foremost flea specialists.

Harry Hopkins is a typical Englishman. He was born on March 25, 1898 in the small town of Hanley, 60 miles southeast of Liverpool. His father was a curate in the Church of England there. Before Harry was a year old his father was assigned to Wigan, 20 miles northeast of Liverpool where he was Vicar of Servington. Harry grew up here. At 18 years he left school, joined the British Armed Forces of World War I and retired at the war's end with a commission. Harry entered Cambridge in 1920 and graduated with a degree in medical entomology in 1923 with specialization in the Mallaphaga. But it was only after another 20 years of study of these insects that he released his only, but massive, paper on them in "The host associations of the lice of mammals" (Hopkins, 1949). Soon after graduation, in October, Harry and Mrs. Hopkins were married and left England for Samoa in November where he became the assistant to Professor P. A. Buxton, the two working for the

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[1] Accepted for publication: November 9, 1970.

[2] 15115 S. W. 74th Avenue, Tigard, OR 97223.

London School of Tropical Medicine upon filariasis.

Four years later Harry was appointed Assistant Medical Entomologist in Kenya and in March of 1926 Harry with his wife sailed for Mombasa. After two years in Kenya Harry was transferred to Uganda as Senior Medical Entomologist and established himself in Kampala close to the north shore of Lake Victoria. Here he remained his entire 20 years of British Colonial Service. While here his work covered the entire field of economic entomology and his problems were in the tse-tse fly, the locust, the louse, the mosquito, and the flea. Harry retired in 1947 and after a few stops in Africa returned to England and visited with friends and relatives around Liverpool until he was called to Tring in January of 1948 to become author of the "Catalog."

Harry is best known in his work on fleas, first in East Africa, then upon world fleas as author of the "Catalog."

One morning during the end of September 1967 Harry came to the siphonapteran laboratory of the Tring Museum as he had for some years, opened his files for volume 5 of the "Catalog," worked his laboratory day, went home and never again returned. Two years previously Harry had spent his vacation in Holland, contracted virus pneumonia there and was never again in the health which had been his joy through all his years. His associates feel his ebbing strength deterred his further siphonapteran work.

Sometime ago Miriam Rothschild (Mrs. George Lane) wrote to me that she had called upon Harry at his home, visited with him in his garden, and when she left felt depressed for Harry had asked her to release him from further work on the "Catalog"; he wished to rest and garden. A little later in response to my yearly letter to this old friend I had a nice newsy letter but nowhere in it was there any reference to fleas. He commented on the interesting times we had had in my digging wild western bulbous plants and sending them to him for the exotic portion of his garden; the last time I worked in Tring, and, to remind me of home there, in a shaded nook were blooming Western Wake Robin Trilliums.

Until recently, Harry, like myself and many others of our age, pottered around in his garden. Harry has a lovely one at "Shire House", a beautiful two story all brick home on the north edge of Tring. To further complicate his declining years, Harry, during an evening of November 1969, tripped over a rug in his home, fell heavily to the floor and seriously shattered the bones of his pelvic region. At the moment, over a year later he still lies in the Alyesbury hospital eight miles north of his home.

As early as 1947 Harry had proved himself a crack siphonapterist in publishing in the Uganda Journal of Natural History "The fleas of East Africa." The 50 page paper was fully illustrated. It lays the foundation for all subsequent siphonapteran work in all Africa but especially in East Africa. However, in spite of plague in many sections of East Africa attention was not again directed towards these insects until I, with National Science Foundation and Fulbright grants, entered East Africa in 1962.

In the 1947 paper Harry published an extensive host index which almost amounted to a catalog of the mice of the area. During this study he felt that no adequate keys were available for the small rodents. In spare moments he worked on the writing of a satisfactory key for these mice, which, after all, carry most of the fleas of any country. As far as I know Harry never completed this paper but in 1962 he sent me a copy to help me with my host index of Tanzania fleas.

During the years of this study Harry found many discrepancies in the listings of type localities of various of the host animals. In 1946, with the help of R. W. Hayman, noted British mammologist, he issued "The type locations of some African mammals" (Hopkins, 1946), a paper listing the correct localities of the animals in his host indexes.

Harry always has been a stickler for taxonomic procedure and never hesitated to call my attention to my taxonomic shortcomings. I recall in 1962, when I first began describing East African fleas, to impress the East Africans, I named the fleas in Swahili, the official language of Tanzania. When the manuscripts were sent to Harry he quite emphatically said I could not Swahilize the names; they must be Latinized. Therefore, the largest flea in Africa became, at Harry's suggestion, *Dinopsyllus titan* rather than "*D. kubwa*." I had wanted to use "kubwa" which to any East African means giant, where "titan" would mean nothing at all. That has been Harry—a stickler on taxonomic procedure, and Harry has always been right.

Harry often has been accused of being a taxonomist, but he really was not, for Harry and I were more interested in the ecology of the flea, particularly the host-flea relationships; the effect of elevation upon these insects, and their relation to plague. In all the years that thousands of fleas passed under the microscope beneath his eye only once did he stop to describe a new flea. Why this one I will never know; instead of naming one of the beautiful African crested fleas that he came across, he described *Xenopsylla philoxera*, a nondescript flea from South Africa (Hopkins, 1949).

In 1932 Harry published on the fleas of rats in Kenya (Hopkins, 1932); 1935 on the bionomics of fleas in East Africa (Hopkins, 1935); 1938 on "Cotton and plague in Uganda" (Hopkins, 1938); 1941 "Methods of control of plague in Uganda" (Hopkins, 1941); 1947 on two giant fleas of East Africa (Hopkins, 1947); 1949 "Report on rats, fleas, and plague in Uganda" (Hopkins, 1949), and 1957 "Host specificity among parasites of vertebrates"

(Hopkins, 1957). Harry coauthored with the American Phillis Johnson (Hopkins and Johnson, 1959) to produce "Two names proposed by Baker for fleas of the genus *Foxella.*"

Harry always has been as generous with his time as with his genius and like Karl Jordan was never too busy to help one with one's siphonapteran problems. I recall that during 1962 after I had collected thousands of fleas in Tanzania 1,000 specimens of *Xenopsylla* (Hubbard, 1965) had been mounted. These small, mostly African fleas are difficult to identify and even specialists avoid them. The 1,000 were sent up to Harry and in spite of his work on volume 3 of the "Catalog" he had the identifications back to me within a month. I have never stopped wondering at his energy.

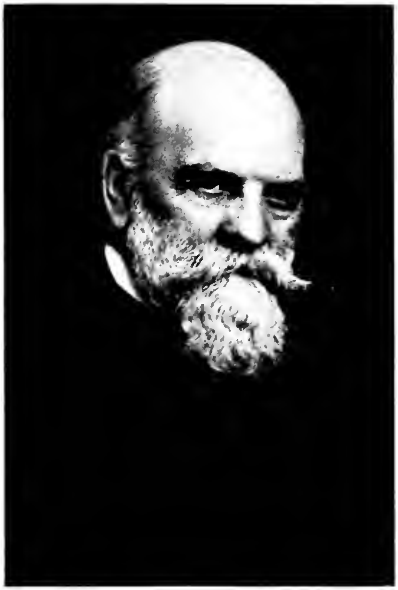
This generosity extended to South Africa for Dr. David Davis of the Medical Ecological Center of Johannesburg wrote to me that Harry, in 1947, finished his work in Uganda, traveled south and spent some days with the staff of the Center laying out the foundation and format for their book on fleas and plague in South Africa. Through the approximately fifteen years spent in the preparation of this thorough volume Harry regularly examined and corrected the manuscript and finally in 1962 after its publication reviewed the book for the Entomologist (Hopkins, 1962). I reviewed the volume the same year for the East African Medical Journal.

While Harry was busy with volumes 3 and 4 of the "Catalog" help was needed by the staff of the Bishop Museum in Honolulu on the fleas of the Islands and so in 1961 Harry published "Insects of Micronesia: the Siphonaptera" (Hopkins, 1961).

Harry has always been thoughtful of others. In 1952 while I was doing the fleas and plague in Iraq for Fulbright I expressed to Harry the desire to visit Tring, talk with the old master Dr. Jordan and possibly motor around the perimeter of the British Isles. Harry at once sent to me his copy of the B. A. A. Handbook with which to plan this trip. I did get to Tring in 1952 but not around the Island. Each year thereafter until 1963 when I did get around the Island Harry sent me his B. A. A. Handbook.

When I went to Tring in 1952 Harry met me at the Museum door, handed me a key, a scratch pad and a pencil and said: "Here is your key to the Museum. Dr. Jordan has not heard a thing for many years. Write him a little note on the pad and he will answer." In this way Harry Hopkins presented me to the grand old bewiskered man, the dean of flea students the world over, Dr. Karl Jordan. I felt humble in the presence of this great naturalist. I spent several days with the kindly old man. I never saw him again; Harry sent me in 1959 the black boardered message which read: "Dr. Karl Jordan, F. R. S. Born 7. XII. 1861. Died 12. I. 1959." In 1962 Harry sent me the little pearl

THE TRING SIPHONAPTERISTS



Karl Jordan
1861-1959

Harry Hopkins
1898-

Frans Smit
1920-

handled knife which Dr. Jordan had used for many years to sharpen the pencils he used to make the illustrations of world fleas.

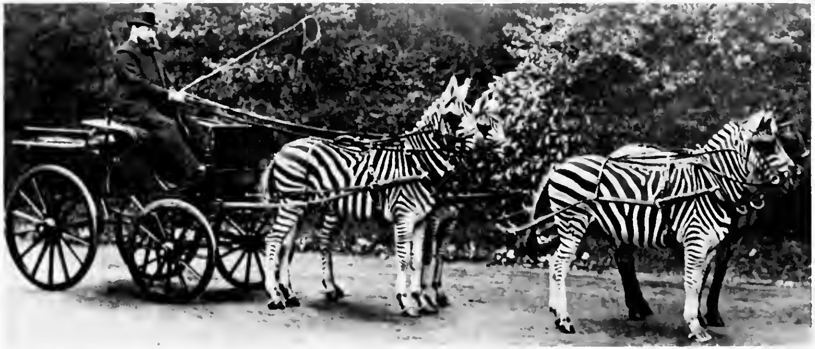
In the gardens at "Shire House" and, perhaps more often, in her house in London Miriam Rothschild often visited with Harry and talked over the problems of getting the "Catalog" on the press. Miriam is in privite life Mrs. George Lane of Oxford. She is the mother of six children who were all raised at Elsfield Manor. The maternal grandfather of these children and Mrs. Lane's father was the Honorable N. Charles Rothschild, senior partner of the great banking house in London and the man who for relaxation and as an avocation layed down the foundation of present day siphonaptery. N. Charles collected in Egypt in the early 1900's and the specimens other than fleas were added to his brother Walter's (Second Lord Rothschild, 1868-1937) Museum of Natural History at Tring, some 35 miles northwest of London. The museum, fully endowed, was given to the British Museum (Natural History) by Walter and now, although still a general natural history museum, houses the N. C. Rothschild collection of fleas, the greatest of its kind in the world. At its inception and for some years this collection was housed in the Rothschild family home in Peterborough but after the death of N. Charles in 1923 and in accordance with a deed of gift executed in 1913 the collection was moved to the Tring Museum.

Although I have corresponded with Miriam and her 20 year old youngest son for some years I know very little about the family. What I have gleaned is that Mrs. Lane was born in 1908 in Peterborough, England which is 80 miles due north of London and about 50 miles northeast of Tring. During vacations she visited her grandmother on the Rothschild estate in Tring and here lived in a large squarish brick mansion which was once the home of Nell Gwynne, built for her in the late 1600's by Charles II, King of England. The mansion has as its background the beautiful, woodsy, Tring Park located near the center of the small, quaint town of Tring. The Tring Museum is practically in the back yard of the mansion. As a child Miriam visited her grandmother and spent many hours there watching Karl Jordan, her father's most distinguished collaborator, work with a passion on the fleas of the world. It has been years since a Rothschild lived in Tring. The old mansion has long been a private school.

In a recent letter from Mrs. Lane she informs me that: "I never attended any school in my life; I was educated at home." Recently Oxford University awarded Mrs. Lane the Doctor of Science degree. She is a professor at the Royal Free Hospital in London and a Trustee of the British Museum (Natural History).

Many of us hoped that Mrs. Lane's young son Charles would become a

THE ENGLISH ROTHSCHILD NATURALISTS



Walter Rothschild with his team of zebras in Tring Park, 1890

Walter Rothschild
1868-1937

N. Charles Rothschild
1877-1923

Miriam Rothschild
1908-

siphonapterist and follow in the footsteps of his grandfather and mother to carry on the name of Rothschild through another generation of flea specialists but Mrs. Lane tells me her son wishes to become a research biochemist. Charles as a teen-ager published a few short papers on insects. At present he is a graduate student in zoology at Oxford University.

In the 15 years that the "Catalog" has been unfolding through volumes 1 to 5 it has become a notable monograph in the field of entomology. Mrs. Lane under her maiden name Miriam Rothschild has been the editor, co-author with Harry Hopkins, and the financial backer of the work; this will constitute a fine monument to her father, N. Charles.

Mrs. Lane has described only about a dozen species of animals new to science, in contrast to her uncle, Walter Rothschild, who described 4,000 and her father, N. Charles, about 500. She can, however, be called a siphonapterist in her own right since she made one outstanding discovery in this field, namely that the breeding cycle of the rabbit flea is geared to the breeding cycle of the host. After co-authoring "Fleas, flukes, and cuckoos" in 1952 Mrs. Lane published 150 short papers and in 1965 invaded the American journals with the publication of "Fleas" in the "Scientific American."

The "Catalog" has been a dream to Mrs. Lane for years. Here is the history of the dream. Many years ago, during 1893, Walter, N. Charles older brother, and Miriam's uncle realized his collections were getting ahead of him and he needed an assistant. In his search for the proper individual he chanced upon a young man in Westphalia, Germany, a beginning school teacher named Karl Jordan (Hubbard, 1947 and 1962). Jordan returned to Tring with Walter and soon became associated with N. Charles and his fleas. For the rest of Charles' life (he died in 1923 at the age of 46) the two were inseparable companions, researchers, and friends. Charles was 16 when Jordan came to Tring, Jordan about twice that age. Through the 30 years that these two men were so closely associated they frequently discussed the possible publication of a monograph on the fleas of the world based upon Charles' collection. Upon the death of Charles, Jordan became master of the Rothschild collection and nurtured it until he was 98 years old, during which year the grand, kindly old master quietly passed away to leave Harry Hopkins as head of world flea students.

Karl Jordan was not only a siphonapterist but a general naturalist. He wrote voluminously on subjects of nature. I had known Karl for many years, but only through correspondence except for our one meeting. A hundred letters must have passed between us. As busy as he was he was never too busy to help and to write to me about western fleas.

But the monograph which Karl and Charles visioned so long did not materialize; two world wars and the death of Charles hindered its inception. Eventually Miriam Rothschild decided to publish the "Catalog". In 1948 Miriam began searching for a young man to author the work. Harry Hopkins was approached and being retired from his African post accepted the authorship. Harry moved to Tring with his family, purchased "Shire House" and set up research quarters in the Tring Museum. During 1953 volume 1 of the "Catalog of the Rothschild collection of fleas" was released by the British Museum, a superb volume; it was the work of Karl Jordan, who layed the taxonomic foundation, Harry Hopkins, and Miriam Rothschild. The volume is dedicated to the grand old master Karl Jordan. Harry authored 4 of these massive, fully illustrated volumes and it was while he was half way through volume 5 that illness caused him to relinquish the remaining work.

Miriam Rothschild feeling in the 1940's that caring for the growing collection of fleas was no longer a one man job did as did her uncle Walter many years back, began looking for a young assistant. In Zutphen, Netherlands, she contacted a young man who was studying agricultural entomology at the Agricultural University of Wageningen. On the 3rd day of January, 1949, this young man, bearing as an impressive set of initials as that of Harry Hopkins, came to Tring. He was F. G. A. M. Smit, known to most of us only as Frans, although the F stands for Franciscanus, followed by Gerardus Albertus Maria. Frans was born in Zutphen, June 7, 1920. This was his home until he came to Tring. In October of 1949 Frans brough his new bride, Caroline van Heurn, to Tring and here through the years they have become the parents of four, three sons and finally the much looked for daughter. Today, at 50, Frans stands alone in the siphonapteran portals at Tring, and is the new author of the "Catalog."

I have known Frans for a long time and we have worked together on occasion. He has helped me through many a problem. I have watched his four children grow. Julius, his older son writes me on his 18th birthday: "Father is away at the moment in Czechoslavakia where he too is busy doing work on his fleas [horrid things]. I put horrid things in brackets because I have always hated the things. I am not at all interested in natural history because it just does not appeal to me." At 19 the young man informs me he will find his place in dramatics. And, so it seems, this is also the case with others: Dr. Jordan, who had no sons, and whose two daughters had no interest in fleas; Mrs. Lane whose last son wishes to become a biochemist; Harry Hopkins who so far as I know has no children and now Frans Smit whose children seem not interested in fleas, the top flea students of the century will pass on without leaving a member of their family to carry on in siphonaptery.

Frans has now been at Tring for 20 years. As is the lot of his countrymen, he is fair, slight and sensitive. He is one of the best flea illustrators in the world. His entire life rotates around the Rothschild collection of fleas. His home is a small brick house with a small yard next to the Museum at 4 Park Street; so he almost lives with the collection. The very many papers he has published are almost all taxonomic. He does little or no field work and it seems likely that to catch a mouse and remove its fleas would be a problem to him. With the death of Karl Jordan in 1959 and the illness of Harry Hopkins in 1966, Frans remains today, without doubt, the world's authority in taxonomic siphonaptery.

Acknowledgements.—This paper has been approved for publication by Miriam Rothschild and Mrs. Harry Hopkins. I am indebted to Dr. David Davis for Harry's bibliography. I am informed on December 15, 1970 by the recorder of Cambridge University that "Mr. George Henry Evans Hopkins who matriculated here in 1920 was admitted to the degree of Bachelor of Arts of this University in 1923 and the degree of Master of Arts in 1927."

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2.0078. Harry Hopkins, master siphonapterist, and his associates. Abstract.—The Rothschild collection at Tring Museum near London was the scene of great activity on the research on fleas, taxonomy, and biology. G. H. E. Hopkins was one of the principal taxonomists at the Museum, along with the great Karl Jordan who set the pace, W. and N. C. Rothschild, Miriam Rothschild, and lately, Frans Smit.— **C. Andresen Hubbard,** *15115 S. W. 74th Avenue, Tigard, OR 97223.*

Descriptors: Siphonaptera; fleas; history; Lord Rothschild; N. Charles Rothschild; Walter Rothschild; Miriam Rothschild; Karl Jordan; Harry Hopkins; Frans Smit; Tring Museum.

[3.0077]

AN OBSERVATION OF THE FEEDING BEHAVIOR OF A SAND-TREADER CRICKET
(Orthoptera; Gryllacrididae; Rhaphidophorinae)[1]

David C. Rentz[2]

Although seldom found in collections, the sand-treader crickets are common inhabitants of sand dune regions of the southwestern United States. Approximately six genera can be considered as sand-treaders contributing more than two dozen species, with at least an equal number yet to be described. These raphidophorine crickets burrow under the sand by day constructing simple tunnels which collapse soon after their builders leave them. Nearly all species are pallid yellow or white and emerge from their burrows to feed after dark. In late spring and early summer when weather conditions have been favorable, after sunset, the dunes may be literally covered with the insects.

In late March 1968 while collecting on the sand dunes near Dale Dry Lake, 25 miles south of 29 Palms, San Bernardino County, California, a large population of an undetermined species of giant sand-treader cricket, *Macrobaenetes* Tinkham, was encountered. Dozens of individuals were found, none mature, almost all in the penultimate instar stage. The ambient temperature was near 45°F but insect activity, among crawling forms, was surprisingly high. A continuous, high wind limited collecting activity but apparently had little effect on the routine of the crickets. A number of observations of the peculiar feeding of the crickets were made which is unreported in the literature.

Six crickets were found feeding; two were discovered eating dried lizard excrement; four were found eating the dried feces of a kangaroo rat (*Dipodomys* sp.). The adaptation of feeding upon such material under windy condi-

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[1] Accepted for publication: November 6, 1970.

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tions is of note. Upon detecting a suitable dropping, the cricket moved forward over it enclosing it in a "cage" formed by its own legs (Fig. 1). The winds were strong enough to buffet the food around within the small enclosure but at no time did a cricket lose his meal to the wind. When the cricket finished he merely lifted his head and one or more legs and the piece blew out from under him.

Coprophily has been reported among raphidophorinae crickets by Monti (1902) and Bailey (1928) but this was for either cellar-dwelling or cave-inhabiting species. Tinkham (1962) reported that *Macrobaenetes kelsoensis* feeds "seemingly on seeds of the dune grass . . . bits of organic matter such as dried leaves . . . dead insects." However, no specific observations were recorded. Gangwere (1962) classified the feculae of the camel crickets he studied to be of the non-elongate, non-granular type like those of most scavengers and predators.

It appears that *Macrobaenetes* species are true omnivores and opportunists. Any organic matter smaller than rodent and lizard droppings was readily blown away by the high winds on the dunes during my observation. It is an established part of the climatic pattern of the deserts of southern California that such winds occur in March, often for many days duration. If the insect occupants were restricted to a single type of food, such as leaf litter or small seeds, they might find existence difficult during periods of continual winds. The camel crickets have adapted to this situation.

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2.0077. An observation of the feeding behavior of a sand-treader cricket. (Orthoptera; Gryllacrididae; Rhaphidophorinae). Abstract.—The sand-treader genus *Macrobaenetes* occurs on the sand dunes of the deserts of the southwestern United States. It has been stated that species feed upon bits of leaf litter, seeds, and other organic matter encountered during its nocturnal wanderings. Six observations on a single evening in March 1968 in San Bernardino County, California indicate that an undetermined species of *Macrobaenetes* feeds on the fecal matter of lizards and kangaroo rats and uses its legs to form a cage enclosing the dropping and preventing it from being blown away.—**David C. Rentz,** *Academy of Natural Sciences of Philadelphia, 19th & Parkway, Philadelphia, PA 19103.*

Descriptors: Orthoptera; Gryllacrididae; Rhaphidophorinae; *Macrobaenetes* sp.;

coprophily; feeding behavior.

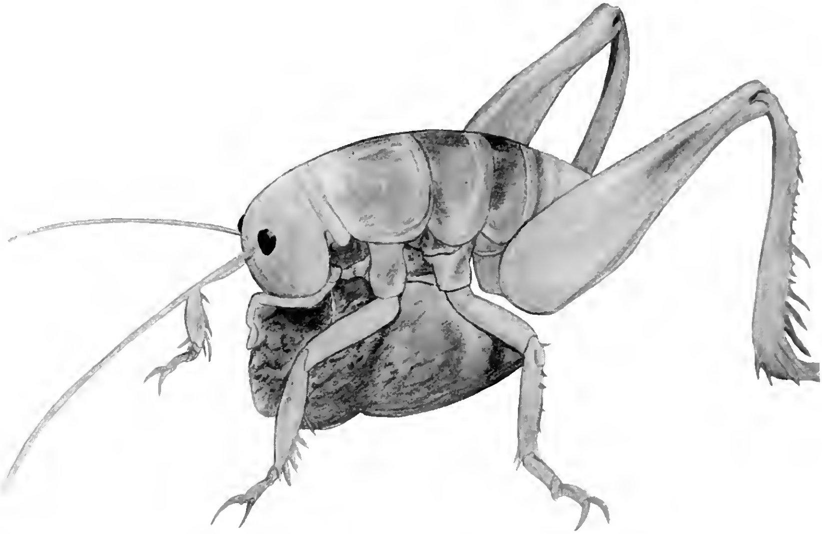

Figure 1. Sand-treader cricket (*Macrobaenetes* sp.) feeding on kangaroo rat dropping. Drawn from a photo by Patricia Schuyler.

The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

DR. GERHARD SCHERER, Museum G. Frey Entomologisches Institut, Hofrat Beisele Strasse 6, 8132 Tutzing bei Munchen, West Germany.–has accepted an invitation from South Dakota State University to fulfill a visiting professorship. (Sponsored by the National Science Foundation.) Dr. Scherer will be with the Entomology-Zoology Department, South Dakota State University, Brookings, SD 57006, from July 1, to December 31, 1971. He will divide his time between lecturing and research in entomology. Taxonomy and zoogeography of Coleoptera, particularly of Chrysomelidae; Alticinae, are his chief interests. Visitors desiring to meet and hear Dr. Scherer during his tour at South Dakota State University are welcome.–**Edward U. Balsbaugh, Jr.**

ANNOUNCEMENT.–The 1971 Summer Institute in Systematics, "Origin and measurement of diversity," is being organized by the Smithsonian Institution. The site is the National Museum of Natural History [United States] and the dates are June 20-July 9, 1971, inclusive.

Unlike previous Institutes, this one will be more subject-oriented, the speakers emphasizing two primary areas: (1) mechanisms by which organismal diversity is attained, and (2) assessment of diversity by a variety of techniques. Mornings will be devoted to these presentations and to discussions; afternoons will be left open to allow participants to use the National Collections for their individual research projects, which they are encouraged to discuss in special informal sessions.

The Institute is limited to 25 participants who will be given air fare and per diem while in Washington. About 10 of them will be doctoral candidates in their last year or two as students; the remaining 15 selections will be from among applicants who have received doctoral degrees within about the past three years.

Assuming that funding is forthcoming, applications may be obtained by sending name and address to: Dr. R. S. Cowan, [U.S.] National Museum of Natural History, Washington, DC 20560, U. S. A.

NOTICE.–The Institute for the Study of Natural Species has been dissolved. The publications have been turned over to the **Bio-Rand Foundation, Inc.,** *1330 Dillon Heights Avenue, Baltimore, MD 21228.* The insect collections have been deposited in the **Florida Collection of Arthropods,** *P. O. Box 1269, Gainesville, FL 32601.* The library and data files are housed at the **Tall Timbers Research Station,** *Tallahassee, FL 32303.* All borrowed specimens of the beetle family Oedemeridae are housed in a hurricane proof building also at the Tall Timbers Research Station.–**Ross H. Arnett, Jr.,** *Route 1, Box 161, Tallahassee, FL 32303.*

The Entomologist's Library

This section contains titles of books, monographs, and articles received by the editor that may be of special interest to entomologists and biologists. A brief statement of contents and items of interest are noted. Brief analytical reviews may be submitted for possible publication. All correspondence for this section should be addressed to Dr. Eugene J. Gerberg, Book Review Editor, 6603 Johnnycake Road, Baltimore, MD 21207.

Publications received.—As soon as a publication is received, it is listed in this section. The following have come to the attention of the editor for this month:

1. General

Evans, Mary Alice and **Howard Ensign Evans.** 1970. William Morton Wheeler, Biologist. Harvard Univ. Press, Cambridge. xii + 363 p. Cloth, $ 11.00.

Hogue, Charles L. and **Fred S. Truxal.** 1970. The insect realm. Los Angeles County Mus. Nat. Hist., Los Angeles. viii + 99 p. Paper, $ 2.00.

Sharp, David. 1970 (reprint). Insects. Dover Publ., New York. V. 1, xi + 584 p.; v. 2, xii + 626 p. Paper, $ 4.50 ea. vol.

6. Physiology

Mazokhin-Porshnyakov, G. A. 1969. Insect vision. Plenum Press, New York. xii + 306 p. Cloth, $ 27.50.

12. Medical entomology and parasitology

James, Maurice T. and **Robert F. Harwood.** 1970. Herm's Medical entomology, 6th ed. Macmillan, New York. 484 p. Cloth.

16. Regional lists

Kirk, Vernon M. 1970. A list of the beetles of South Carolina. Part 2—Mountain, Piedmont, and Southern Coastal Plain. Tech. Bull. 1038. South Carolina Agric. Exp. Stat., Clemson, South Carolina. 117 p.

The following parts of the catalog of Diptera south of the United States have been received. To date, of the 106 family fascicles, 52 have been issued, and of the 4 general fascicles, 1 has been issued.

Alexander, Charles P. and **Mabel M. Alexander.** 1970. Family Tipulidae. A catalogue of the Diptera of the Americas south of the United States. Part 4. Musee de Zoologie, Sao Paulo, Brazil. 259 p.

Martin, Charles H. and **Nelson Papavero.** 1970. Family Asilidae. *Loc. cit.* Part 35b. 139 p.

Robinson, Harold. 1970. Family Dolichopodidae. *Loc. cit.* Part 40. 91 p.

Steyskal, George C. 1970. Family Somatiidae. *Loc. cit.* Part 94. 2 p.

17. Identification aids

Acarina

Thewke, Siegfried E. and **Wilbur R. Enns.** 1970. The spider-mite complex (Acarina: Tetranychoidea) in Missouri. Univ. Missouri Mus. Cont., Mon. no. 1, Columbia, Mo. 106 p. Paper, $ 2.00.

Arachnida

Mascord, Ramon. 1970. Australian spiders in color. Charles E. Tuttle Co., Rutland, Vermont. 112 p. Cloth, $ 6.75.

Coleoptera

Gressitt, J. L., J. A. Rondon, and **S. von Breuning.** 1970. Cerambycid-beetles of Laos. Entomology Dept. B. P. Bishop Mus., Honolulu, Hawaii. vi + 651. Cloth, $ 17.50; Paper $ 16.00.

4. Natural History

Sauer, Jonathan D. 1967. Plants and man on the Seycheles Coast. Univ. Wisconsin Press, Madison. x + 132 p. Cloth, $ 5.00.

A fascinating book describing an historical account of the islands' coastal vegetation and the shaping of the plant distribution patterns by natural environment and human activities. The present distribution patterns are characterizedby photographs, transects, and maps of sample areas.

This book would be of interest to ecologists, botanists, biologists, and any one interested in the natural history of islands.–*Ed.*

6. Physiology

Engelmann, F. 1970. The physiology of insect reproduction. Pergamon Press, New York. x + 307 p. Cloth, $ 18.75.

This is volume 44 of the Zoology Division of the International Series of Monographs in Pure and Applied Biology and is the result of the author's interest in a comprehensive understanding of the basic phenomena governing reproductive processes in insects. This monograph covers nearly all aspects of insect reproduction with the exception of population ecology. Contents include chapters on genitalia, sex determination, parthenogensis, sex differentiation, gonadal development, mating, factors that affect egg productionand fecundity, hormonal control of egg maturation, endocrine influence on reproduction in the male insect, oviposition, heterogony, viviparity, functional hermaphoditism, and insect societies. A glossary and numerous references are provided. This book will be a useful reference for graduate students and researchers working on aspects of insect physiology.–**Frederick W. Kutz.**

7. Environment

Benson, G. K. and **J. G. Phillips.** 1970. Hormones and the environment. Cambridge University Press, New York. xvi + 629 p. Cloth, $ 22.50.

Only one article on insects, but other invertebrates are briefly discussed.–*Ed.*

UNESCO. 1970. Use and conservation of the biosphere. Proc. Intergovernmental Conf. of experts on the scientific basis for rational use and conservation of the resources of the biosphere. 1968. Paris. UNIPUB, Inc., P. O. Box 433, New York, NY 10016. 272 p. Paper, $ 6.00.

This is the tenth volume in the Natural Resources Research Series, organized by UNESCO with the assistance of the UN, FAO, and WHO. The biosphere was taken as that part of the world in which life can exist, including, therefore, certain parts of the lithosphere, hydrosphere, and atmosphere. The resources considered were biological ones. The discussions of the conference were based on reports presented by member states and 10 review papers. The conference adopted a series of recommendations to member states and international organizations relating to fields of research, education at all levels and scientific policy and structures.–*Ed.*

11. Ecology

UNESCO. 1970. Ecology of the subarctic regions. UNIPUB, Inc. 650 First Ave., New York, NY 10016. 364 p. Cloth, $ 19.00.

The present volume consists of papers presented at a symposium sponsored by UNESCO in Finland in 1966. The papers presented were divided into nine sections: subarctic definition; meteorology of subarctic regions; snow cover as an ecological factor; weathering and geomorphological processes; permafrost as an ecological factor; main features of soil-forming processes; ecology of subarctic vegetation; ecology of important species of the subarctic fauna; conservation of nature and rational use of renewable national resources of subarctic regions.–*Ed.*

12. Medical entomology and parasitology

Dunn, Angus M. 1969. Veterinary helminthology. Lea and Febiger, Philadelphia. xi + 302 p. Cloth, $ 17.00.

This book was written for the undergraduate veterinary student and for postgraduate students in other disciplines encountering veterinary helminthology for the first time. Discussions include descriptions of the more important parasites and their life cycles; a brief consideration of the host-parasite relationship, and the hosts themselves, ranging from small to large animals. The text is supplemented with 211 illustrations in 76 figures.

The usefulness of this book is seriously jeopardized by the presentation of some outdated information. In particular, the sections dealing with canine dirofilariasis (dog heartworm) are misleading. The author states that this parasite occurs over most of the world, but excludes arctic and northern temperate areas. In reality, *Dirofilaria immitis* has been known from Minnesota since 1956. Thus, the geographic distribution includes at least some northern temperate areas. The author continues by reporting that it is thought by some workers that the flea is probably the natural vector of *D. immitis.* This theory of flea transmission was refuted in 1956 upon the discovery that two species of filariid parasites occur in dogs in the United States. One (*D. immitis*) is known only to complete development in certain mosquitoes and the other (probably *Dipetalonema reconditum*) can complete development in several arthropods, including a few species of fleas. There are other misconceptions presented in this section, but the two above examples should substantiate the reviewer's comments.– **Frederick W. Kutz.**

13. Pest management

Wood, D. L., R. M. Silverstein, and **M. Nakajima** (eds.). 1970. Control of insect behavior by natural products. Academic Press, New York. lx + 345 p. Cloth, $ 11.00.

This book is based on one of the seminars on new biochemical approaches to pest control. There are chapters on pheromone research with stored-product Coleoptera, by W. E. Burkholder; some general considerations of insects' responses to the chemicals in food plants, by V. G. Dethier; pheromones of the honey bee, *Apis mellifer* L., by N. E. Gary; the substances that control the feeding behavior and the growth of the silkworm, *Bombyx mori* L., by Y. Hamamura; sensory responses of phytophagous Lepidoptera to chemical and tactile stimuli, by F. E. Hanson; aggregation of the German cockroach, *Blattella germanica* (L.), by S. Ishii, methodology for isolation, identification, and synthesis of sex pheromones in the Lepidoptera, by M. Jacobson; volatile organic sulfur compounds as insect attractants with special reference to host selection, by Y. Matsumoto; pheromones of social insects by J. C. Moser; insect antifeedants in plants, by K. Munakata; 1, 3-Diolein, a house fly attractant in the mushroom, *Amanita muscaria* (L.), by T. Muto and R. Sugawara; studies on sex pheromones of the stored grain moths, by M. Nakajima; insect attractants of vegetable origin with special reference to the rice stem borer and fruit-piercing moths, by T. Saito and K. Munakata; the chemistry of attractants for Chrysopidae from *Actinidia polygama* Miq., by T. Sakan, S. Isoe and S. Be Hyeon; sex pheromones of Lepidoptera, by H. H. Shorey; methodology for isolation and identification of insect pheromones–examples from Coleoptera, by R. M. Silverstein; pheromones of bark beetles, by D. L. Wood; electrophysiological investigation of insect olfaction, by M. Yamada; host attractants for the rice weevil and the cheese mite, by I. Yamamoto and R. Yamamoto.

In the past few years research aimed at establishing alternative means of pest controls have received increased attention. One of the most promising of these is the use of naturally occurring organic compounds that influence insect chemosensory behavior as attractants, repellents, sterilants, deterrants, and arrestants.

This book will be of interest to natural product chemists, biochemists, behaviorists, ecologists, and entomologists.–*Ed.*

18. Techniques

Philipson, J. (ed.). 1970. Methods of study in soil ecology. UNIPUB, Inc., New York. 303 p.

This UNESCO publication is based on the proceedings of a symposium organized jointly by Unesco and the International Biological Program (IBP). It was held in Paris, November 1967. The book is divided into eleven sections, each consisting of from one to seven papers by internationally recognized scientists. The papers are written in either French or English, with the summary in the other language. The 39 papers in this volume cover general problems in soil ecology, structural and functional aspects of soil ecosystems, soil respiration, and methods for the study of production by soil microorganisms, macrophytes, mesofauna, arthropods, nematodes, earthworms, and enchytraeids. The final paper is by Dr. J. van der Drift and deals with a look into the future in an attempt to point out those problems of soil ecology which require the most urgent attention.

At the end of a number of the papers a transcript of the discussion is included. These questions by participants in the conference, and the replies, convey the intense interest which must have been generated at the symposium. Figures and tables in the papers help to illustrate the main points made by each of the authors. The bibliography at the end of each paper will be most helpful to the neophyte in the field of soil ecology. This is an excellent volume for anyone interested in learning of the complex questions involved in soil research, answers to which must at least be estimated if we are to derive valid models of the soil ecosystem.–**John M. Ferris**, *Department of Entomology, Purdue University, Lafayette, IN 47907.*

examined, and long, detailed descriptions, discussions of nomenclatural problems will be recommended for **Data Documents for Systematic Entomology.** Instructions for this will be furnished on request (see Vol. 81, pp. 1-11 and recent issues). Short notes will be promptly published in **The Entomologist's Record.** Literature notices, short reviews, and books received will be published in **The Entomologist's Library.** Study notices, want items, and for sale notices are published in **The Entomologist's Market Place.** All manuscripts should follow the format recommended in the CBE "Style Manual".

MEMOIRS AMERICAN ENTOMOLOGICAL SOCIETY

No. 20.	*Howard E. Evans*–A Revision of the Mexican and Central American Spider Wasps of the Subfamily Pompilinae (Hymenoptera: Pompilidae). 433 pages, 11 plates, 80 maps.	$12.50
No. 21.	*Eric G. Mathews*–A Taxonomic and Zoogeographic Survey of the Scarabaeidae of the Antilles (Coleoptera: Scarabaeidae). 134 pages, 144 figures.	$4.00
No. 22.	*Richard M. Fox*–A Monograph of the Ithomiidae (Lepidoptera) Part III. The tribe Mechanitini Fox. 190 pages, 170 figures, 1 color plate.	$9.00
No. 23.	*Beatrice R. Vogel*–A list of New North American Spiders (1940-1966). 186 pages.	$9.00
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No. 25.	*Michael G. Emsley*–The Schizopteridae (Hemiptera: Heteroptera) with the description of new species from Trinidad. 154 pp.	$6.50
No. 26.	*James R. Zimmerman*–A taxonomic Revision of the Aquatic Beetle Genus *Laccophilus* (Dytiscidae) of North America, 275 pp.	$12.00
	Clarence E. Mickel–A Review of the Mutillid Genus *Chyphotes* Blake (Hymenoptera: Mutillidae, Apterogyninae). 110 pages, 10 plates, 26 maps.	$2.50
	Arthur M. Shapiro–Butterflies of the Delaware Valley. 63 pages, 11 plates, 10 habitat photographs.	$1.50

THE AMERICAN ENTOMOLOGICAL SOCIETY
1900 Race Street, Philadelphia, PA 19103, U.S.A.

The Entomologist's Market Place

Advertisements of goods or services for sale are accepted at $1.00 per line, payable in advance to the editor. Notices of wants and exchanges not exceeding three lines are free to subscribers. Positions open, and position wanted notices are included here and may be referred to by box numbers. All insertions are continued from month to month, the new ones are added at the end of the column, and, when necessary, the older ones at the top are discontinued.

Shield-backed katydids of the genus *Steiroxys* wanted for taxonomic study. D. C. Rentz, Department of Entomology, Academy of Natural Sciences of Philadelphia, 19th and the Parkway, Philadelphia, PA 19103.

For sale: Papers and reprints on entomology and arthropods (*no* Lepidoptera). List sent in return for stamped self-addressed envelope. Rossell Rahn, Sawyer, MI 49125.

Subantarctic entomology, *particularly of South Georgia and Heard Island, with biogeographical summary.* Ed. by J. L. Gressitt. Pacific Insects Monograph 23, 1970, 383 p, ill. incl. color pl. $ 9.50 hard binding; $ 8.50 wr., Bishop Museum Press, Box 6037, Honolulu, HI 96818.

Wanted to buy: Living cocoons of *H. cecropia, P. cynthia, A. polyphemus, H. columbia,* and other species. **Richard K. Zajdel,** *1709 Jamestown Place, Churchill, PA 15235.*

Wanted: Cleridae preserved in fluid (Formalin, Bouin's, etc.) for internal anatomy studies. Will trade, buy or any other arrangement. Especially interested in foreign material. **G. Ekis,** *Rutgers University, Entomology Department, New Brunswick, NJ 08903.*

Wanted: Customers; I am trying to liquidate large stock of Lepidoptera as well as my own collection. Discounts on all orders–write for list. Russell L. Dunn, Sedona, AZ 86336.

Wanted: Adult Cuterebridae (Diptera) for revision in progress. Prompt return or report. Curtis W. Sabrosky, Systematic Entomology Laboratory, USDA, c/o U. S. National Museum, Washington, DC 20560.

For sale: Coleoptera and Lepidoptera of the World. List available for 40 cents in international stamps. Write: Monsieur Richard Doisy, 9, rue des Bons Enfants, 89-Auxerre, France.

For sale: Complete set of "Pacific Insects", volumes 1-10, $ 66.00 plus shipping cost; complete set only. R. H. Arnett, Route 1, Box 161, Tallahassee, FL 32303.

For sale: Complete set of "Evolutlon", vols. 1-24, $ 400.00 plus shipping cost; complete set only. R. H. Arnett, Route 1, Box 161, Tallahassee, FL 32303.

"Beetles of the United States": I am revising this book; users please sent corrections and authors, please send reprints. I will exchange reprints of my papers and also papers on exotic Coleoptera. R. H. Arnett, Route 1, Box 161, Tallahassee, FL 32303.

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ENTOMOLOGICAL NEWS

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THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS

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ENTOMOLOGICAL NEWS is published monthly by The American Entomological Society at the Academy of Natural Sciences, 1900 Race Street, Philadelphia, PA 19103, U. S. A. Editorial Staff: H. W. Allen, S. S. Roback, and R. H. Arnett, Jr. (Editor); E. J. Gerberg (Editor, **The Entomologist's Library).**

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MANUSCRIPTS and all communications concerning same should be addressed to: **Dr. R. H. Arnett, Jr., Route 1, Box 161, Tallahassee, FL 32303.** The receipt of all papers will be acknowledged and, if accepted, they will be published as soon as possible, usually within three months. Articles longer than eight printed pages may be published in two or more installments, unless the author is willing to pay the cost of a sufficient number of additional pages in any one issue to enable such an article to appear without division. **BOOKS FOR REVIEW** should be sent to the review editor at: 6603 Johnnycake Road, Baltimore, MD 21207.

PAGE CHARGES are normally made only for over-length articles, or for articles published ahead of their regular place in the issues, and then only as additional pages for an issue. In cases where authors have received grant money for publication, or their institution normally pays publication costs, they will be billed at the rate of $ 18.75 per page.

ILLUSTRATIONS: Authors will be charged for text-figures and halftones at the following rate: Each line cut regardless of size, $ 1.50; each halftone regardless of size, $ 4.50. Size limit of illustrations, when printed, 4½ x 6½ inches.

SEPARATES printed without removal of extraneous matter, side-stitched, without covers will be supplied by the printer at 15 cents each for the first 100, and 25 cents each for each additional separate. Additional copies cost more because they are produced only by printing extra copies of the journal. Extraneous matter is confined to the back page if any is present. Usually articles are free of extraneous matter. **REPRINTS** are not available. However, each author will be provided with two clean separates of the article so that he may arrange for reprinting of the article by offset as he chooses.

EDITORIAL POLICY: Manuscripts on insect life and related terrestrial arthropods are appropriate for submission to ENTOMOLOGICAL NEWS. Titles should be carefully composed to reflect the true contents of the article, and be kept as brief as possible. A short informative abstract (not a descriptive abstract) of about 150 words should be supplied on a separate sheet, complete with title and ending with the authors name and address. In addition, the author should supply a list of descriptors, or key words at the end of the abstract. The author's complete mailing address, including zip code number, should be given as a footnote to the article. All papers describing new taxa should include enough information to make them useful to the non-specialist. Generally this requires a key and a short review or discussion of the group, plus reference to existing revisions or monographs. Illustrations are almost always required. Articles of an archival nature, including new taxa as separate descriptions for validation, new distribution records, or records of specimens

(Continued on back inside cover.)

SECOND-CLASS POSTAGE PAID AT TALLAHASSEE, FLORIDA

[3.0076]

SCORPION NOMENCLATURE AND MENSURATION[1]

Herbert L. Stahnke[2]

One of our serious academic problems is the increasing break-down in inter-disciplinary communication. As disciplinary splintering occurs the jargon increases and the house of academia is becoming more and more like the proverbial Tower of Babel.

Systematists of the order Scorpionida are not only guilty of this type of deviation but, with an increasing interest in the area, scorpiologists and para-scorpiologists are creating a Tower of Babel of their own. In order to co-ordinate scorpion nomenclature within the order and with that of other areas of arthropodology, the basic terminology of Snodgrass (1952) is recommended. Since this would not include all structures important in scorpion systematics other terms used currently are presented together with nomenclature for structures heretofore referred to in sometimes vague, generalized terms. The general structures are illustrated in Figures 1 and 2[3]. In order to assist the novice in interpreting some of the older, as well as some of the current literature, a comparative nomenclatural, columnar table is presented. English synonyms or other equivalents are indicated in parentheses in column two. Equivalents in French, German, and Spanish are given in columns 3-5 respectively. The French nomenclature is almost entirely that of Vachon (1952); the German, primarily after Kraepelin (1899) and Werner (1935); the Spanish after Hoffman (1931, 1932). The author gratefully acknowledges the assistance of M. deVerde in completing the Spanish equivalents.

Procedures in mensuration are given for two reasons. First, the large numbers of heavily sclerotized structures make possible the obtaining of

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[1] Accepted for publication: November 28, 1970.

[2] Poisonous Animals Research Laboratory, Arizona State University, Tempe, Arizona, 85281.

[3] All label numbers are in reference to those in the "code number" column of Table 1.

accurate quantitative data. Second, quantitative data can present a more precise concept of genetic relationships while pointing up sexual dimorphism and revealing allometric development. The latter type of information is extremely important.

The scorpion body divisions can be thought of in various ways (Figs. 1 and 2). The anterior broad portion, including the unsegmented carapace and the following seven segments, is referred to as the **trunk** and the following six segments as the **tail** or **cauda**. The trunk consists of the **cephalothorax** and the **preabdomen** while the cauda is composed of five **postabdominal** segments plus the sting bearing **telson**.

The cephalothorax is also called the **prosoma** while the rest of the body, i.e., the pre- and postabdomen plus the telson, is called the **opisthosoma**. This "hind portion" of the animal is further divided into the **mesosoma** (preabdomen) and the **metasoma** (postabdomen plus telson or cauda).

The **carapace**, an unsegmented sclerotized plate covering the cephalothorax, is a very revealing structure in systematics. Its general contour, the

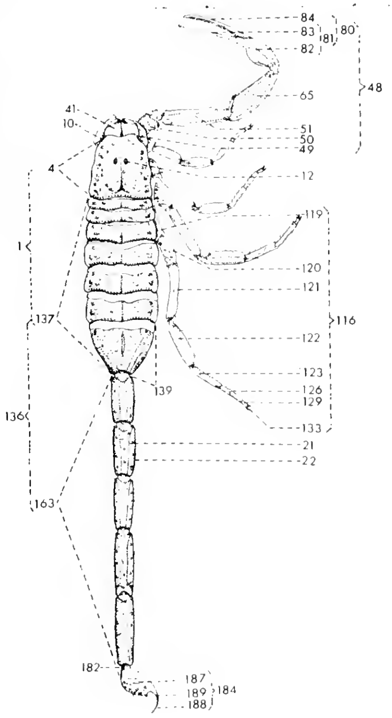

Figure 1. Dorsal aspect of generalized scorpion. (See Table 1 code numbers for label numbers.

surface features, as well as the size and spatial relationships of the median and lateral eyes are helpful. The nature of the anterior margin, whether it is concave, straight, or convex is significant. The ratio of the anterior width, to the median or posterior width can be important as well as the anterior-posterior divergence.

The following carapacial measurements are important since this structure is not generally subject to allometric development:

1. **Length** Distance between the anterior and posterior margins along the longitudinal axis. If either margin is lobed, the measurements are made from a line tangent to those lobes. All measurements are made with an ocular, metric reticle.
2. **Anterior width** The distance between the exterior margins of the first pair of lateral eyes (Fig. 3).
3. **Median width** Lateral margin to margin distance at level of anterior margin of median eyes.
4. **Posterior width** Greatest lateral margin to margin distance in posterior portion of carapace. In dried or poorly preserved specimens this measurement may not always be reliable due to a tendency of this carapacial curvature to change its arc.
5. **First lateral eyes to median eyes** Distance between adjacent margins of these eyes.
6. **Median eyes to anterior margin** Distance from anterior margin, as above described, to anterior margin of median eyes.
7. **Median eyes to posterior margin** Distance from *anterior* margin of median eyes to posterior carapacial margin, as described above.
8. **Width of median ocular tubercle** The distance between the exterior margins of the median eyes.

The anterior-posterior divergence is obtained by dividing the quantity, posterior width minus anterior width, by the carapacial length.

Surface features that are important, besides the size and density of the granules or tubercles or the possible reticular or/and punctate conditions, are the nature and presence of furrows and keels. These (furrows: Nos. 16-26; keels: Nos. 28-34) are illustrated in Figure 3.

The shape of the sternum (Figs. 2 and 4 A-D) plays an important role in distinguishing the higher categories but is of little value at the generic, or lower, level. Its contour is effected somewhat by allometric development. Such variation may prove a taxonomic pitfall.

The appendages of the prosoma consist of the chelicersa (kē-liś-er-a), pedipalps and walking legs. The first mentioned consists of a basal piece and a chela. The denticles on the superior and inferior margins of the fingers may be important; the former generally at the generic level and the inferior sometimes at both the generic and species levels. The setaceous condition is of little taxonomic value.

The pedipalps are an excellent source of taxonomic data, both subjective and quantitative. They consist of the following subdivisions: coxa, trochanter, femur, patella, and chela (pincer) which is composed of the tibia, made of the manus (hand) and its finger, and the tarsus (movable finger) (Figs. 1 and 2). Considering the chelae in their natural position it is generally possible to recognize on the manus a superior, inferior, and exterior surface (the "Hinterhand" of Kraepelin; "face ventrale" of Vachon) (Fig. 5, ExS). Various ridges (crests), or keels, may be present on these surfaces. On the superior face, generally the most prominent crest is the **digital** keel (90). This is often in the form of an elongated S and may be prolonged medially along the tibial finger and divide the superior surface into **interior** and **exterior** areas. Sometimes the digital keel is so strongly developed as to place these two areas at approximately right angles to each other. Inwardly the superior and inferior surfaces

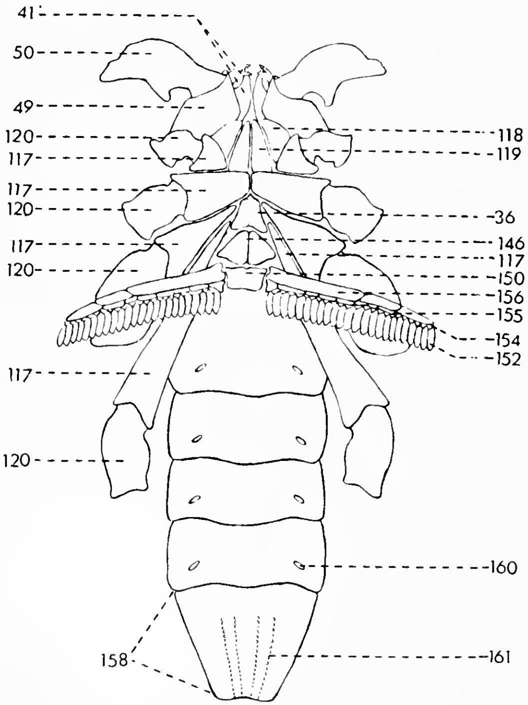

Figure 2. Ventral aspect of generalized scorpion.

are separated by the **interior marginal** keel (94). Along the other extreme margin of the superior surface is the **exterior marginal** keel (87) which in some taxa extends diagonally distad across the exterior surfaces (Ex S). Between the digital and the two marginal keels may be found additional, or secondary keels.

Moving inwardly from the digital keel may be the **sub-digital** keel (Fig. 5, 91), extending distally only part way along the manus surface. Next is the **inner secondary keel** (92) which is sometimes a prominent keel and may extend along the inner aspect of the tibial finger. Between this keel and the interior marginal keel may be a short **sub-inner secondary** keel (93).

Exteriorly from the **digital** keel is found first the **exterior secondary** keel (Fig. 5, 89). At times this ridge is sufficiently developed to cause the exterior area to be equivalent in height to the digital keel and produce a subcylindrical contour of the manus. The next keel, the **secondary accessory** (88), although generally vestigial, may extend over one-half the distal portion of the manus from the superior end of the tarso-tibial articulation.

There are fewer keels on the inferior surface. An **inferior digital** may be recognized as well as an **inferior exterior** keel (Fig. 5, 100) and an **inferior secondary** keel. These are not often of taxonomic value.

The keels and intercarinal spaces may have surface features of considerable taxonomic value. These will be discussed later.

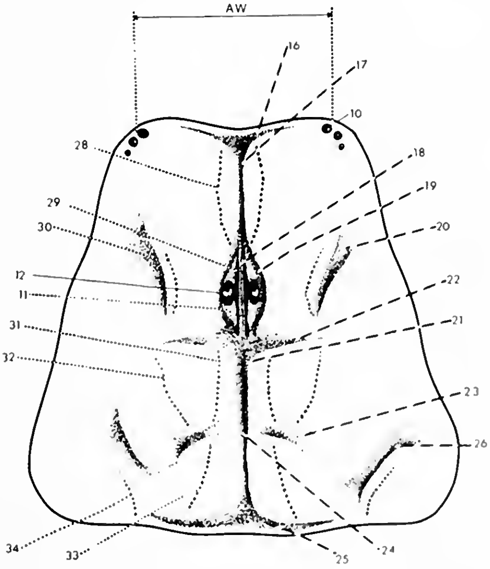

Figure 3. Generalized carapace. A. W.=Anterior Width.

The cutting edge of the tibial finger and tarsus may bear different shapes and patterns of granules, tubercles, denticles, and lobes. The accompanying figures illustrate two of the common patterns (Figs. 6 and 7).

The segment proximad from the tibia is the **patella**, forming the "bend" in the pedipalp. Of taxonomic importance are the state of development of its eight keels, the surface features of these keels, and the intercarinal areas.

Proximad from the patella and at about right angles to it on a resting scorpion, is the somewhat more elongate **femur.** The chela, patella, and femur simulate a U-formation. Like the patella, its keels (seven) and the formations on them

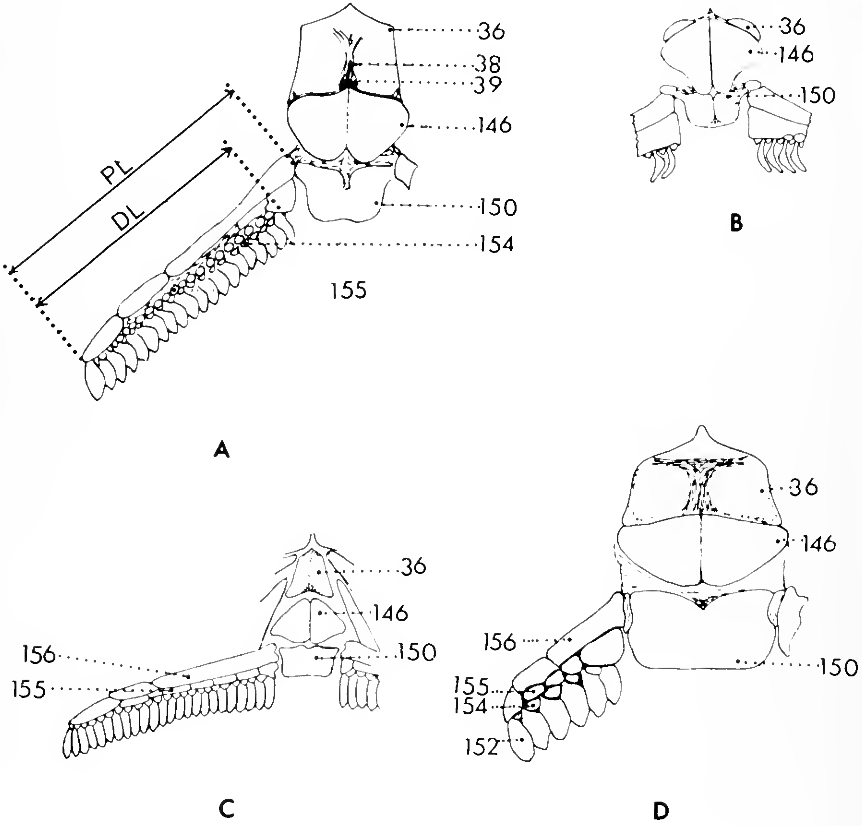

Figure 4. Sternum, genital operculum and pectines. A. *Vejovis spinigerus* (Wood), PL = Pecten Length; DL = Dentate margin Length. B. *Bothriurus* sp. C. *Centruroides sculpturatus* Ewing. D. *Superstitionia donensis* Stahnke.

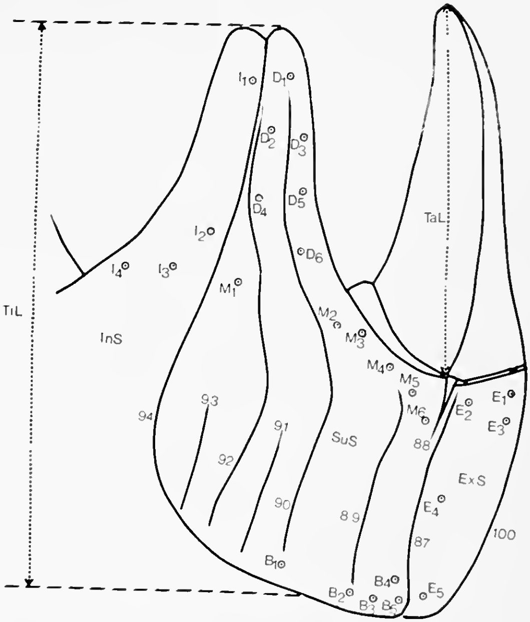

Figure 5. Generalized pedipalp chela. TaL=Tarsus Length; TiL=Tibia Length; InS=Inferior Surface; SuS=Superior Surface; ExS=Exterior Surface. I_1, etc.=Inferior, D_1, etc.=Digital, M_1, etc.=Manus, B_1, etc.=Basal, E_1 etc.=Exterior trichobothria. Code numbers=keels.

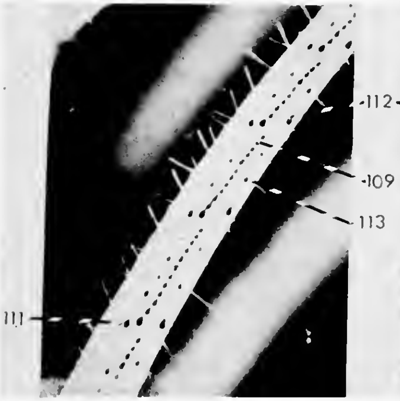

Figure 6. Centuroides sculpturatus Ewing pedipalp tarsus cutting edge. Supernumerary granules (113) include all those between the larger lateral granules.

Figure 7. Hadrurus hirsutus (Wood) pedipalp tarsus cutting edge.

and in the intercarinal spaces may be of taxonomic value.

The trochanter and coxa are of little taxonomic importance.

The dimensions of the pedipalp structures and how they are obtained are given below:

1. **Total length** The value used is the sum total of the respective lengths of the femur, patella, and tibia. The coxal and trochanter length are omitted because of their irregular form which would lend to errors and make measurement meaningless.
2. **Tibia length** Shortest distance from proximal margin at point of tibiopatellar articulation, approximately through trichobothrium B_1, to distal tip of finger. See Figure 5 (TiL).
3. **Manus length** From proximal margin at point of articulation (as in 2 above) to digital commissure.
4. **Manus width** Greatest interior to exterior marginal width.
5. **Manus thickness** Greatest distance between inferior and superior surfaces.
6. **Exterior surface length** From proximal margin of manus through trichobothrium E_5 to the line of tarso-tibial articulation.
7. **Tarsus length** The shortest distance from the most superior point of the tarso-tibial articulation to the most distal point of the tarsus. (See Fig. 5, TaL).
8. **Patella length** The length of the non-telescoping portion along the dorsal surface.
9. **Patella width** Greatest, basic width at mid-way between distal and proximal margins. This is not a very practical or precise measure because of unusual protuberances on the inner surface in some taxa.
10. **Femur length** The length of the non-telescoping portion along the dorsal surface.
11. **Femur width** Greatest width at distal one-third.

The walking legs consist of the coxa, trochanter, femur, patella, tibia, tarsus (consisting of tarsomere I and tarsomere II, the foot) and the pretarsus. This last segment is quite inconspicuous but bears two **lateral claws** and a **ventro-median claw**. (Fig. 8).

The legs occasionally are of taxonomic importance. For example, bristlecombs are generally found on the lateral aspect of the tarso-tibial leg segments of psammophilic species. The comparative lengths and widths of the tibia and tarsomere I of leg IV frequently are helpful taxonomic indicators; as is the total length of leg IV. This quantity would not include tarsomere II and the pre-tarsus. These structures frequently would be difficult to measure and their inclusion would not make the quantity more meaningful.

Some rather inconspicuous leg structures (Fig. 8) (tibial spur, pedal spur, bristles, etc. on tarsomere II and the pretarsus) have proven to be of considerable taxonomic significance. The **tibial spur** (124), found in the tibio-tarsal connective tissue, is present in some Buthidae but absent on others. The **pedal spurs** (127), located in the connective tissue between tarsomere I and II are present on all scorpions.[4] However, on some taxa there may be one present on both exterior and interior aspects while on others only an exterior spur is present. Again a spur may be forked or have 4 or 5 lateral subdivisions. The sole of tarsomere II may bear various projections. These may be small pads, long setae or stout spines. In the latter case there may be a double row with the number on the exterior and interior margins varying from each other but constant for a given taxa. In some taxa this number is constant on each pair of legs but may be variable from leg pair to leg pair. The **median lobe** of tarsomere II varies in length, shape and number, and position of terminal setae from taxon to taxon. The **lateral lobes** may be strongly convex, bearing spines on their margin, or almost straight. The **median claw** of the pretarsus may vary in length between taxa. This may be true also of the **lateral claws.**

The anterior portion of the opisthosoma, the **mesosoma**, consists of seven segments. Each one is covered dorsally by a sclerotized plate, a **tergite**, which has an anterior transverse raised portion, the **pretergite**. This is often hidden

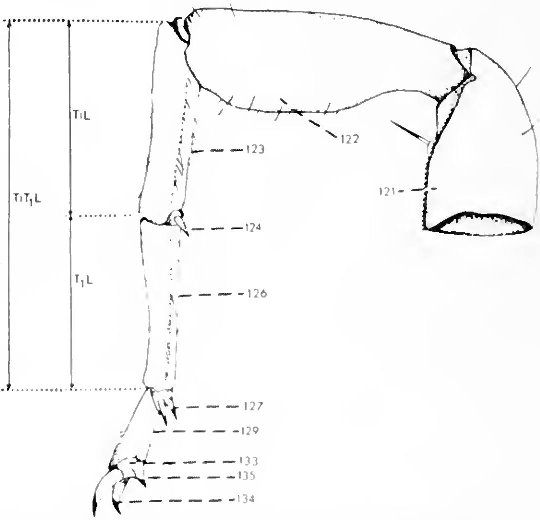

Figure 8. Generalized leg IV. TiT_1L=Tibia+tarsomere I length; T_1L=Tarsomere I length; TiL=Tibia Length.

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[4] Two species are now known to lack pedal spurs: *Oeclus purvesi* L. Becker, 1880 (Diplocentridae) and a new troglobite scorpion, *Typhlochactus rhodesi* Mitchell, 1968 (Chactidae).

by the over-lap of the anterior tergite in a poorly fed scorpion. The tergites become progressively longer from anterior to posterior. The first six frequently have very nearly the same surface features, i.e., similar granules, punctations, keels, etc. These tergites may bear from one to five keels. Tergite VII usually narrows abruptly posteriad so that its posterior width is about equal to that of the first caudal segment (Figs. 1 and 2). The surface features are usually markedly different from the first six. It is generally more coarsely granular and bears at least vestiges of three to five keels. Setae are generally few on all tergites and have little taxonomic value.

Only segments III-VII are completely covered ventrally by sclerotized plates, the **sternites** (Fig. 2). Segment I has a remnant in the form of two small sclerotized plates, the **genital opercula**. These are frequently united medially in the female and completely or partially separated in the male. They cover the genital aperture, the **gonotreme**, and on the male may partially or completely cover two genital papillae. These papillae vary in size on an inter-taxon basis and may be absent on some taxa. The sternite of segment II is represented by a small sclerotized plate, the **basal piece** (Fig. 2 and 4), which serves as a point of attachment and articulation of the pectens. It has some taxonomic value at the species level and may be helpful in sex determination.

The connective membranes between the genital area and the basal piece are referred to as the **post-genital** fold; that posterior to the basal piece as the **post-basal** fold. In some taxa the basal piece has a hinged accessory sclerotized posterior extension that folds inwardly on poorly fed scorpions. In satiated specimens this secondary portion is at the same level as the main body of the basal piece and gives a deceptive concept of its general configuration.

Sternites III to VI laterally bear a pair of respiratory apertures, the **stigmata** (Fig. 2). These may be circular, elliptical, or slit-like in shape; differences that are usually significant in the higher categories. These sternites seldom are granular, generally only sparsely hirsute and without keels. Sternite VII frequently is granular and may have two pair of lateral keels and a pattern of macrochaetes (Fig. 2).

The tergites and sternites laterally are bound together by the **plural** membranes. In lighter colored taxa these membranes may contain a black pigment which may be of specific significance.

The length of the mesosoma may be measured in two ways. Often this is simply an over-all measurement. As such, the quantity has small value because its magnitude will depend on the condition of nourishment. In an engorged specimen the intersegmental membranes are fully stretched so that the respective terga and sterna are separated from each other by a considerable distance. In a starved specimen, each tergite will over-lap the pretergite area of the one posterior to it. The only satisfactory method for determining the mesosoma length is to do so by taking the sum of the individual tergal lengths, measured along the median line and including only the sclerotized area; this will include the pretergite. The "over-all" length may be as much as 40% greater than the "sum total" length.

The pectens, whose tactile function is clearly established, show sexual dimorphism as well as inter-taxon variation. Considerable variation also occurs during maturation within a species in some taxa; especially in the males. Moving from the exterior to the interior margins the pecten consists of the following linearly arranged sclerotized structures (see Figs. 4 B-D and 9): Three marginal lamellae, median lamellae, sub-triangular fulcra and pectinal teeth. The median lamellae vary in shape and number in different taxa. In some cases they are numerous, small, vaulted, circular plates (Fig. 4B); in others they are few in number and of varying shapes (Fig. 4C). In a few taxa they are completely absent.

The fulcra are small subtriangular sclerites positioned between the base of the teeth. Each fulcrum may bear a cluster of macrochaetes, the number of which may have taxonomic value. However, caution must be exercised since the number varies with the age of the specimen.

The teeth vary in shape and number inter- and intra-sexually within the species. Inter-specific variation in shape and number also may be great. Some taxa have only three pectinal teeth while others have over forty. It is of interest to note that a reduction in number of teeth does not assure a subsequent reduction in over-all pectinal length. This is especially noticeable on females. Therefore, the ratio of pectinal length to dentate margin length is frequently valuable in determining sex differences as well as a part of the taxon characterization (Fig. 4B). On the ventro-anterior margin of each tooth are found numerous minute, stubby bristles, the **sensilla** (Fig. 9, 153). The number of these sensory setae is greater on males and shows inter-taxon variation.

Vachon (1952) calls our attention to the taxonomic importance of the dorsal side (nearest to the sternal surface, i.e., the side hidden from view) in some cases. The various sclerotized plates are not as sharply delimited. In some cases the fulcra are small circular, vaulted plates while in others they are pointed or bear either a macro- or microchaete. The teeth, likewise, sometimes bear setae of constant number. These dorsal structures, consequently, have taxonomic usefulness and because of their protected condition, are less likely to be destroyed through normal scorpion activities, handling or preservation.

The metasoma (or cauda) (Fig. 1) consists of five sclerotized rings, progressively increasing in length posteriad, plus the telson. Distinct tergites and sternites are not discernible. The cauda is of great systematic importance and possesses numerous structures providing variability. These consist of surface features, keels, and three-dimensional variations in size. A dorsal furrow, extending throughout the length of the postabdomen, varies in depth due to the degree of carinate development and shows sexual dimorphism.

The first four caudal segments may have the following five pairs of keels: Dorsals, superior laterals (Fig. 1, 21 and 22), median laterals, inferior laterals, and inferior medians. These show different degrees of development and ornamentation on the various segments. Some may be well developed but smooth, or bearing confluent granules, distinct tuberculate, truncated, spinous or serrate granules.

Caudal segment V is always the longest of the five; usually lacks the dorsal keels, the median laterals are often weakly developed and only one inferior median keel is present. This makes seven possible keels, instead of 10 as on segments I-IV. Generally the available keels bear well developed ornamentations which frequently have considerable taxonomic importance. The color and setaceous condition of this segment sometimes varies markedly from I-IV. At the ventro-distal end of segment V is found the anal arch. This often bears an anterior and posterior transverse crest (Fig. 10). The absence, presence and/or shape of the denticles on these crests, as well as the macrochaetes in the intercrestal area, are sometimes of taxonomic interest. Vachon (1952)

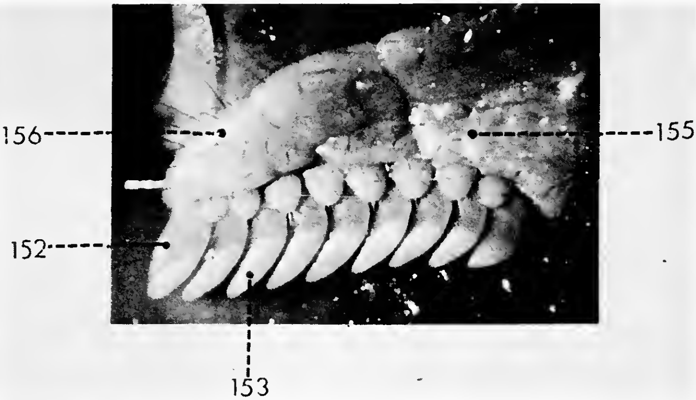

Figure 9. Scorpio maurus de Geer ventral surface right pecten. Light area (153) densely covered by sensilla.

Table 1. **Scorpion Nomenclature and Mensuration** *(Part 1)*

Code Nos.	Recommended Nomenclature	Equivalents		
		French	German	Spanish
1.	1. Trunk (cephalothorax + preabdomen or prosoma + mesosoma)	1. Trone	1. Truncus	1. Tronco
2.	II. Prosoma (cephalothorax)	2. Céphalothorax	2. Cephalothorax	2. Cefalotorax
3.	A. Dorsal	3. Face dorsal	3. Dorsal (Rucken-flache)	3. Dorsal
4.	1. Carapace (scutum)	4. Bouclier	4. Ruckenschield	4. Carapacho
5.	a. Configuration	5.	5.	5. Contorno del carapacho
6.	1) Anterior margin	6. Front	6.	6. Depresion anterior muesca media anterior
7.	2) Frontal lobes	7.	7. Stirnloben	7. Lobulos frontalea
8.	3) Anterior-posterior divergence	8.	8.	8. Divergencia antero-posterior
9.	b. Eyes	9.	9.	9. Ojos
10.	1) Lateral eyes (ocelli)	10. Yeux lateraux	10. Seitenaugen	10. Ojos laterales
11.	2) Ocular tubercle	11. Tubercule oculaire	11. Augenhugel	11. Tuberculo ocular
12.	a) Median eyes (central eyes)	12. Yeux medians	12. Mittelaugen	12. Oculi principales (ojos medios)
13.	b) Superciliary crests	13.	13. Superciliarwulst	13. Crestas superciliares
14.	3) Interocular triangle (frontal erea, anteocular triangle)	14.	14.	14. Triangulo interocular
15.	c. Furrows	15. Sillon	15. Furche (Rinne)	15. Surco (acanalado)
16.	1) Anterior marginal	16.	16.	16. Marginal anterior
17.	2) Anterior median	17.	17.	17. Medio anterior
18.	3) Medien oculer	18.	18.	18. Ocular medio
19.	4) Lateral ocular	19.	19.	19. Ocular lateral
20.	5) Central lateral	20.	20.	20. Lateral central
21.	6) Central median	21.	21.	21. Central medio
22.	7) Central transverse	22.	22.	22. Central transverso
23.	8) Posterior transverse	23.	23.	23. Posterior transverso
24.	9) Posterior median	24.	24.	24. Medio posterior
25.	10) Posterior marginal	25.	25.	25. Marginal posterior
26.	11) Posterior lateral	26.	26.	26. Lateral posterior
27.	d. Keels	27. Carenes	27. Kielen	27. Quillas, cristae
28.	1) Anterior median	28. Médiales oculaires	28. Vorderer medial	28. Media anterior (anteriores medias)
29.	2) Superciliary	29. Part of: médiales oculaires	29. Superciliarwulst	29. Superciliar
30.	3) Lateral oculer	30. Laterales oculaires	30. Vorderer lateral	30. Ocular lateral
31.	4) Central median	31. Médiales centrales	31. Mittlerer medial	31. Central media
32.	5) Central lateral	32. Láterales centrales	32. Mittlerer lateral	32. Central lateral
33.	6) Posterior median	33. Médiales postérieures	33. Hinterer medial	33. Posterior media
34.	7) Posterior lateral	34. Láterales postérieures	34. Hinterer lateral	34. Posterior lateral
35.	B. Ventral	35. Face ventrale	35. (Bauchseite) (Bauch-standig) ventral	35. Ventral
36.	1. Sternum	36. Sternum	36. Sternum	36. Esternón
37.	a. Shape	37. Forme	37. Gestalt	37. Configuración
38.	b. Median furrow	38. Sillon medians	38. Median-furche	38. Surco medio
39.	c. Basal pit	39.	39.	39. Foso anterior
40.	2. Appendages	40. Appendices	40. Anhange	40. Apéndices
41.	a. Chelicerae (Mandibulae)	41. Chéliceres	41. Mandibeln (Oberkiefer, Kiefernfubler)	41. Queliceros (cheliceres)
42.	1) Basal segment	42. Article de base	42. Basalglied	42. Segmento basilar (Basal)
43.	2) Chela	43. Pince	43. Mandibeln	43. Quela
44.	a) Manus (hand)	44. Main	44. Hand	44. Mano
45.	b) Fingers	45. Doigt	45. Mandibularfingers	45. Dedos
46.	(1) Fixed	46. Fixe	46. Unbeweglichen	46. Fijo (Dedoinmóvil o apófisis)
47.	(2) Movable	47. Mobile	47. Beweglichen	47. Movil (Segmento distal o dedomóvil)
48.	b. Pedipalps (palps, maxillary)	48. Pettes-mâchoires	48. Maxillarpalpen (Kiefern taster, Unterkiefer	48. Pedipalpos (Quelo, palpos, palpos maxilares)
49.	1) Coxa	49. Hanches	49. Coxen (Huften)	49. Coxa
50.	2) Trochanter	50. Trochanter	50. Trochanter	50. Trocanter
51.	3) Femur (humerus, forearm)	51. Avant bras (Prefemur)	51. Femur (Oberarm) (Humerus)	51. Femur
52.	a) Surfaces	52. Faces	52. Flachen	52.
53.	(1) Dorsal	53. Face dorsale	53. Oberflache	53.
54.	(2) Ventral	54. Face ventrale	54. Unterflache	54.

Table 1. Scorpion Nomenclature and Mensuration *(Part 2)*

Code Nos.	Recommended Nomenclature	Equivalents		
		French	German	Spanish
55.	(3) Interior	55. Face interne	55. Vorderflache	55.
56.	(4) Exterior	56. Face laterale	56. Hinterflache	56.
57.	b) Keels	57. Carenes	57. Kielen	57.
58.	(1) Dorso-interior	58. Dorsal interne	58. Vorderrandkiel	58.
59.	(2) Dorso-median	59.	59.	59.
60.	(3) Proximo-marginal	60. Pédiculaire	60.	60.
61.	(4) Dorso-exterior	61. Dorsale externe	61. Hinterrandkiel	61.
62.	(5) Exterio-median	62.	62.	62.
63.	(6) Ventro-exterior	63.	63.	63.
64.	(7) Ventro-interior	64. Ventrale interne	64.	64.
65.	4) Patella (brachium, tibia)	65. Bras (Femur) (Tibia)	65. Tibia (Unterarm)	65. Tibia (Patela
66.	a) Surfaces	66. Faces	66. Flachen	66.
67.	(1) Dorsal	67. Dorsale	67. Oberflache	67.
68.	(2) Ventral	68. Ventrale	68. Unterflache	68.
69.	(3) Interior	69. Interne	69. Vorderflache	69.
70.	(4) Exterior	70. Externe	70. Hinterflache	70.
71.	b) Keels	71. Carenes	71. Kielen	71. Quillas
72.	(1) Dorso-interior	72. Interne dorsale	72. Vorderrandkiel	72.
73.	(2) Dorsal	73. Dorsale	73.	73.
74.	(3) Dorso-median	74. Médian dorsale	74.	74.
75.	(4) Dorso-exterior	75. Laterále dorsale	75. Hinterrandkiel	75.
76.	(5) Exterior-median	76. Externe	76.	76.
77.	(6) Ventro-exterior	77. Laterále ventrale	77.	77.
78.	(7) Ventro-median	78. Médiane ventrale	78.	78.
79.	(8) Ventro-interior	79. Interne ventrale	79.	79.
80.	5) Chela (pincers)	80. Main (Tibio-tarsus)	80. Schere	80. Quela (Tenazas)
81.	a) Tibia	81. Tibio	81.	81. Tibia (Mano)
82.	(1) Manus (hand)	82. Main	82. Hand	82. Mano
83.	(2) Finger (fixed finger)	83. Doigt fixe	83. Unbeweglichen	83. Dedo inmovil
84.	b) Tarsus (movable finger)	84. Doigt mobile (post-tarse)	84. Beweglichen	84. Dedo móvil (Tarso)
85.	c) Superior surface	85. Face externe	85. Oberhand	85. Cara superior
86.	(1) Keels	86. Carénes	86. Kielen	86. Quillas
87.	(a) Exterior marginal	87. Ventral extreme	87. Aussenrandkiel	87. Arista exterior
88.	(b) Secondary accessory	88. Ventral accessoire	88.	88.
89.	(c) Exterior secondary	89. Médiane	89. Aussennebenkiel	89. Auxiliares superiores
90.	(d) Digital	90. Intermédiaire	90. Fingerkiel	90. Digital
91.	(e) Sub-digital	91.	91.	91.
92.	(f) Inner secondary	92. Dorsal accessoire	92. Innennebenkiel	92. Secundaria interna
93.	(g) Subinner secondary	93.	93.	93.
94.	(h) Interior marginal	94. Dorsal axiale	94. Innenrandkiel	94. Arista interior
95.	(2) Areas	95.	95. Flachen	95.
96.	(a) Inner	96.	96. Innenflache	96.
97.	(b) Exterior	97.	97. Aussenflàche	97.
98.	d) Inferior surface	98. Face interne	98. Unterflache	98. Cara inferior
99.	(1) Keels	99. Carénes	99. Kielen	99. Quillas
100.	(a) Exterior marginal	100. Ventral interne	100. Aussenrandkiel	100. Arista exterior
101.	(b) Exterior secondary	101. Médiane	101. Aussennebenkiel	101. Auxiliares superiores
102.	(c) Digital	102. Intermediaire	102. Fingerkiel	102. Digital
103.	(d) Inner secondary	103. Dorsal accessoire	103. Innennebenkiel	103. Secundaria interna
104.	e) Exterior surface	104. Face ventrale	104. Hinterhand	104. Cara exterior
105.	f) Cutting edges of fingers	105. Face interne	105. Schneide	105.
106.	(1) Median granules (median series)	106.	106.	106. Granulos medios
107.	(a) One long row	107.	107. Einfache reihe	107.
108.	(b) Series of rows	108.	108. Reihenfolge	108.
109.	(c) Non-imbricated oblique rows	109.	109. Non-dachziegelartig Schrágreigen	109.
110.	(d) Imbricated oblique rows	110.	110. (Uberreinander greifenden) Dachziegelartig Schrágreihen	110.

Table 1. Scorpion Nomenclature and Mensuration *(Part 3)*

Code Nos.	Recommended Nomenclature	Equivalents: French	Equivalents: German	Equivalents: Spanish
111.	(2) External lateral granules (outer series)	111.	111. Aussere Seitenkornchen	111. Granulos externos laterales
112.	(3) Internal lateral granules (inner series)	112.	112. Inner Seitenkornchen	112. Granulos laterales internos
113.	(4) Supernumerary granules	113.	113. Uberzahlige Kornchen	113. Granulos supernumera
114.	(5) Lobes	114. Lobes	114. Loben	114. Lobulos
115.	6) Trichobothria	115. Trichobothries	115. Trichobothrien (Horhaar)	115. Tricobotrias
116.	c. Walking legs	116. Pattes ambulatoires	116. Laufbeinen	116. Patas (Caminadoras)
117.	1) Coxa	117. Hanches	117. Coxen (Huften)	117.
118.	a) Coxal endite I (maxillary lobes I)	118. Processus maxillaires I	118. Maxillarfortsatz I	118. Lóbulos maxilares I
119.	b) Coxal endite II (maxillary lobes II)	119. Processus maxillaires II	119. Maxillarfortsatz II	119. Lóbulos maxilares II
120.	2) Trochanter	120. Trochanter	120. Trochanter	120. Trocanter
121.	3) Femur	121. Prefemur	121. Femur (Schenkel)	121. Fémur
122.	4) Patella (tibia)	122. Femur	122. Tibia (Schiene)	122. Tibia (Patella)
123.	5) Tibia (metatarsus)	123. Tibia	123. Tarsengliede I	123. Metatarsus
124.	a) Tibial spur	124. Eperon tibial	124. Tarsalsporn	124. Espolon (Calcar)
125.	6) Tarsus	125. (Tarse)	125. (Tarsenglieder)	125. Tarso
126.	a) Tarsomere I	126. Basitarse	126. Tarsengliede II	126. Pretarsus (Tarsómero I)
127.	(1) Pedal spurs	127. Eperon basitarsaux	127. Crunddorn	127. Espina tarsus
128.	(2) Bristle comb	128. Pecten	128.	128.
129.	b) Tarsomere II	129. Tarse	129. Tarsengliede III	129. (Tarsomero II)
130.	(1) Inferior spines or pads and/or bristles	130. Epines ou coussinets et/ou de soies	130. Unter dornen, wulste un/oder haar	130.
131.	(2) Median lobe (tarsal process, unguicular lobe)	131. Languette tarsale	131. Krallenlappen	131. Lobulo unguicular
132.	(3) Lateral lobes (terminal lobes)	132. Lobe tarsale	132. Endloben	132. Lobulos terminales laterales
133.	7) Pretarsus (epitarsus)	133. Post-tarse	133.	133. Pretarsus
134.	a) Lateral claws (ungues)	134. Griffes	134. Krallen (Endkrallen)	134. Unas
135.	b) Median claw (dactyl, unguicular spine)	135. Talon	135. Gehstachel	135. Espina unguicular
136.	III. Opisthosoma (abdomen + telson)	136. Opisthosoma	136. Opisthosoma	136. Opistosoma (Abdomen)
137.	A. Mesosoma (preabdomen)	137. Mesosoma (abdomen)	137. Mesosoma (Abdomen)	137. Mesosoma (Preabdomen)
138.	1. Dorsal	138. Face dorsale	138. Dorsal (Ruckenseite)	138. Dorsal
139.	a. Tergites (I-VII) (terga)	139. Tergite	139. Ruckenplatten	139. Tergitos
140.	1) Pretergites	140. Prétergite	140.	140.
141.	2) Keels	141. Carénes	141. Kielen	141. Quillas
142.	a) Median	142. Axiale	142. Medial kiele	142. Medias
143.	b) Median laterals	143. Laterale	143. Seitenkiele	143. Laterales
144.	c) Lateral	144. Laterale	144. Seitenkiele	144. Laterales
145.	2. Ventral	145. Face ventrale	145. Ventral (Bauchseite)	145. Ventral
146.	a. Genital operculum (I)	146. Opercules genitaux	146. Genital klappe	146. Opercula genital (I)
147.	1) Gonotreme (genital aperture)	147. Ouverture genitale	147.	147. Gonotrema
148.	2) Genital papillae	148. Crochets copulateurs	148.	148. Papilas genitales
149.	b. Post-genital fold	149.	149.	149.
150.	c. Basal piece (II)	150. Plaque pectinifere	150. Kammgrundstuck	150. Lamina Basilar (II)
151.	1) Pectens (pectines; <u>Sing.</u> pecten)	151. Peignes	151. Kamme	151. Peines
152.	a) Teeth	152. Dents (lamelles)	152. Kammzahne	152. Dentes
153.	(1) Sensilla	153.	153. Sinnesborsten	153.
154.	b) Fulcra	154. Fulcres	154. Fulcra	154. Fulcros
155.	c) Middle lamellae	155. Piéces médianes	155. Mittllamellen	155. Laminas medias
156.	d) Marginal lamellae	156. Pieces dorsales	156. Randlamellen	156. Laminas marginale

Table 1. Scorpion Nomenclature and Mensuration *(Part 4)*

Code Nos.	Recommended Nomenclature	Equivalents		
		French	German	Spanish
157.	d. Post-basal fold	157.	157.	157.
158.	e. Sternites (III-VII)	158. Sternite	158. Bauchenplatten	158. Esternitos (III-VII)
159.	1) Pre-sternite	159. Presternite	159.	159.
160.	2) Stigmata (spiracles)	160. Stigmate	160. Stigmen	160. Estigmas (Espiraculos)
161.	3) Keels (VII)	161. Carénes	161. Kielen	161. Quillas (VII)
162.	3. Pleural membranes	162. Pleurum abdominal	162.	162.
163.	B. Metasoma (cauda, tail, postabdomen + telson)	163. Metasoma (queue)	163. Cauda (Postabdomen)	163. Metasoma (Cola a postabdomen)
164.	1. Postabdomen	164. Postabdomen	164. Postabdomen	164. Postabdomen
165.	a. Segments I-IV (XV-XIX)	165. Anneaux I-IV	165. Ringen I-IV	165. Segments I-IV
166.	1) Dorsal furrow	166. Gouttière (Concavite dorsale)	166. Dorsalrinne	166. Surco dorsal
167.	2) Keels	167. Carénes	167. Kielen	167. Quillas
168.	a) Dorsals	168. Dorsales	168. Dorsalkiele	168. Dorsal
169.	b) Superior laterals	169. Latérale-dorsale	169. Oberer lateralkiele	169. Laterales superiores
170.	c) Median laterals	170. Intermédiaire	170. Nebenkiele	170. Laterales medias
171.	d) Inferior laterals	171. Latérale-ventrale	171. Untere lateralkiele	171. Lateral inferiores
172.	e) Inferior medians	172. Ventrale	172. Unteren medialkiele	172. Medias inferiores
173.	b. Segment V	173. Anneau V	173. Ringe V	173. Segmento V
174.	1) Keels	174. Carénes	174.	174.
175.	a) Superior laterals	175. Laterale-dorsale	175. Oberer lateralkiele	175. Laterales superiores
176.	b) Inferior laterals	176. Laterale-ventrale	176. Untere lateralkiele	176. Lateral inferiores
177.	c) Inferior median	177. Axiale	177. Unteren medialkiele	177. Media inferiore
178.	2) Anal arch	178. Cadre anal	178.	178. Arco anal
179.	a) Anterior crest	179.	179.	179. Cresta anterior
180.	b) Posterior crest	180.	180.	180. Cresta posterior
181.	c) Intercrestal area	181.	181.	181. Area intercrestal
182.	3) Anal papilla	182. Papilles anales	182.	182.
183.	c. Intercarinal areas	183.	183.	183. Espacio intercarenaus
184.	2. Telson	184. Telson	184.	184. Telson
185.	a. Peduncle (pedicle)	185. Pedicule	185.	185. Pedunculo
186.	b. Pedicular plate	186. Plaque pediculaire	186.	186. Opercule anal
187.	c. Vesicle (ampulla)	187. Vésicule	187. Blase	187. Vesicula
188.	d. Aculeus (sting)	188. Aiguillon	188. Stachel	188. Aguijón
189.	e. Subaculear tubercle or tooth	189. Dent sous l'aiquillon	189. Stachel Dorn oder Hocker	189. Diente subaculear
190.	C. Miscellany	190. Miscellanées	190. Miszellaneen	190. Miscelanea
191.	1. Surface features	191. Traits de surface	191. Aussenseite Kennzeichen (Skulptur des chitinpanzers)	191. Facciones superficie
192.	a. Smooth	192. Lisse	192. Glatt	192. Lisa
193.	b. Punctate	193. Pointillé	193. Punktiert	193. Puntuado
194.	c. Immovable projections	194. Projection fixe	194. Umbeweglichen ausbildungen	194. Proyecciones inmoviles
195.	1) Granules	195. Granules	195. Kornchen	195. Gránulos
196.	2) Tubercles	196. Tubercules	196. Hocker	196. Tubérculos
197.	3) Spines	197. Epines	197. Dornen	197. Espinas
198.	4) Denticles	198. Denticules	198. Zahnchen	198. Denticulos
199.	d. Movable projections	199. Projection mobile	199. Beweglichen ausbildungen	199. Proyecciones móviles
200.	1) Setae	200. Soies	200. Borsten	200. Sedas
201.	a) Macrochaetes	201. Macrochete	201. Makroborsten	201. Macrosedas
202.	b) Microchaetes	202. Microchète	202. Mikroborsten	202. Microsedas
203.(115)	c) Trichobothria	203. Trichobothria	203. Trichobothrien (Horhaar)	203. Tricobotrias
204.	e. Reticulations	204. Reticulums	204. Netzwerken	204. Reticulaciones
205.	1) Costate	205. Côte (caréne)	205. Gerippt	205. Costifero
206.	2) Pigmented	206. Pigmenté	206. Pigmenthaltig	206. Pigmentada
207.	3) Punctate	207. Pointillé	207. Punktiert	207. Puntuado
208.	f. Color	208. Colour	208. Farbe	208. Color

classifies the anal arch into three forms: Circular lobed, circular regular and angular. In some taxa, the inferior median keel does not extend to the anal arch. Instead it may fork, or a crescentic arrangement of denticles may be present. This crescent and the enclosed area varies at both the generic and species level in some families.

The intercarinal areas of all segments may bear important surface features, such as, size and density of granules, presence of costate or pigment reticulations and setaceous patterns.

The telson is quite variable in the three dimensions of the vesicle, the surface features and the length, taper, and curvature of the aculeus, as well as the absence or presence of a subaculear tooth or tubercle (Fig. 10).

The length of the cauda is reported in various ways. This may consist of the over-all length of the abdominal segments only or including the telson. This is not a valid measurement because this over-all length is dependent on the degree of relaxation of the intersegmental tissue. The most accurately reproducible and valid method is to take the sum total of the non-telescoping portion of each segment plus the length of the telson. This latter measure-

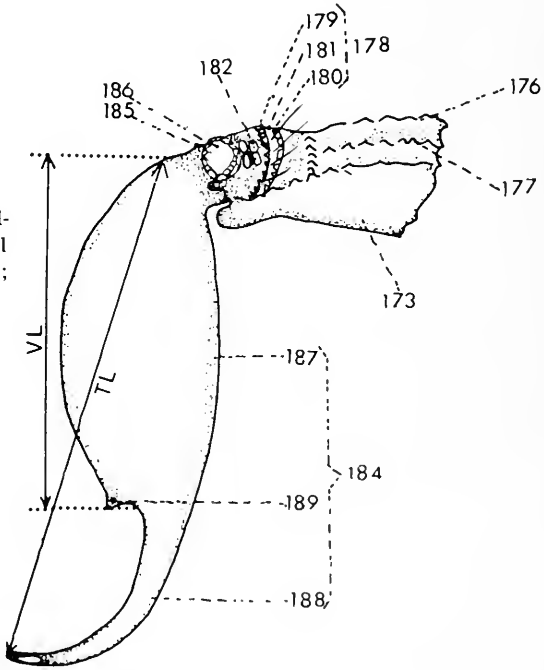

Figure 10. Generalized telson and distal end of caudal segment V. TL=Telson Length; VL=Vesicle Length.

ment is the shortest distance between the "heel" of the vesicle and the tip of the aculeus (Fig. 10). Height and width measurements of the segments consist of the largest distance between margins of the segment proper. Thus the measurements would not extend to the extremities of any large abrupt, protuberances but rather near their base. Measurements of this type obviously cannot be precise.

In the description of taxon surface features the terminology used is often inaccurate and/or too general. An example is the term rugose, which literally means wrinkled. Some authors have used it to mean any rough, coarse surface. Frequently, the surface was costate reticulate or coarsely tuberculate or punctate. Kraepelin occasionally resorted to picturesque terminology which left the novice in a quandry. For example, he describes the middle lamellae of some pectens as resembling a string of pearls (*perlschnurartig*). Precisely he meant a series of vaulted sclerotized circular plates. Expressions of color are misleading. For example, the term melanic. The biochemist tells us that melanins are a series of pigments ranging from brown through black. Thus the term melanic is not adequately precise. Other undesirable color expressions are: ochroid, caledonian brown, flesh, tanbark, geranium, etc.

The nomenclature here introduced for surface features (191-208) are in sufficient use to give them a relatively precise meaning. It is true that in some cases, as in granules and tubercles, we have a matter of subjectiveness. Also, "granule" has a generic connotation including tubercles. However, the general context and adjectives, such as minute, fine, and coarse, provide clarification. There should be no difficulty with the use of granule versus denticle. More care should be exercised in describing the immovable projections on the cutting edges of the pedipalp chela. Here one finds rows of granules or tubercles as well as an accompanying denticulate condition (Figs. 6 and 7). The same situation may be found on the keels of both pedipalp and caudal segments. These may have generic or specific significance.

The only movable projections of great taxonomic value are the trichobothria (Fig. 5). These are found only on the femur, patella and tibia of the pedipalps. Their number and patterns are relatively constant and the distances between them can be measured very precisely. They are valuable even in old, poorly preserved specimens since even though the bristle is lost, the cup-like aroela from which it arises is readily recognized. Macrochaetes, the large non-sensory setae, also leave a somewhat cup-shaped areola but the bristle base completely fills the inner space while that of the trichobothria does not. Also, the lip of the trichobothrial areola is generally whitish.

The trichobothria intact are readily recognized from other setae. The bristle is very long and thin, reacts to the slightest movement of air and is not readily broken off. The shaft of the ordinary setae is much thicker at the base, generally shorter, stiff and fragile. Only under special circumstances do they have taxonomic value and less so on old, poorly preserved material.

The macrochaetes are heavy bodied, stiff, colored; they arise from a relatively areolar cup which is completely filled by the vase of the bristle. Microchaetes are whitish, small, fine bristles with a base attached to a poorly developed areolar cup.

Reticular patterns are often encountered, either due to pigment, punctations or a costate condition. In some taxa the pigment reticulum of the juvenile forms is gradually replaced by the costate condition as a consequence of maturation. Frequently the costate condition is part of the pattern of sexual dimorphism.

Color is often a deceiving taxonomic trait. The pattern and shade of color may vary with maturation and hybridization. Consequently, its importance should be viewed with caution. However, when color of a taxon or specimen is described, simplicity of expression is most effective. Use of the primary colors in a variable manner is most likely to convey as precise a concept as is necessary. Vachon has set an excellent example in this respect. Color codes, because of the variety of surface conditions and the consequent light reflectivity are not very satisfactory.

The list-outline of nomenclature provided in Table 1, besides improving communication, will serve also as a valuable check-list when describing a new taxon or making a comparative study of several taxa. This will permit the specialist to be more selective in choosing descriptive data and prevent long, redundant descriptions. The quantitative data made possible from the above suggestions can also supply excellent data for population studies and move away more rapidly from the old typological species concept.

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3.0076. Scorpion nomenclature and mensuration. Abstract.—The check-list, illustrations, and descriptions of the anatomy of scorpions make possible accurate measurements, descriptions of taxa, and uniformity of scorpion nomenclature.—**Herbert L. Stahnke,** *Poisonous Animals Research Laboratory, Arizona State University, Tempe, AZ 85281.*

Descriptors: Scorpion; Scorpionida; anatomical terminology; mensuration.

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