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Three New Species of *Vejovis* from Death Valley, California

(Scorpionida: Vejovidae)

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During April of 1968 a one-week survey of the scorpion fauna of Death Valley was made. Samples were taken along the entire length of this desert region in as many different ecological situations as was possible within the available time. Study of the several hundred scorpion specimens in our samples indicated that Death Valley has a diverse scorpion fauna. Three distinct and undescribed species belonging to the genus *Vejovis* were found and are here described.

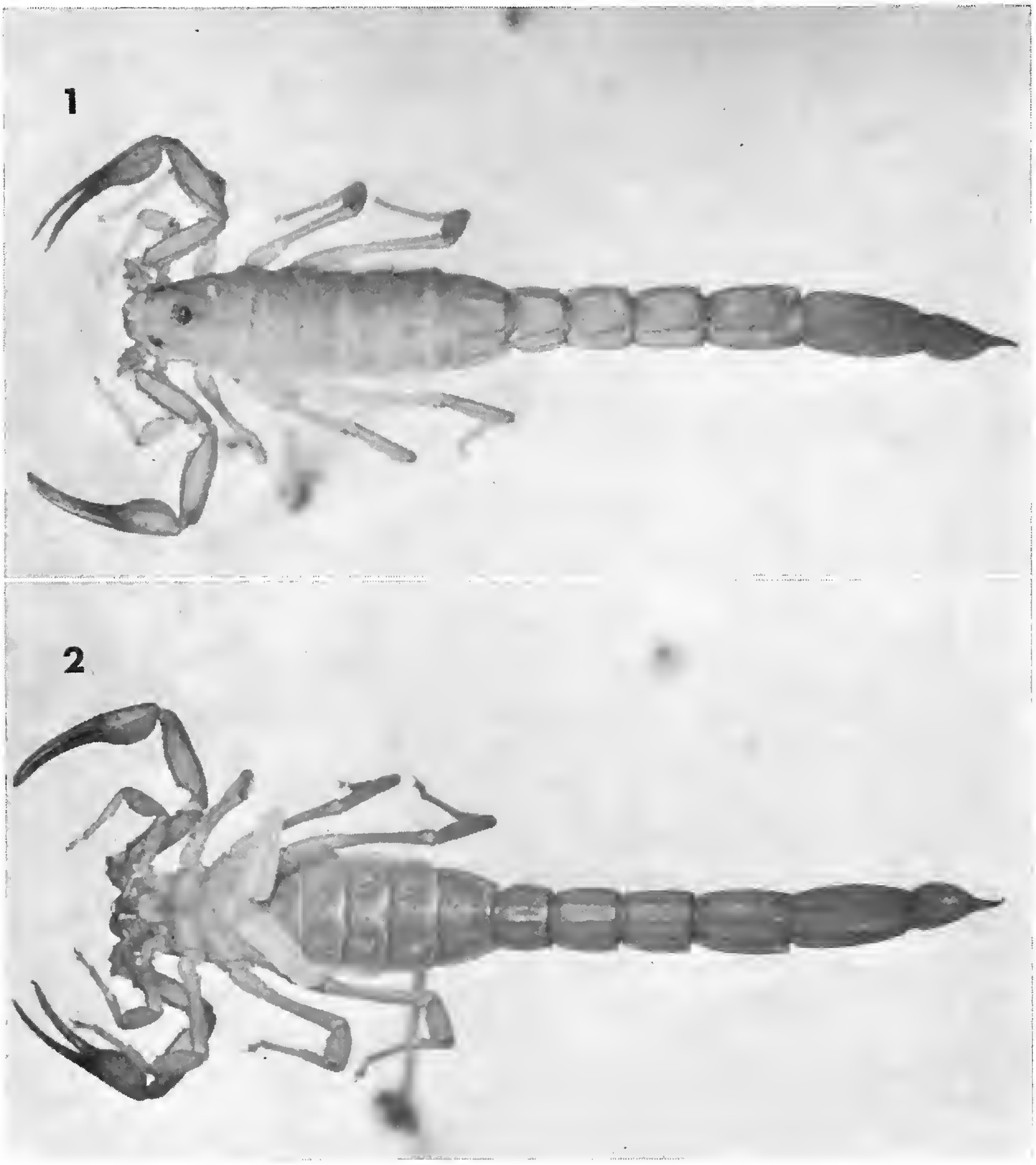
Vejovis gramenestris Williams, new species

(Figs. 1, 2)

DIAGNOSIS.—Moderate to small sized species of *Vejovis*. Total body length probably seldom exceeds 35 millimeters. Coloration light brownish-yellow over most of body. Pedipalps long and slender, fixed finger longer than palm; carapace longer than palm; keels developed on palm, medial ones being granular; large elongate terminal tooth on distal end of fingers. First metasomal segment broader than long; second metasomal segment as long as wide; fifth segment longer than either carapace or fixed finger. Pectines with proximal tooth elongate on female; 16 to 17 teeth in males, 12 to 14 teeth in females. Inferior border of movable cheliceral finger lacking denticles. Inferior median and lateral keels of metasoma finely serrate.

Similar to *Vejovis wupatkiensis* Stahnke but differing in the following ways: smaller body size; fewer pectinal teeth; light brownish-yellow in base color and lacking melanic markings; fifth metasomal segment distinctly longer than movable finger of pedipalp in males and with fifth metasomal segment approximating movable finger length in females (in *V. wupatkiensis* movable finger slightly longer than metasomal segment V in males, females with movable finger distinctly longer than metasomal segment V).

HOLOTYPE MALE.—*Coloration.*—Carapace, mesosoma, metasoma and walking legs pale brownish-yellow with faint suggestion of underlying dusky pigmentation; telson and metasomal segment V darker and more brownish than other caudal



FIGS. 1 and 2. *Vejovis gramenestris* Williams, holotype male. FIG. 1. Dorsal view. FIG. 2. Ventral view.

segments; pedipalp fingers slightly more brownish than palm; pedipalps whitish; pretarsal claws whitish; cheliceral teeth light tan.

Carapace.—Anterior margin with six erect hairs and with median emargination; median eyes less than ¼ carapace length at that point; carapace surface irregular and granular.

Mesosoma.—All tergites granular; tergite 7 with two pairs of dentate lateral keels, posterior granule of each keel largest. Sternites agranular; last sternite with one pair of smooth to crenulate lateral keels.

Metasoma.—Dorsal keels of segments I to IV serrate, last serration of each keel largest; dorsolateral keels serrate on I to IV, last serration of each keel largest on segments I to III, keel composed of more irregular and broad granules on V; lateral keels serrate and almost complete on I, serrate on posterior ½ of II, serrate on posterior ⅓ of III, absent on IV, crenulate on anterior ⅔ of V; inferior

TABLE 1. Measurements (in millimeters) of *Vejovis gramenestris* Williams, new species, holotype and allotype.

	Holotype (male)	Allotype (female)
Total length	24.6	32.8
Carapace, length	3.0	3.7
width (at median eyes)	2.2	2.8
Mesosoma, length	7.2	12.3
Metasoma, length	11.4	13.1
segment I (length/width)	1.6/1.8	1.8/2.3
segment II (length/width)	1.8/1.8	2.1/2.2
segment III (length/width)	1.9/1.7	2.3/2.1
segment IV (length/width)	2.6/1.8	2.9/2.1
segment V (length/width)	3.5/1.7	4.0/2.1
Telson, length	3.0	3.7
Vesicle (length/width)	2.1/1.2	2.4/1.6
depth	0.9	1.2
Aculeus, length	0.9	1.3
Pedipalp		
Humerus (length/width)	2.6/0.7	3.4/1.0
Brachium (length/width)	2.9/0.9	3.7/1.3
Chela (length/width)	4.5/1.0	5.9/1.2
depth	1.0	1.3
movable finger, length	2.9	4.0
fixed finger, length	2.5	3.5
Pectines		
teeth (left/right)	17/17	14/14
middle lamellae	10	8

lateral keels crenulate on segments I to IV, serrate on V; inferior median keels smooth to crenulate on I, crenulate on II–IV, serrate on V. Each inferior median keel on segments I to IV set with three bristles. All intercarinal spaces of segment V granular.

Telson.—Ventral surface with eight pairs of long reddish hairs, most of these approximate aculeus in length; vesicle quite smooth, agranular; aculeus with pronounced curvature; broad subaculear tubercule.

Genital Operculum.—Completely divided longitudinally; set with about eight reddish hairs; genital papillae visible externally.

Chelicerae.—Inferior border of movable finger smooth, completely lacking denticles.

Pedipalps.—Palm only slightly swollen; keels distinct. Internal margin of fingers not scalloped; terminal tooth of each finger distinctively elongate and overhang each other when fingers closed.

Standard Measurements.—Table 1.

ALLOTYPE FEMALE.—Morphologically similar to holotype with the following exceptions: considerably larger in all body proportions as well as overall length;

pectines with fewer teeth (14 instead of 17); middle lamellae fewer (8 instead of 10); proximal pectinal tooth somewhat elongate; no genital papillae; genital operculum not completely divided longitudinally.

Standard Measurements.—Table 1.

Study of 20 paratopotypes indicated little variation from the descriptions of holotype and allotype. Two males were juveniles with carapace lengths of 2.4 millimeters while 18 females varied in carapace length from 2.7 to 3.8 millimeters (predominantly 3.6 millimeters). Pectine tooth count varied from 12 to 14 for the females while both males had 16 pectinal teeth. Several specimens had small "L-shaped" dark markings at the anterolateral corner of the carapace.

Holotype male, allotype and 20 paratopotypes were collected in DEATH VALLEY AT TRAVERTINE SPRING (½ MILE EAST OF FURNACE CREEK INN), INYO COUNTY, CALIFORNIA, 11 April 1968 by S. C. Williams, V. F. Lee, and R. Lewert. Holotype and allotype are permanently deposited in the California Academy of Sciences.

This species is named "gramenestris" because of its grass dwelling habits. It was abundantly found living in the grasses adjacent to springs. At night it was found climbing the grass stems apparently in search of food.

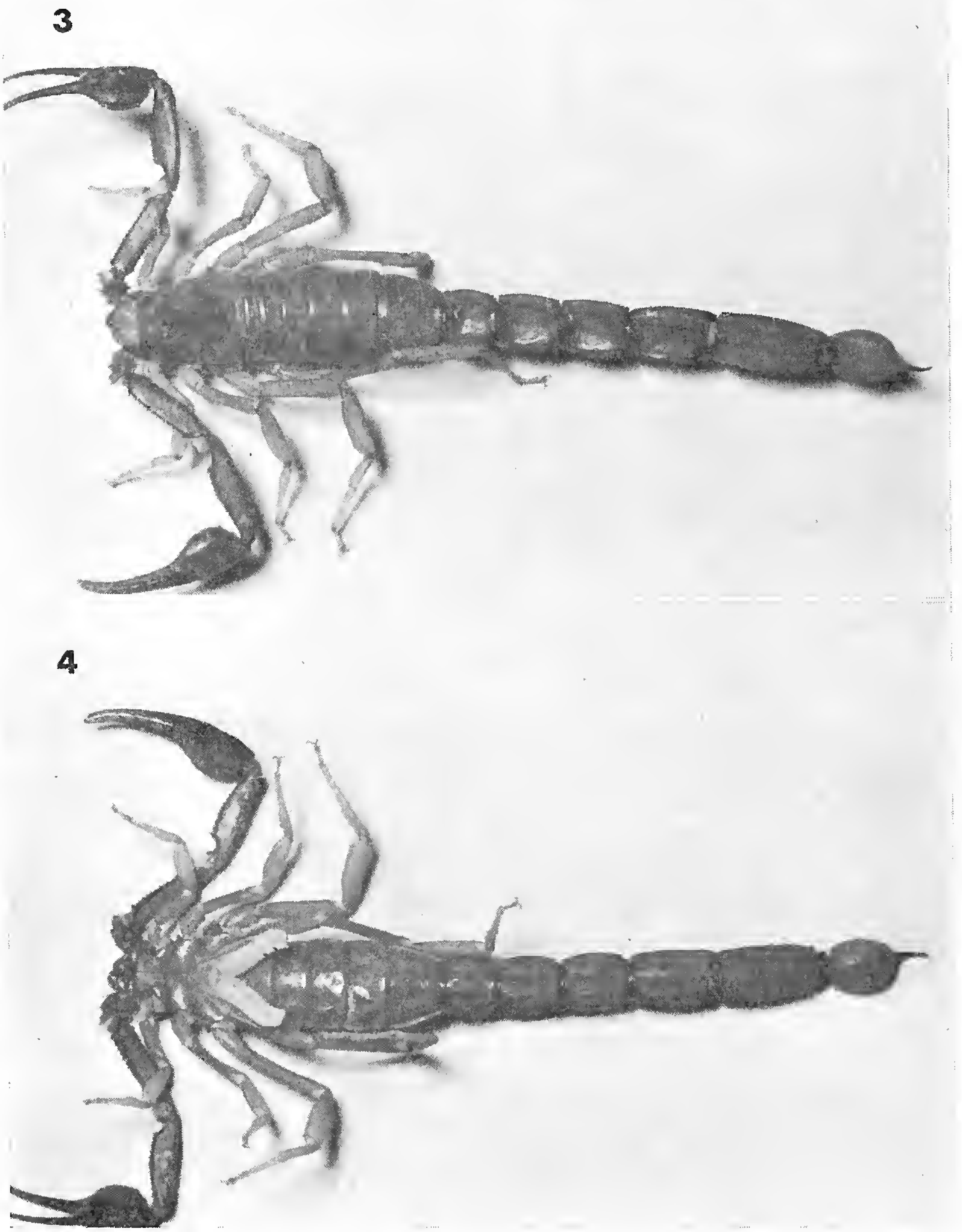
Eleven additional paratypes were studied from the following locations in Death Valley, Inyo County, California: Grapevine Spring (4 miles east of Ubehebe Crater), 12 April 1968 (S. C. Williams, V. F. Lee, J. Bigelow), 1 female; 20 Mule Team Canyon, 14 April 1968 (M. A. Cazier, J. Bigelow), 8 males, 2 females.

This very small species of *Vejovis* was found only around permanent springs where it was under travertine rocks during the day and climbing in the grasses at night. This is a very active species and is capable of rapid locomotion for extended periods of time. While collecting samples two members of our party were stung by this species on the fingers. The sting was characterized by a sharp burning sensation which lasted for five to ten minutes. No swelling, no reddening, and no urticaria accompanied the sting. Most specimens were collected by the ultraviolet detection method, but several were found by rock turning.

Vejovis deserticola Williams, new species

(Figs. 3, 4)

DIAGNOSIS.—Moderate sized species of *Vejovis*. General body color brownish-amber with legs yellowish, pectines almost white and pedipalp chela reddish. Inferior median keels of metasoma all present and crenulate or serrate; inferior lateral keels all serrate. Movable finger of pedipalp distinctly longer than carapace, palm or metasomal segment V. Male with 21 or 22 pectinal teeth, female with 20



Figs. 3 and 4. *Vejovis deserticola* Williams, holotype male. Fig. 3. Dorsal view. Fig. 4. Ventral view.

teeth. Proximal tooth of female pectine longest. Movable finger of chelicerae with inferior border lacking denticles.

Closest known relative is *Vejovis wupatkiensis* Stahnke. Distinguished from *V. wupatkiensis* by the following characters: pectinal teeth greater in number for both sexes; vesicle densely covered by coarse granules on ventral and lateral surfaces; much larger species in all body proportions.

HOLOTYPE MALE.—*Coloration.*—Base color of prosoma and mesosoma brownish-amber; metasoma similar but more yellowish-amber; walking legs brownish-yellow; pedipalp hands reddish-amber; pectines almost white; carapace with faint suggestion of underlying dusky markings. Eyes black, teeth of chelicerae, and most keel serrations reddish; aculeus reddish-brown; pretarsal claws yellowish-brown; fingers of pedipalp reddish. Keels on metasoma and pedipalps appear contrastingly reddish-brown due to heavy development rather than to underlying pigmentation.

Carapace.—Anterior margin with distinct broad median emargination, set with 6 bristles. Lateral eyes three per group, most anterior distinctly largest, most posterior one greatly reduced in size; median eye diad distinctly less than ¼ carapace width at that point. Carapace surface rough and uneven, covered by large coarse granules.

Mesosoma.—Tergites densely covered by large granules, tergite 7 with two pair of well developed conspicuous lateral keels, these serrate. Sternites agranular; surface texture uneven; one pair serrate keels on last sternite; lateral margin of sternites with serrate granules.

Metasoma.—Dorsal and dorsolateral keels well developed and regularly serrate on segments I to IV; dorsolateral keels of segment V distinct, broad and more granular than serrate. Lateral keels serrate along almost entire length of I, posterior ¼ of II and III, absent on IV, present and serrate on anterior ¾ of V. Inferior median keels well developed on all segments; crenulate on I to III; crenulate to serrate on IV; serrate on V. Inferior lateral keels well developed and regularly serrate on all segments. All inferior intercarinal spaces smooth, agranular.

Telson.—Vesicle globular and densely covered with large granules from ventral and lateral aspect. Heavy granulation also occurs in lateral regions of dorsal aspect of vesicle. Subaculear tubercule large, distinct. Aculeus short and well curved.

Genital Operculum.—Completely divided longitudinally; large distinct genital papillae visible externally. Genital operculum with six reddish bristles.

Chelicerae.—Inferior border of movable finger smooth, completely lacking denticles.

Pedipalps.—Palm only slightly swollen, keels well developed, granular. Fixed finger same length as carapace, movable finger distinctly longer than carapace. Caudal segment V longer than fixed finger but shorter than movable finger. Internal margin of fingers not scalloped; distal tooth of each finger greatly elongate and overlap when fingers closed.

Standard Measurements.—Table 2.

ALLOTYPE FEMALE.—Morphologically the same as holotype with the following exceptions: pectinal teeth fewer (20/20 instead of 22/21); pectinal teeth distinctly shorter; proximal pectinal tooth distinctly longer than others; no genital papillae; genital operculum not completely divided longitudinally; slightly longer total body size.

Standard Measurements.—Table 2.

The *holotype male* and allotype were collected at TRAVERTINE SPRING, ½ MILE EAST OF FURNACE CREEK INN, DEATH VALLEY NATIONAL MON-

TABLE 2. Measurements (in millimeters) of *Vejovis deserticola* Williams, new species, holotype and allotype.

	Holotype (male)	Allotype (female)
Total length	42.6	45.0
Carapace, length	5.2	5.2
width (at median eyes)	3.9	4.2
Mesosoma, length	11.2	13.7
Metasoma, length	20.6	19.8
segment I (length/width)	2.9/3.2	2.8/3.3
segment II (length/width)	3.3/3.2	3.1/3.2
segment III (length/width)	3.5/3.2	3.3/3.2
segment IV (length/width)	4.7/3.1	4.4/3.1
segment V (length/width)	6.2/3.0	6.2/3.1
Telson, length	5.6	6.3
Vesicle (length/width)	3.9/2.8	4.2/2.8
depth	2.2	2.2
Aculeus, length	1.7	2.1
Pedipalp		
Humerus (length/width)	5.5/1.3	5.5/1.4
Brachium (length/width)	5.9/1.6	5.9/1.7
Chela (length/width)	9.2/2.3	9.3/2.2
depth	2.7	2.7
movable finger, length	6.5	6.6
fixed finger, length	5.2	5.4
Pectines		
teeth (left/right)	22/21	20/20
middle lamellae	14	14

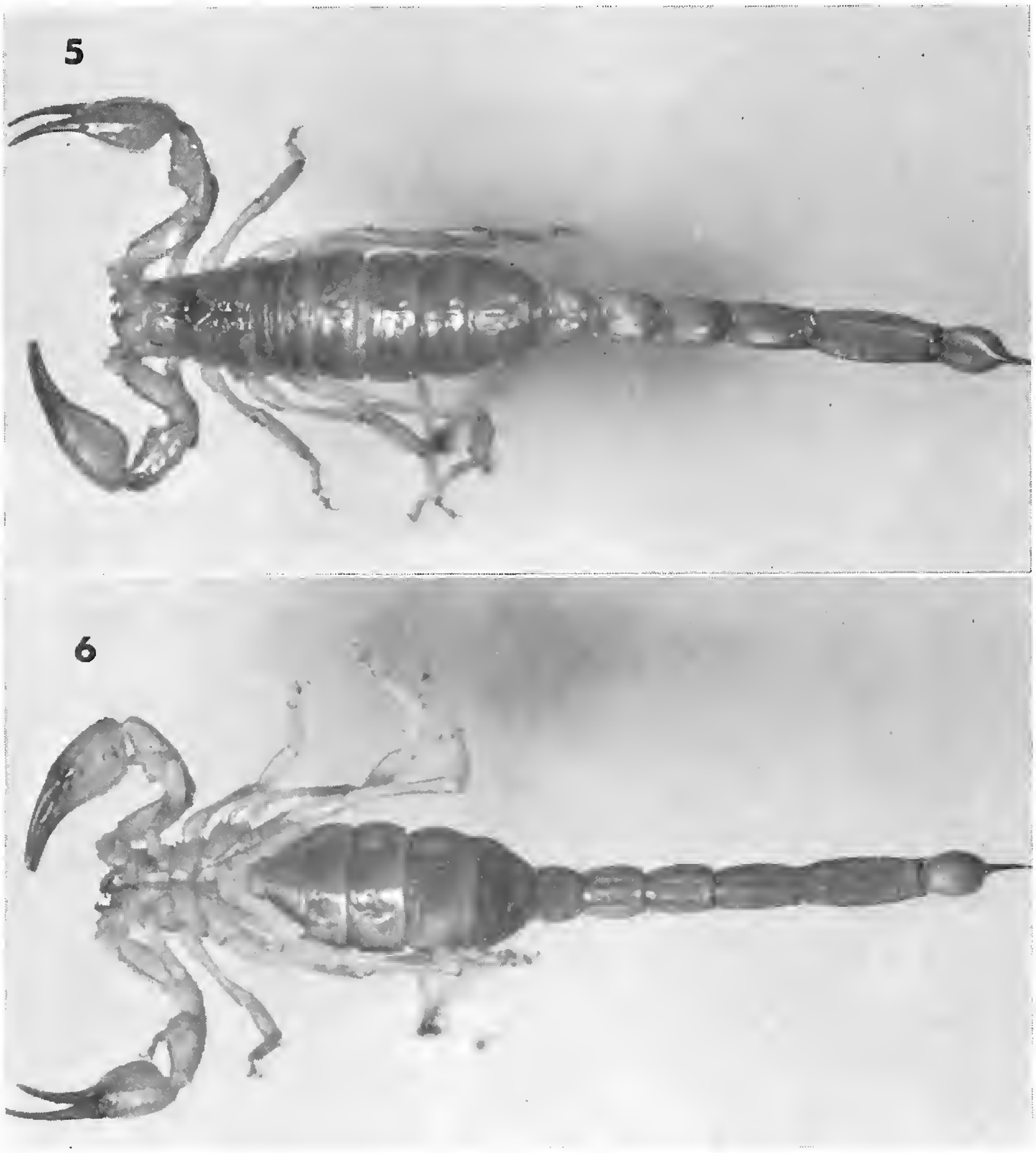
UMENT, INYO COUNTY, CALIFORNIA, 11 April 1968, by S. C. Williams and V. F. Lee. Both specimens were collected on a rocky slope at night by means of ultraviolet detection. The holotype is permanently deposited in the California Academy of Sciences.

This species is named "deserticola" because its only known habitat is Death Valley, one of the harshest deserts in North America.

Vejovis shulovi Williams, new species

(Figs. 5, 6)

DIAGNOSIS.—Moderate sized species of *Vejovis* in the *Paruroctonus* subgenus. Base color pale yellowish with underlying dusky markings on carapace and dorsum of mesosoma; mature females with contrasting reddish pedipalp fingers. Short swollen pedipalp hand with fixed finger shorter than palm, carapace or caudal segment IV; palm heavily keeled. All metasomal keels present, inferior keels mostly crenate or serrate. Chelicerae with three small denticles on inferior border



FIGS. 5 and 6. *Vejovis shulovi* Williams, holotype female. FIG. 5. Dorsal view. FIG. 6. Ventral view.

of movable cheliceral finger, the two terminal teeth on this finger subequal. Pectinal teeth 19 to 20 in males, 13 to 15 in females; teeth borne only on distal ⅔ of comb in females.

Appears related to *Vejovis bantai* Gertsch and Soleglad but distinguishable by the following characters: pectines with fewer teeth, females 13 to 15 (not 17), males 19 to 20 (not 23); fewer middle lamellae; inferior median keels not essentially obsolete on metasomal segments I and II; inferior median keels of metasomal segments I to IV with 3,4,4,5 pairs of reddish hairs (not 3,3,3,3 pairs) respectively; pedipalp hand not nearly as wide as long.

HOLOTYPE FEMALE.—*Coloration.*—Base color of cuticle pale yellow; carapace with underlying dusky pigmentation; mesosoma with dusky underlying pigmentation; walking legs with faint regional dusky markings; pedipalp fingers contrastingly light reddish; pectines whitish; most of cuticle with polished shiny appearance.

Carapace.—Anterior margin subtly convex, set with six bristles; median eyes more than ¼ but less than ⅓ carapace width at that point; carapace surface irregular and set with coarse granules.

Mesosoma.—Tergites with relatively few granules, these small; tergite 7 with poorly developed median keel and two pair of dentate lateral keels; sternites agranular.

Metasoma.—Dorsal and dorsolateral keels crenulate to serrate, never ending in enlarged tooth; lateral keels crenulate to dentate on most of segment I, dentate on posterior ⅛ of II and III, absent on IV; irregularly crenulate on anterior ⅖ of V. Inferior lateral keels smooth to crenulate on segments I to III; crenulate to serrate on IV; serrate on V. Inferior median keels basically smooth on segments I to III; crenulate to serrate on IV; serrate on V. Inferior median keels of segments I to IV with 3, 4, 4, 5 pairs of stout reddish bristles. Inferior intercarinal space of segment V abundantly granular.

Telson.—Ventral side basically agranular, set with about 10 pairs of moderately long reddish hairs; aculeus long, slender; subtle broad subaculear tubercule.

Pectines.—Inferior surface densely hirsute; each fulcrum with about six reddish hairs; each middle lamella with about four reddish hairs; 14 teeth; 12 middle lamellae; proximal ⅓ of pectine without teeth.

Genital Operculum.—Not completely divided longitudinally; with about 15 long reddish hairs.

Chelicerae.—Inferior border of movable finger with three small denticles; terminal tooth on superior border smaller but still subequal.

Pedipalps.—Hand swollen, all keels distinct and granular. Both movable and fixed finger shorter than carapace; palm longer than fixed finger but shorter than movable finger; fixed finger shorter than metasomal segment IV. Internal margin of fingers moderately scalloped proximally; proximal teeth do not meet when fingers closed.

Standard Measurements.—Table 3.

ALLOTYPE MALE.—Color and morphology essentially the same as holotype with the following exceptions: smaller total length; carapace narrower; pectines with more teeth (19 instead of 14); middle lamellae more numerous (14 instead of 12); genital papillae showing externally; pedipalp fingers not reddish; pedipalp keels not as conspicuous.

Standard Measurements.—Table 3.

Study of 11 paratopotypes indicated little variation from the descriptions of the holotype and allotype. The two males had carapace lengths of 2.6 and 3.8 millimeters and pectine tooth counts of 19/20. Although the genital papillae were visible externally, the smaller body sizes indicated these specimens may have been sub-adult. The nine females varied in carapace length from 4.1 to 5.3 millimeters. Pectinal tooth counts varied from 13 to 15 (predominantly 13 and 14). The

TABLE 3. Measurements (in millimeters) of *Vejovis shulovi* Williams, new species, holotype and allotype.

	Holotype (female)	Allotype (male)
Total length	38.3	34.4
Carapace, length	4.9	4.4
width (at median eyes)	3.5	3.2
Mesosoma, length	11.3	11.1
Metasoma, length	16.8	14.5
segment I (length/width)	2.2/2.4	2.0/2.1
segment II (length/width)	2.7/2.3	2.3/2.0
segment II (length/width)	2.8/2.1	2.4/1.9
segment IV (length/width)	3.7/2.0	3.2/1.7
segment V (length/width)	5.4/2.0	4.6/1.7
Telson, length	5.3	4.4
Vesicle (length/width)	3.2/2.0	2.6/1.6
depth	1.7	1.3
Aculeus, length	2.1	1.8
Pedipalp		
Humerus (length/width)	3.7/1.3	3.4/1.2
Brachium (length/width)	4.1/1.8	3.5/1.6
Chela (length/width)	7.1/2.4	5.9/1.8
depth	2.6	1.9
movable finger, length	4.4	3.2
fixed finger, length	3.1	2.3
Pectines		
teeth (left/right)	14/14	19/19
middle lamellae	12	14

female with carapace length of 4.1 millimeters was probably a sub-adult judging by the less swollen pedipalp hands and lack of red coloration of the fingers.

The *holotype female*, allotype and 11 paratopotypes were collected in Death Valley at Grapevine Spring (4 miles east of Ubehebe Crater), Inyo County, California, 12 April 1968 by S. C. Williams, V. F. Lee and J. Bigelow. All specimens were collected by ultraviolet detection in early evening. The holotype and allotype are permanently deposited in the California Academy of Sciences.

This species is named "shulovi" in honor of Professor Aaron Shulov of the Hebrew University in Jerusalem, Israel. Professor Shulov has made many fine contributions to the understanding of basic scorpion biology and venoms. His numerous scientific papers have been a source of great stimulation to students of scorpions all over the world.

In addition to the holotype, allotype and 11 paratopotypes, an additional 20 paratypes were available for study. These were collected in the following locality in Death Valley, Inyo County, California: Scotty's Ranch, elevation 3000 feet, 13 April 1968 (M. A. Cazier, B. Nevelyn, J. Bigelow, G. Lytle), 20 females.

This species is known only from the north end of Death Valley, Inyo County, California. It was found in two localities, and was not abundant. The females greatly outnumbered the relatively rare males in our samples. All of the specimens appeared to be mature or nearly so, younger juveniles were completely absent. A female was selected as the holotype of this species for several reasons. Males were very rare in the samples available, and there was some question whether or not these males were sexually mature. Also, the females appear to have species characteristics as definitive or more so than the males of this species.

The habitat in which this species was found was characterized by fine sedimentary soil, abundantly covered with dark volcanic surface rock. The area was hot and arid, but a small spring supplied surface water which formed a small stream which flowed into the desert for some ¼ of a mile. The vegetation, except adjacent to the stream, was very sparse.

ACKNOWLEDGMENTS.—Much appreciation is due to Vincent F. Lee for assistance in the field and to Charlene F. Williams for clerical assistance. This work was partially supported by research grant GB 7679 from the National Science Foundation and by a Faculty Research Leave from San Francisco State College.

Two New Genera of Termitophiles Associated with *Longipeditermes longipes* (Haviland)[1]

(Coleoptera: Staphylinidae; Isoptera: Nasutitermitinae)

David H. Kistner
Chico State College, California

During his Oriental field trip in 1963, Professor Alfred E. Emerson, University of Chicago, collected many termitophiles. Among the most spectacular of these was a series taken in nests of *Longipeditermes longipes* (Haviland) from which termite genus, no previous termitophiles had ever been taken. Needless to say, all of the genera and species collected are new, some even representing new termitophilous subtribes. The genera and species are not only remarkable from the point of view of termitophilous adaptations but are also remarkable because of the number of species and genera involved. I am therefore beginning a series of papers in which I shall describe the fauna associated with this interesting termite. I estimate that at least 3 papers will be devoted to the description of new forms and then the 4th and last will be devoted to the general relationships shown by this diverse termitophile fauna.

I wish to thank Dr. Emerson for providing the specimens which form the basis of this paper, for determining the host termites, and for reading and commenting on this paper. All types of the species described herein are in the collection of the author. Specimens of the host termites are in the Emerson Collection of the American Museum of Natural History, New York, and representative series are in the collection of the author. All measurements are in mm and techniques involved in the study of the specimens are given by Kistner (1968).

I wish to thank Mr. David Harwood, Miss Lynette Hawver, Mr. Herbert Jacobson, Mr. Matthew Rees, Miss Lynn Royce, and Miss Virginia Sleppy, all of Chico State College, for technical assistance.

All of the species herein described belong to the subtribe Termitozyrina, tribe Myrmedoniini, subfamily Aleocharinae.

Genus **Longipedoxenus** Kistner, new genus

Most closely related to *Termitosymbia* Seevers from which it is distinguished by its overall appearance, the presence of only 1 pair of paratergites on abdominal segments III–VII and the lack of a vertexal arcade.

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

The Pan-Pacific Entomologist 46: 12–27. January 1970

FIGS. 1–2. *Longipedoxenus shinneri.* FIG. 1. Dorsal view. FIG. 2. Lateral view.

Overall shape as in Figs. 1, 2, and 3. Head shaped as in Fig. 1. Dorsal sculpture consists of a depression in middle of vertex. Clypeus membranous. Antennae inserted in dorsal sockets at inner margin of eyes with no vertexal arcade apparent. Ventral surface of head capsule without distinction; with no infraorbital carinae. Gula relatively short; narrowest anteriorly, becoming wider posteriorly. Mentum almost as long as gula, separately articulated, somewhat membranous. Antennae 11-segmented, elongate, shaped as in Fig. 13. Labrum shaped as in Fig. 7. Mandibles nearly symmetrical, shaped as in Figs. 4 and 6. Maxillae shaped as in Fig. 8 with four-segmented palpi much longer than lacinia and galea. Labium shaped as in Fig. 5; palpi 3-segmented. Both maxillae and labium somewhat membranous.

Pronotum shaped as in Fig. 1. Details of pronotal sculpture (partially visible in Fig. 1) consist of median ridge starting at median point of anterior border and

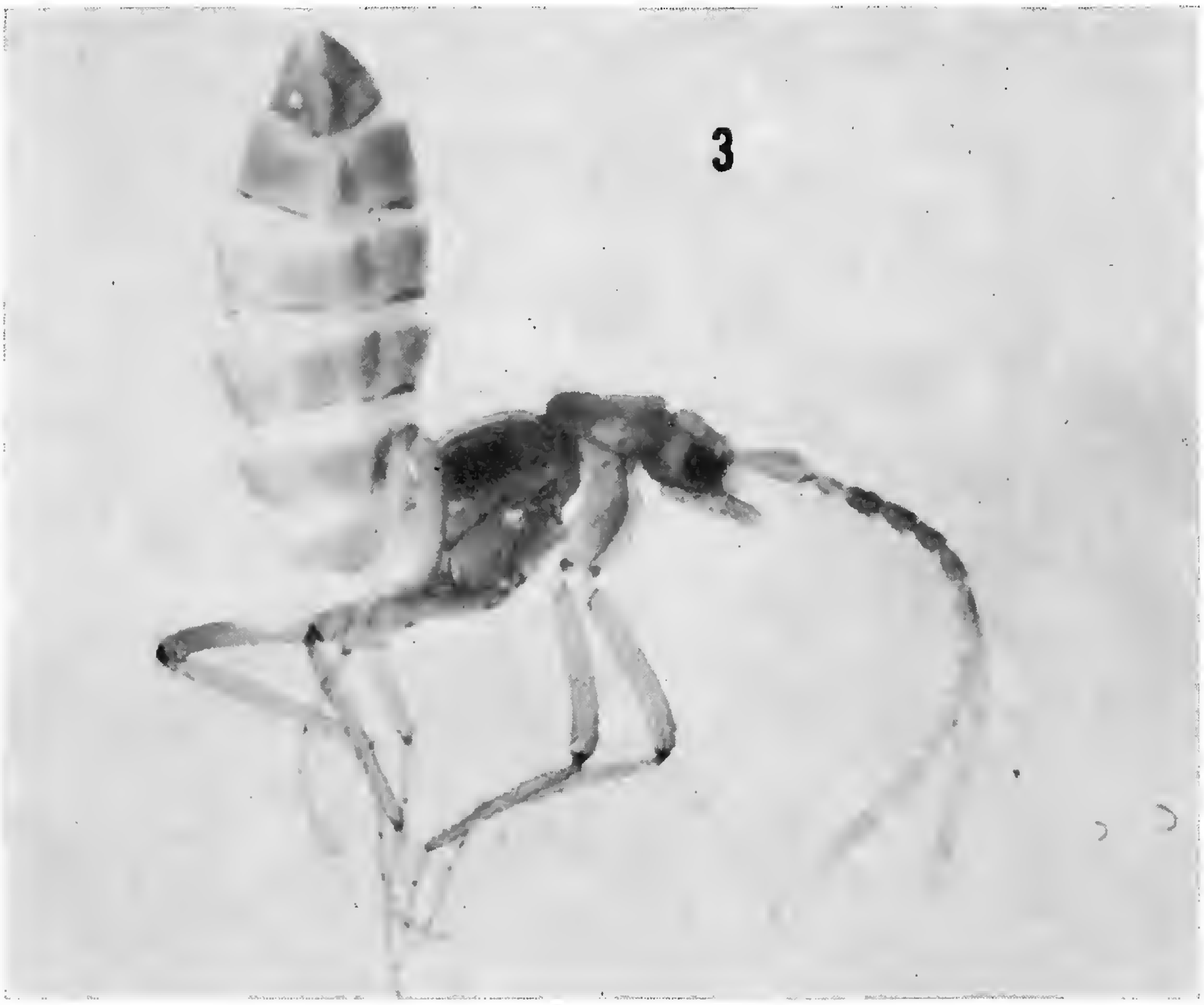

FIG. 3. *Longipedoxenus shinneri.* Lateral view showing abdomen in an upright position.

a longitudinal indentation to each side of this. Prosternum acarinate, relatively small, leaving a large amount of exposed membrane. Procoxal cavities closed behind by membrane. Mesothoracic peritremes small, completely surrounded by membrane, forming a strap-like process from sides of hypomera to median line. Metasternum about twice length of mesosternum. Mesocoxal cavities in a strict sense rather widely separated, but indentations of meso- and metasternum into which the large coxae fit, fall rather closely together at their medial borders. Mesosternal intercoxal process broad, blunt, acarinate. Elytra shaped as in Fig. 1, with some median posterior indentations and sinuate lateral borders. Wings present, of usual staphylinid venation. Legs elongate. Pro-, meso-, and metalegs shaped as in Figs. 10, 11, and 9 respectively. Tarsal formula 4-5-5.

Abdomen both physogastric and scaphoidal and can be held partially recurved over back or straight out; shaped as in Figs. 1, 2, and 3. Abdominal segment I membranous. Abdominal segment II represented by tergite alone. Abdominal segments III–VII represented by tergite, sternite, and but 1 pair of paratergites each. Abdominal segment VIII represented by tergite and sternite only. Segment IX trivalved, shaped as in Fig. 12. Male genitalia bulbous; specific shape variable by species. Spermatheca present; shape variable by species.

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FIGS. 4–8. *Longipedoxenus shinneri.* FIG. 4. Right mandible. FIG. 5. Labium. FIG. 6. Left mandible. FIG. 7. Labrum. FIG. 8. Maxilla.

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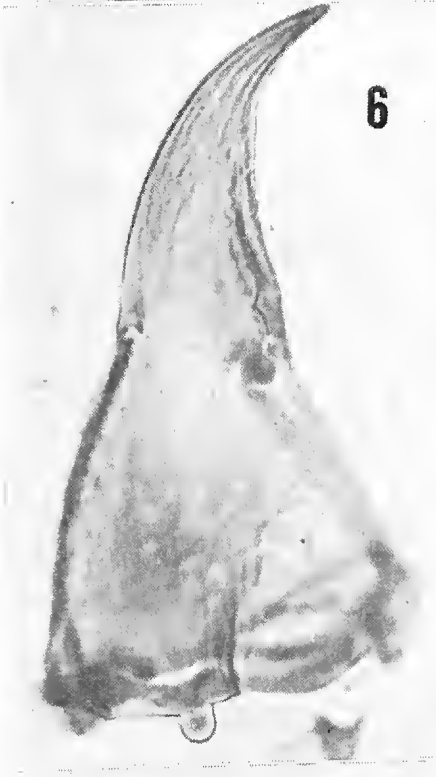

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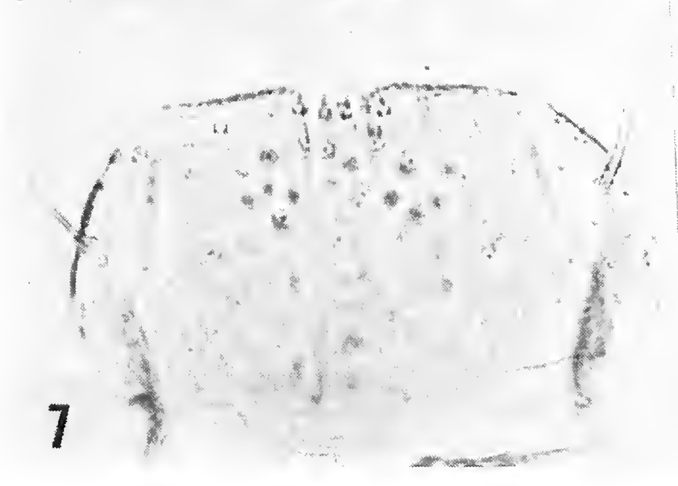

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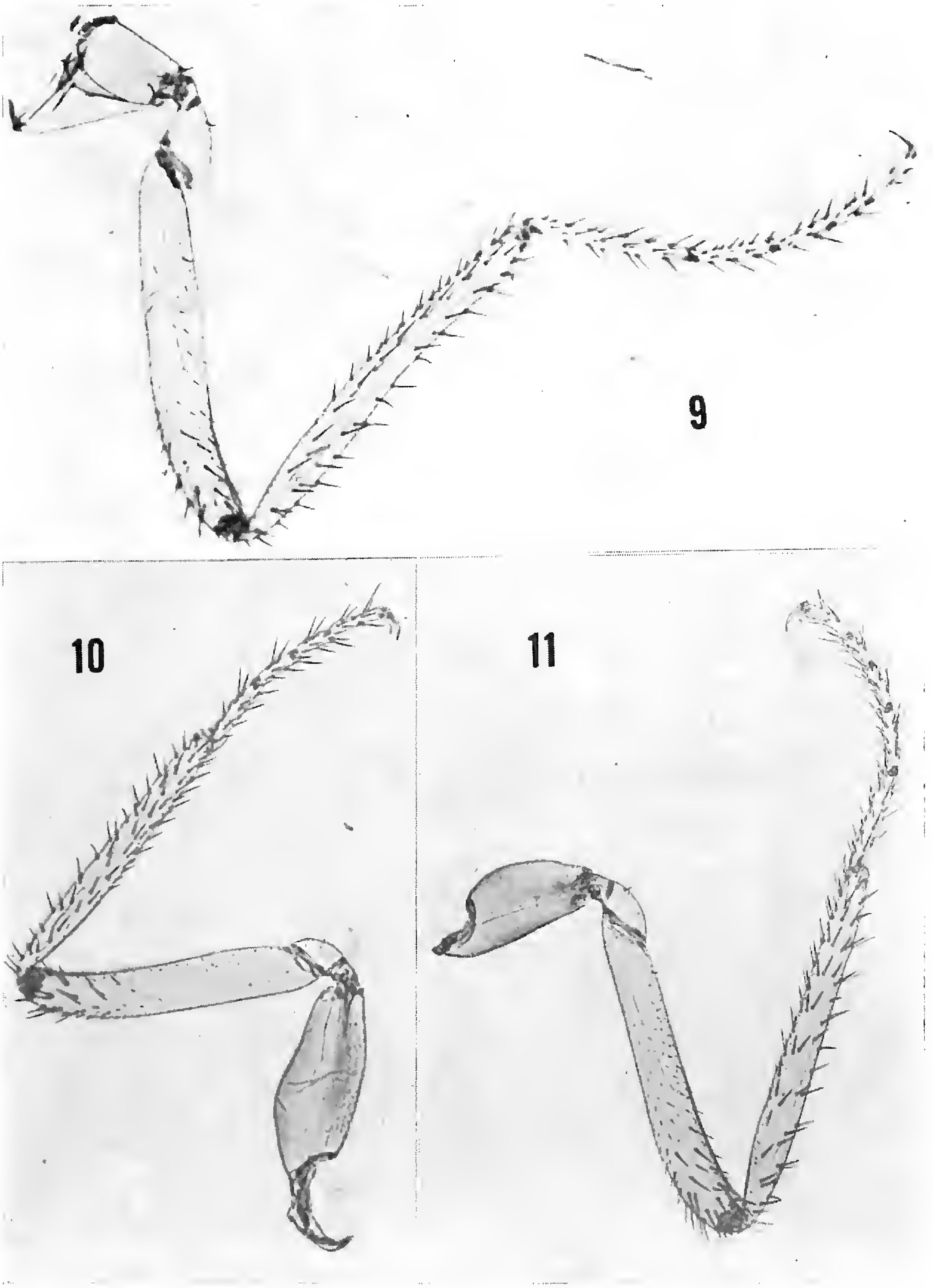
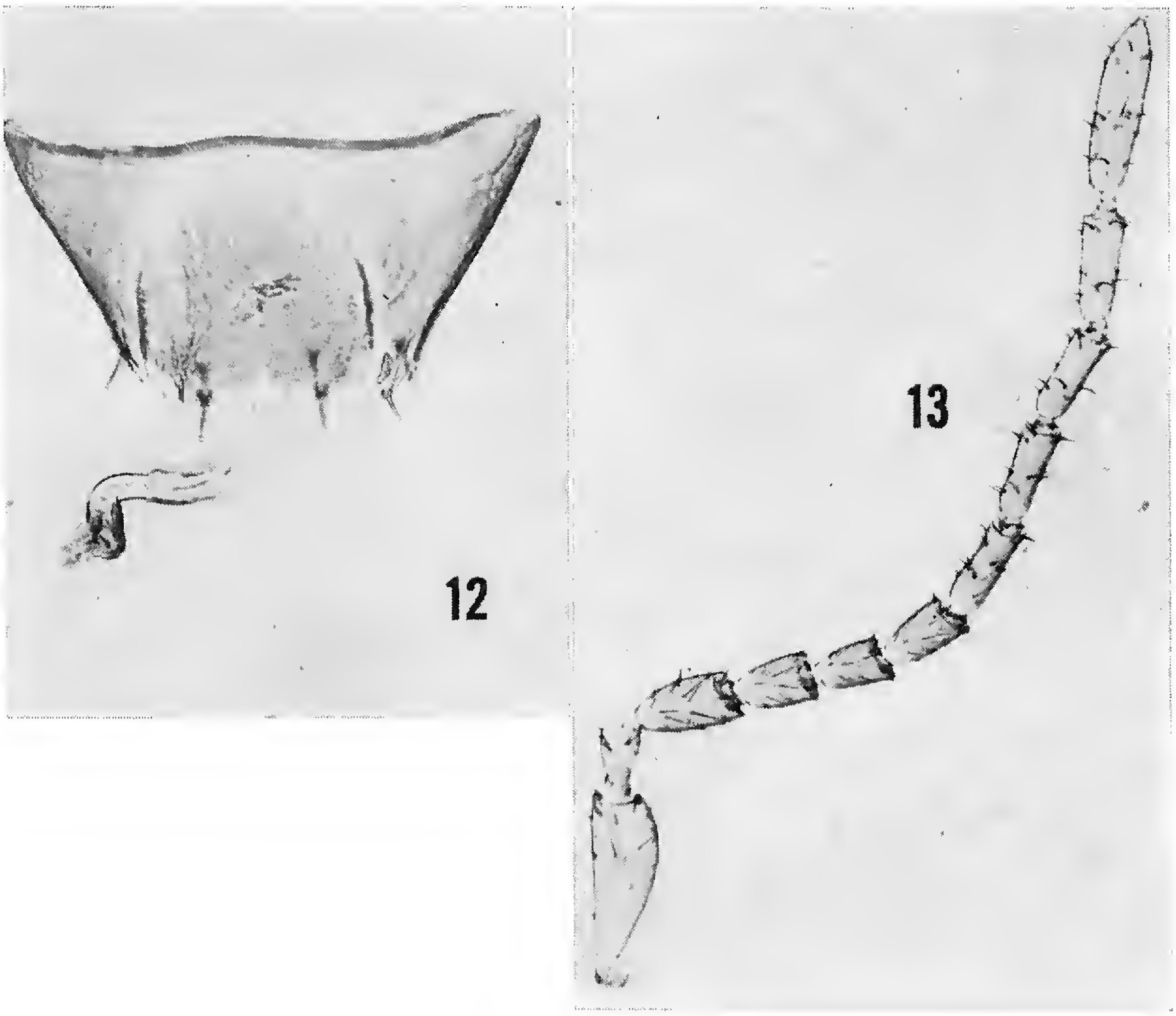


FIGS. 9–11. *Longipedoxenus shinneri.* FIG. 9. Metaleg. FIG. 10. Proleg. FIG. 11. Mesoleg.

The abdomen is both physogastric and scaphoidal at the same time. The physogastry is achieved by the enlargement of membranes between the abdominal segments, particularly those at the anterior of the abdomen. Scaphoidal shape is achieved by broadening the tergites and



FIGS. 12–13. *Longipedoxenus shinneri*. FIG. 12. Abdominal segment IX. FIG. 13. Antenna.

sternites, particularly those at the posterior of the abdomen. The accentuated folds at the anterior borders of tergite IV probably have something to do with the glandular system of the abdomen. Evidence from the sclerotization of abdominal tergites VI and VII indicates 2 small defense gland reservoirs in the posterior of segment VI.

TYPE SPECIES.—*Longipedoxenus shinneri* Kistner.

KEY TO SPECIES

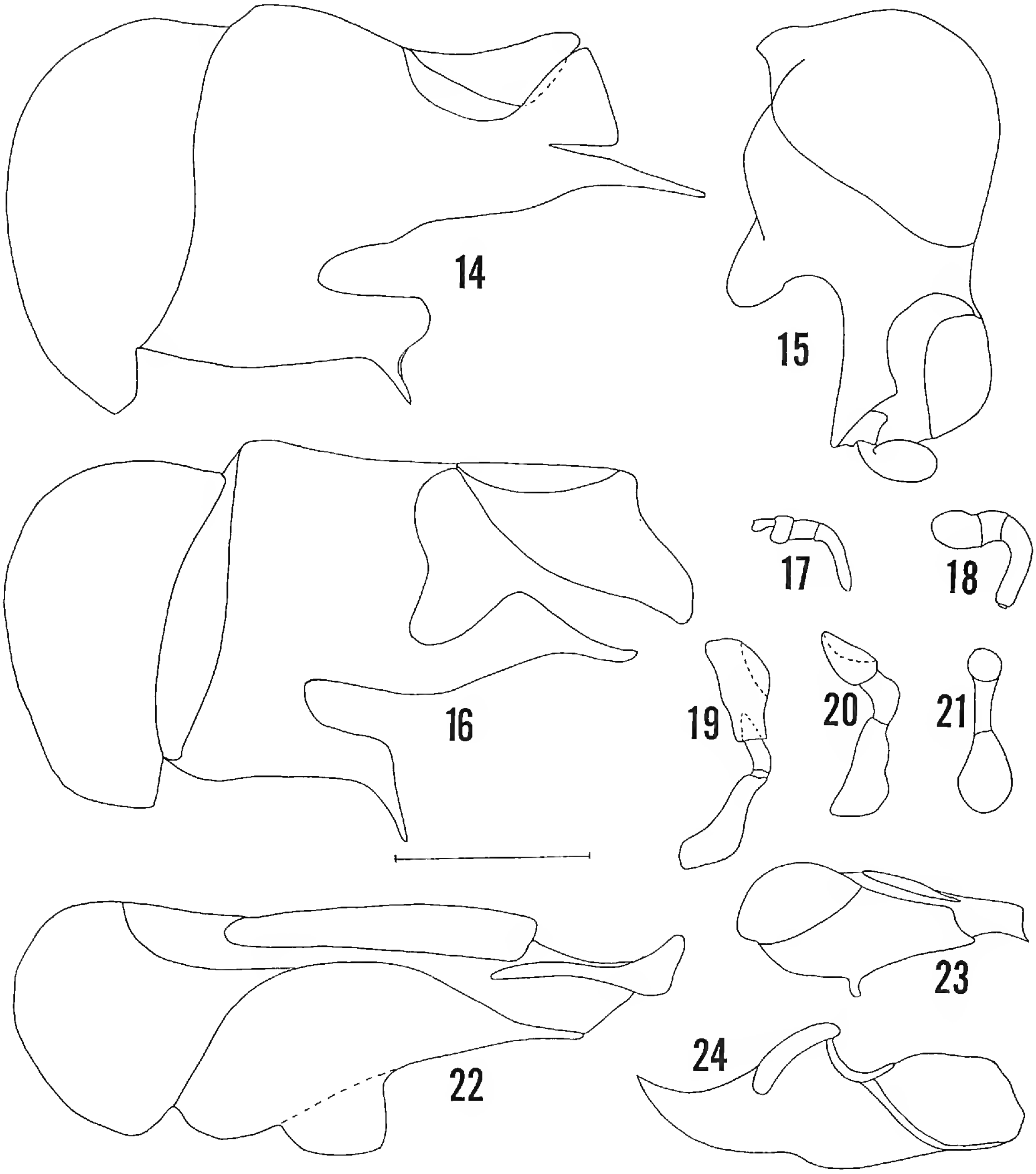
Hairy species, abdominal sternites III–IV with 3–4 rows of long black curly setae .... *L. emersoni* n. sp.

Slightly hirsute species, abdominal sternites III–V with a sparse apical row of short black setae and an anteapical median group of 2–3 short black setae .... *L. shinneri* n. sp.

Longipedoxenus emersoni Kistner, new species

(Figs. 18, 23)

Related to *L. shinneri* from which it is distinguished by its smaller size, the differences in chaetotaxy, as well as the shape of the male genitalia and the spermatheca.



FIGS. 14–24. Male genitalia. FIGS. 14–16, 22, 23. Median lobes of male genitalia. FIG. 14. *Longipedisymbia bouceki.* FIG. 15. *Longipedoxenus shinneri.* FIG. 16. *Longipedisymbia carlislei.* FIG. 22. *Longipedisymbia bradburni.* FIG. 23. *Longipedoxenus emersoni.* FIG. 24. Lateral lobe of male genitalia, *L. shinneri.* FIGS. 17–21. Spermatheca. FIG. 17. *L. shinneri.* FIG. 18. *L. emersoni.* FIG. 19. *L. carlislei.* FIG. 20. *L. bouceki.* FIG. 21. *L. bradburni.* Scale represents 0.25 mm and applies to all figures.

Color yellowish-brown throughout except for black eyes, and white membranes between abdominal sclerites. Chaetotaxy of abdominal tergites II–VIII as follows: 0, 0, 2,2,2,0,2-6. The 2 on tergites IV–VI barely visible; the 2 on tergite VIII are anterior to row of 6. Chaetotaxy of abdominal sternites III–VIII as follows: III–V with 3 to 4 rows of long black curly setae; VI with apical row of long curly setae and anteapical group of 2–3; VII, 4; VIII, 6. Median lobe of male genitalia shaped as in Fig. 23. Lateral lobe of male genitalia shaped as in *L. shinneri*. Spermatheca shaped as in Fig. 18.

Measurements.—Pronotum length, 0.33–0.35; head length, 0.30–0.32 (measured from the edge of the vertex to the nuchal ridge). Number measured, 5.

Holotype male No. 13520, MALAYA, SUNGEI BULOH FOREST RESERVE, 3° 10′ N., 101° 34′ E., altitude 150 feet, 18 March 1963, Coll. A. and Eleanor Emerson, C. M. Low, and R. D. Menon, in vicinity of queen.

Paratypes.—4, same data as the holotype.

The species is named for one of the collectors, Dr. A. E. Emerson.

Longipedoxenus shinneri Kistner, new species

(Figs. 1–13, 15, 17, 24)

Related to *L. emersoni* from which it is distinguished by its larger size, differences in the chaetotaxy, as well as the shape of the male genitalia and the spermatheca.

Color yellowish-brown throughout except for black eyes, and white membranes between abdominal sclerites. Chaetotaxy of abdominal tergites II–VIII as follows: II–VII, 0; VIII, 6 apical, 2 anteapical. Chaetotaxy of abdominal sternites III–VIII as follows: III–VIII all with a sparse apical row of short black setae, III–VI with anteapical median group of 2–3 short black setae additionally. Median lobe of male genitalia shaped as in Fig. 15. Lateral lobe of male genitalia shaped as in Fig. 24. Spermatheca shaped as in Fig. 17.

Measurements.—Pronotum length, 0.43–0.45; head length, 0.31–0.32 (measured from the anterior edge of the vertex to the nuchal ridge). Number measured, 10.

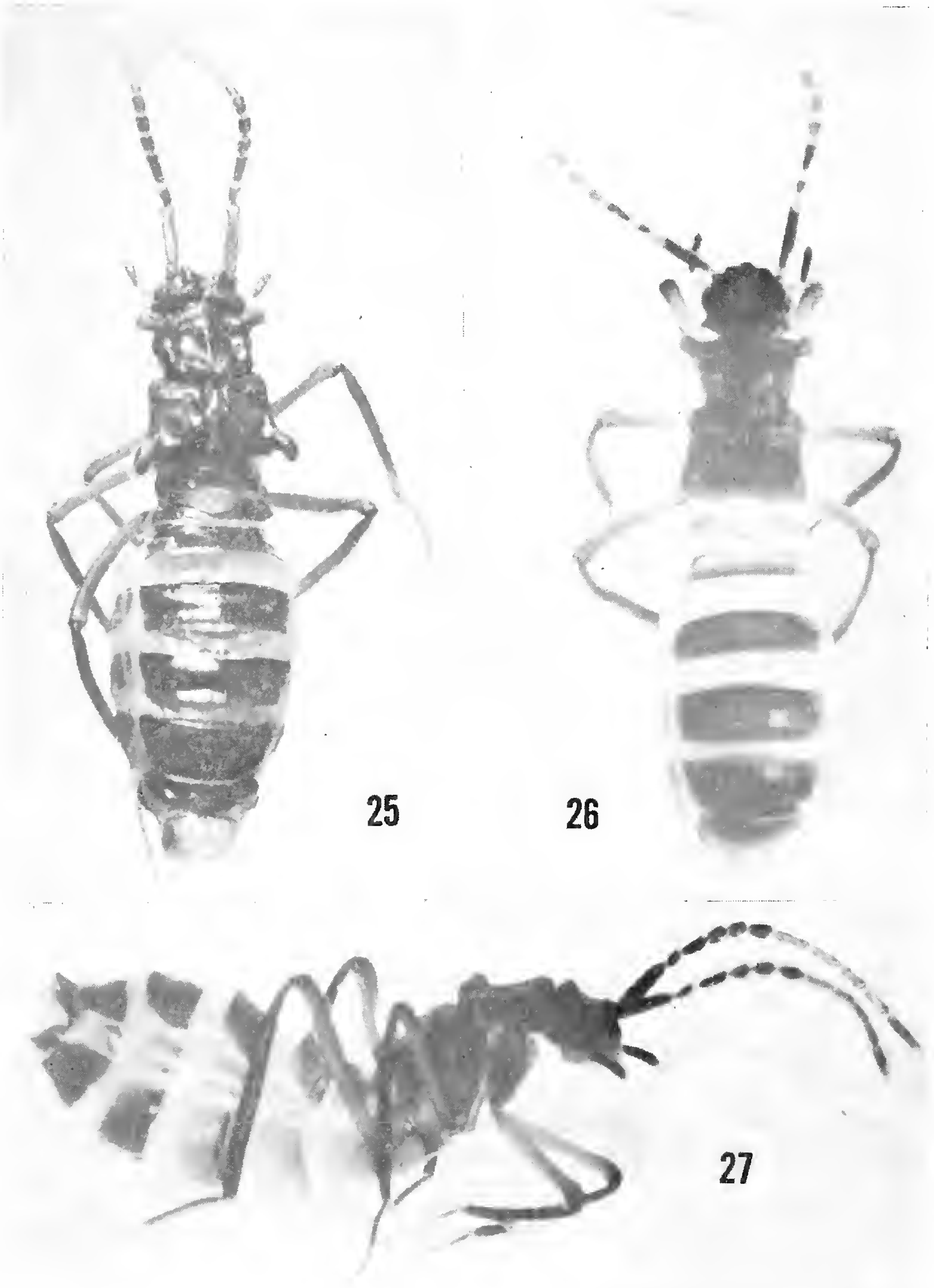
Holotype male No. 13521, MALAYA, SUNGEI BULOH FOREST RESERVE, 3° 10′ N., 101° 34′ E., altitude 150 feet, 18 March 1963, Coll. A. and Eleanor Emerson, C. M. Low, and R. D. Menon, in the vicinity of the queen.

Paratypes.—4, same data as the holotype; 6, Sarawak, 1° 38′ N., 113° 35′ E., altitude 950 feet, 7 February 1963, Coll. A. and Eleanor Emerson and W. King, in cells under log near nest, vial No. 1; 9, Sarawak, same nest, date, and collectors as previous vial, from nest in hard log, vial No. 2.

This species is named for the late Mr. Ernest G. Shinner of Chicago in honor of his long interest in philanthropic causes of the Chicago area.

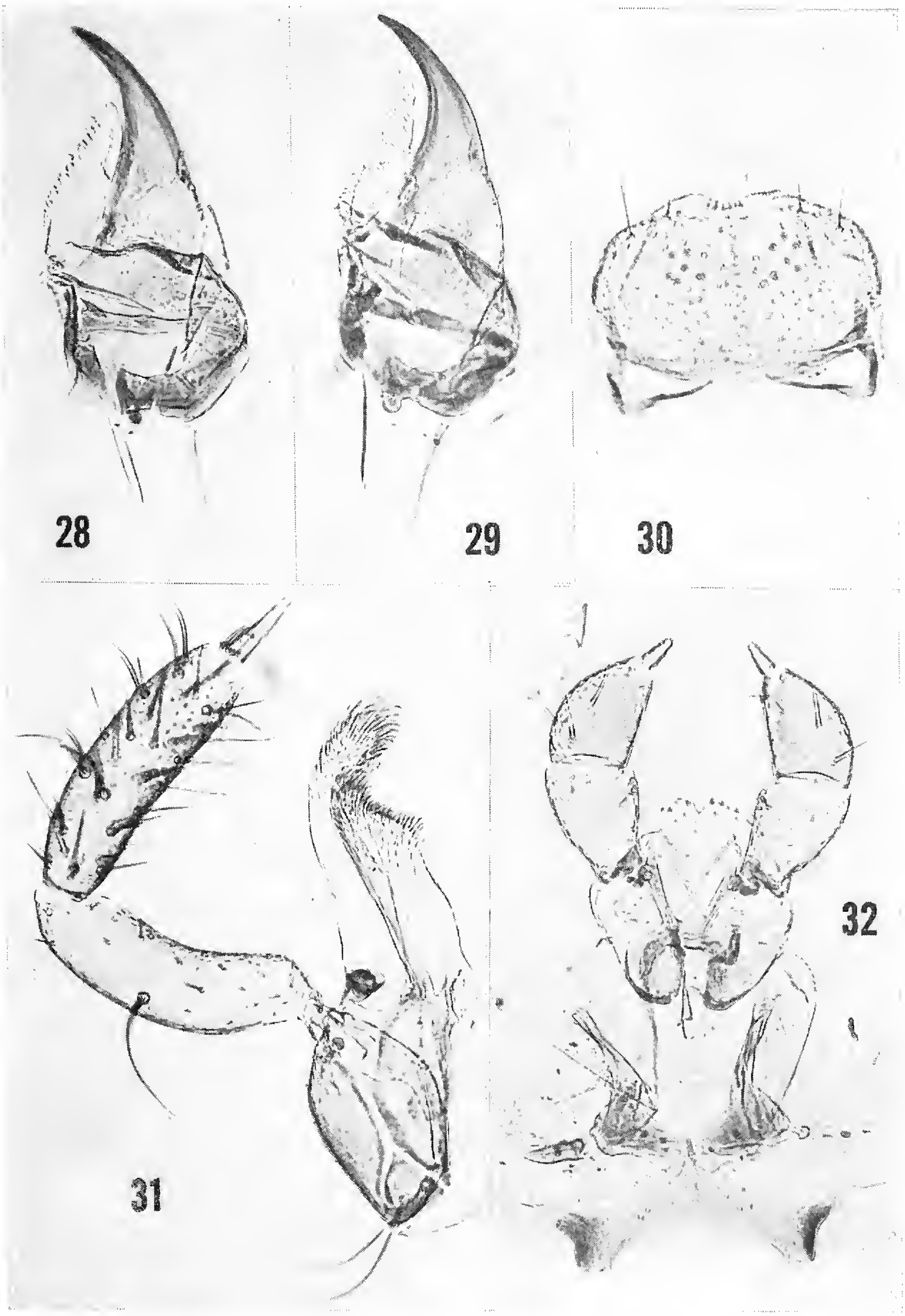
Genus **Longipedisymbia** Kistner, new genus

Closely related to both *Termitosymbia* and *Longipedoxenus* from which it is distinguished by the peculiar lateral processes of the pronotum. Also distinguished from *Termitosymbia* by the approximately equal-sized paratergites. Also distinguished from *Longipedoxenus* by the presence of 2 pairs of paratergites on abdominal segments IV–VI and the lack of a membranous clypeus.



Figs. 25–27. Fig. 25. *Longipedisymbia bouceki*, dorsal view. Fig. 26. *L. carlislei*, dorsal view. Fig. 27. *L. carlislei*, lateral view.

Overall shape as in Figs. 25, 26, and 27. Dorsal head shape somewhat variable by species. Basically it is subtriangular with a depression in middle of vertex and 2 smaller depressions on sides of vertex behind antennal fossae. Protuberances from the head vary between species. Clypeus not membranous. Gula-sub-



Figs. 28–32. *Longipedisymbia bradburni.* Fig. 28. Right mandible. Fig. 29. Left mandible. Fig. 30. Labrum. Fig. 31. Maxilla. Fig. 32. Labium.

mentum developed at an angle so that anterior end is lower than posterior edge at foramen magnum. Mentum separately articulated and about half length of gula-submentum. Sculpture of head otherwise variable by species. Antennae

11-segmented, shaped as in Fig. 36, with antennal fossae opening dorsally near inner corners of eyes; without arcade but with prominence medial to each antennal insertion. Labrum shaped as in Fig. 30. Maxillae shaped as in Fig. 31, palpi 4-segmented, with palps much longer than lacinia and galea. Mandibles symmetrical, shaped as in Figs. 28 and 29. Labium shaped as in Fig. 32, palpi 3-segmented.

Pronotum shaped as in Fig. 25, with lateral projection from each anterior corner. Other sculpture consists of 2 depressions, each lateral to median keel-like structure. Prosternum less than ⅕ length of pronotum; without carina. Prothoracic coxal cavities closed behind by membrane. Mesothoracic peritremes weakly sclerotized and not developed from lateral edges of pronotum. Metasternum about twice length of mesosternum. Mesocoxal cavities widely separated by broad, blunt, acarinate mesothoracic intercoxal process. Elytra shape variable by species; what varies appears to be only the process at posterior lateral corner which can be virtually absent or extremely well-developed. Wings present and with usual staphylinid venation. Legs extremely long with elongate coxae. Pro-, meso-, and metalegs shaped as in Figs. 37, 33, and 34 respectively; tarsal formula 4-5-5.

Abdomen physogastric and held in extended position (at least in all of the dead specimens); shaped as in Figs. 26 and 27. Abdominal segment I membranous. Abdominal segment II represented by tergite alone. Segment III represented by tergite and sternite alone (no paratergites). Segments IV–VI represented by tergite and sternite and 2 pairs of paratergites each. Segment VII represented by tergite, sternite, and 1 pair of paratergites, shaped as in Fig. 40. In one species anterior margin of the paratergites notched which may indicate paratergites fused, and in 2 other species paratergites actually double. Segment VIII represented by tergite and sternite only; shaped as in Fig. 39. Segment IX trivalved and shaped as in Fig. 38. Male genitalia bulbous, specific shape variable by species. Spermatheca present; shape variable by species.

Physogastry of the abdomen is achieved by the expansion of the membranes. Two grooves are present in the chitin at the anterior corners of tergite IV. These probably represent egress points for some of the abdominal glandular system. From the sclerotization of tergites VI and VII, there would appear to be a small median reservoir for the defense gland.

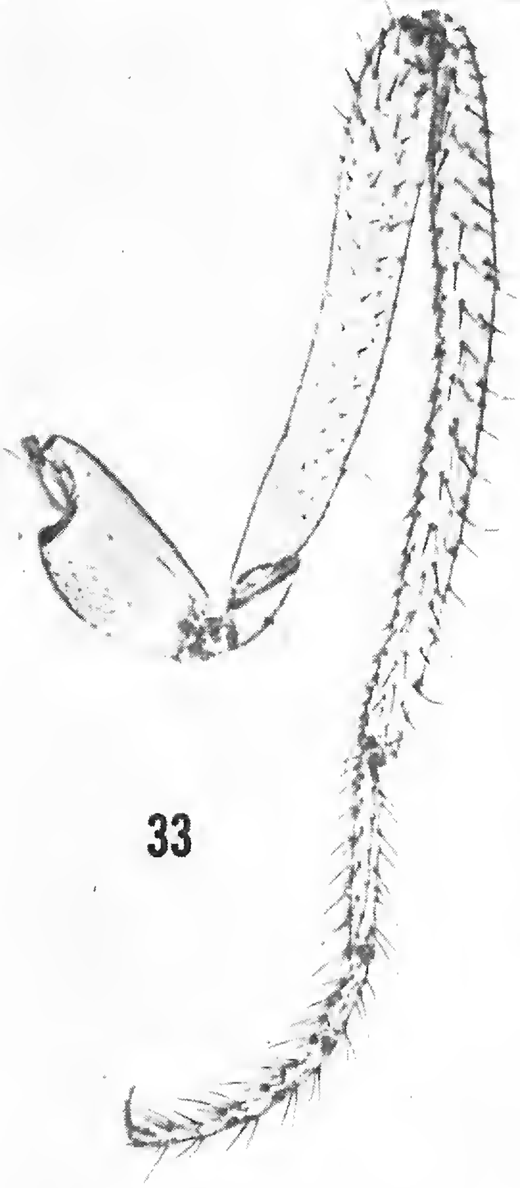
TYPE SPECIES.—*Longipedisymbia carlislei* Kistner.

KEY TO SPECIES

1. Head with well-developed angular projections from lateral border behind eyes (Fig. 25) 2
   Head without well-developed angular projections from lateral border behind eyes .... *L. bradburni* n. sp.

→

FIGS. 33–36. *Longipedisymbia bradburni.* FIG. 33. Mesoleg. FIG. 34. Metaleg. FIG. 35. Lateral lobe of the male genitalia. FIG. 36. Antenna.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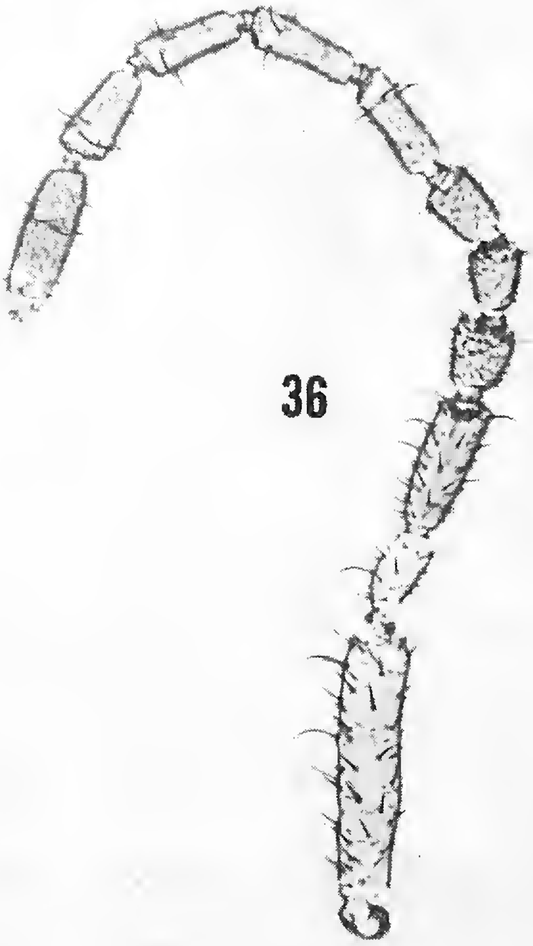
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2. Elytra with a long process from lateral posterior corner; sternites IV–VI with but an apical and an anteapical row of short black setae .... *L. bouceki* n. sp.
   Elytra with but a small bump at lateral posterior corners; sternites IV–VI with many long, black, curly setae which are not arranged in definite rows .... *L. carlislei* n. sp.

Longipedisymbia bouceki Kistner, new species

(Figs. 14, 20, 25)

Distinguished from *L. carlislei* to which it is most closely related by the shape of the elytra and the chaetotaxy of the abdomen as well as the shape of the male genitalia and spermatheca.

Color light reddish-brown throughout except for the white abdominal membranes. Head with definite projections from anterior border of vertex median to antennal fossae and with well-developed angular projections from lateral border behind eyes (Fig. 25). Elytra with well-developed projections from posterior lateral borders (Fig. 25). Abdominal segment VII with 2 distinct pairs of paratergites. Chaetotaxy of abdominal tergites II–VIII as follows: 0, 6, 16, 14, 8, 4-0, 4-4. Sternite III with apical row of short black setae and anteapical cluster of 4–6 setae in center. Sternites IV–VI with apical and anteapical row of short black setae. Sternites VII and VIII with apical and anteapical row of setae slightly longer than those of preceding segments. Outer paratergites on segments IV–VI with 1 black seta each. Median lobe of male genitalia shaped as in Fig. 14. Lateral lobes of male genitalia shaped as *L. bradburni* (Fig. 35). Spermatheca shaped as in Fig. 20.

Measurements.—Pronotum length, 0.65–0.67; head length, 0.31–0.32; elytra length, 0.45–0.47. Number measured, 6.

Holotype male No. 13522, MALAYA, SUNGEI BULOH FOREST RESERVE, 3° 10′ N., 101° 34′ E., 18 March 1963, Coll. A. and Eleanor Emerson, C. M. Low, and R. D. Menon, altitude 150 feet, near queen. In collection of D. H. Kistner.

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

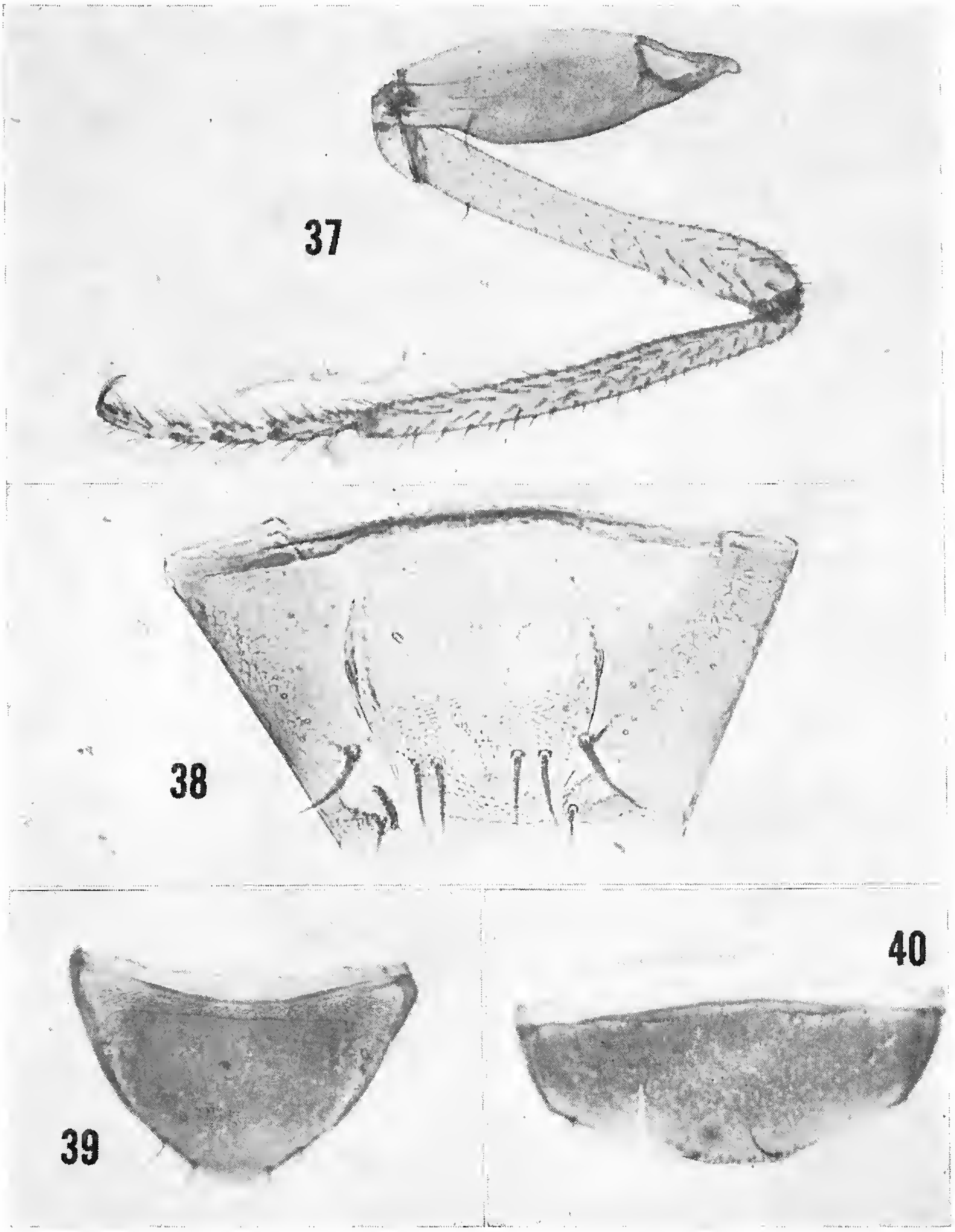
This species is named for Mr. George Boucek, Secretary of the Shinner Foundation, Chicago.

Longipedisymbia bradburni Kistner, new species

(Figs. 21, 22, 28–40)

Distinguished from *L. bouceki* to which it is most closely related by the lack of projections from the lateral border of the head behind the eyes, its slenderer and smaller form, the abdominal chaetotaxy, as well as the shape of the male genitalia and the spermatheca.

Color reddish-brown throughout except for white abdominal membranes. Pronotum and appendages somewhat lighter in color than head, elytra, and abdomen.



FIGS. 37–40. *Longipedisymbia bradburni.* FIG. 37. Proleg. FIG. 38. Abdominal segment IX of female. FIG. 39. Abdominal segment VIII. FIG. 40. Abdominal segment VII.

Head with vertex squared behind eyes; without definite projections median to antennal fossae. Elytra with well-developed projections from posterior lateral borders. Abdominal segment VII with 2 distinct, although thin pairs of paratergites. Chaetotaxy of abdominal tergites II–VIII as follows: 0, 2, 4, 4, 4, 0, 4; those on tergites III–VI very tiny. Chaetotaxy of abdominal sternites III–VIII: 2-4, 4-6, 2-6, 0-6, 6, 4. Those mentioned first on sternites III–VI are anteapical, those mentioned second are apical. Median lobe of male genitalia shaped as in Fig. 22. Lateral lobe of male genitalia shaped as in Fig. 35. Spermatheca shaped as in Fig. 21.

Measurements.—Pronotum length, 0.56–0.62; head length, 0.32–0.35; elytra length, 0.40–0.42. Number measured, 5.

Holotype male No. 13523, MALAYA, SUNGEI BULOH FOREST RESERVE, 3° 10′ N., 101° 34′ E., 18 March 1963, Coll. A. and Eleanor Emerson, C. M. Low, and R. D. Menon, altitude 150 feet, near queen.

Paratypes.—2, same data as the holotype; 4, Sarawak, 1° 38′ N., 113° 35′ E., 7 February 1963, altitude 950 feet, Coll. A. and Eleanor Emerson and W. King, vial No. 2, ex nest in hard log.

This species is named for Mr. Robert Bradburn of Chicago, Illinois.

Longipedisymbia carlislei Kistner, new species

(Figs. 16, 19, 26–27)

Distinguished from *L. bouceki* to which it is most closely related by its larger size, the lack of very long processes from the lateral posterior corners of the elytra, the abdominal chaetotaxy, as well as the shape of the male genitalia and the spermatheca.

Color reddish-brown throughout except for white abdominal membranes. Abdominal sternites III–V and appendages are somewhat lighter in color than rest of body. Head with vertex bearing definite projections from lateral borders behind eyes. Vertex also with squared-off projections from anterior border of head medial to antennal fossae. Elytra with scarcely any projections from posterior lateral corners (Fig. 26). Abdominal segment VII with 2 paratergites fused together but having indentation at anterior border (Fig. 27). Chactotaxy of abdominal tergites II–VIII as follows: 0, 6, 16, 12, 10, 0, 0-8. Setae of tergites III–VI extremely small and quite probably give inaccurate counts as it is not always possible to see the socket if a seta is missing. Sternites III–VI have many setae long, curly, not arranged in definite rows, the setae 4 or more deep from anterior to posterior. Sternite VII with apical and anteapical row of setae. Sternite VIII with 4 setae. Median lobe of male genitalia shaped as in Fig. 16. Lateral lobe shaped as in *L. bradburni.* Spermatheca shaped as in Fig. 19.

Measurements.—Pronotum length, 0.70–0.75; head length, 0.45–0.47; elytra length, 0.50–0.55. Number measured, 5.

Holotype male No. 13525, MALAYA, SUNGEI BULOH FOREST RESERVE, 3° 10′ N., 101° 34′ E., altitude 150 feet, 18 March 1963, Coll. A. and Eleanor Emerson, C. M. Low, and R. D. Menon, near queen.

Paratypes.—5, same data as the holotype; 1, Sarawak, 1° 38′ N., 113° 35′ E., altitude 950 feet, 7 February 1963, Coll. A. and Eleanor Emerson and W. King, vial No. 1, in cells under log near nest.

This species is named for Dr. W. T. Carlisle of Chicago.

LITERATURE CITED

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Occurrence of *Malacosoma incurvum discoloratum* in Zion Canyon, Utah

(Lepidoptera: Lasiocampidae)

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The tent caterpillar, *Malacosoma incurvum discoloratum* (Neumoegen), feeds on a wide variety of plant hosts (Stehr and Cook, 1968). These authors proposed that the common name of *M. incurvum* be the "Southwestern tent caterpillar" due to its range in southwestern North America. Infestations have been reported on Fremont cottonwood, *Populus fremontii* S. Watson in Zion National Park, Utah and in the lower reaches of the Virgin River as early as 1923. Unlike many tent caterpillar populations, this one has not reached extremely low levels between population peaks. When endemic levels have been reached in the Zion population, noticeable centers of insect activity have persisted. Additionally, the highly concentrated public use in the Park has caused interest in population levels that might elsewhere receive little notice.

Egg masses of the insect have been identified on *Populus fremontii* S. Wats., *P. alba* L., *P. augustifolia* James, *Salix* sp., and apricot, (*Prunus* sp.). Previous synonymy included *M. fragilis mus* form *discolorata* (Neumoegen); *M. fragilis incurva* var. *discolorata* (Neumoegen); *M. fragilis incurva* (Henry Edwards), *sensu* Dyar; *Clisiocampa fragilis* (Stretch), *sensu* Neumoegen and Dyar; and *Clisiocampa mus* var. *discolorata* Neumoegen (Stehr and Cook, 1968). Local reference to the population described herein has often been in the form of the Great Basin tent caterpillar, *Malacosoma fragile* (Stretch).

The purpose of this paper is to report the insect's occurrence on Fremont cottonwood along the Virgin River in the main canyon of Zion Park. This cottonwood characteristically occupies alluvial stream bottoms and their borders and contributes to their stability (Sudworth,

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[1] Branch of Insect and Disease Prevention and Control, Division of Timber Management.

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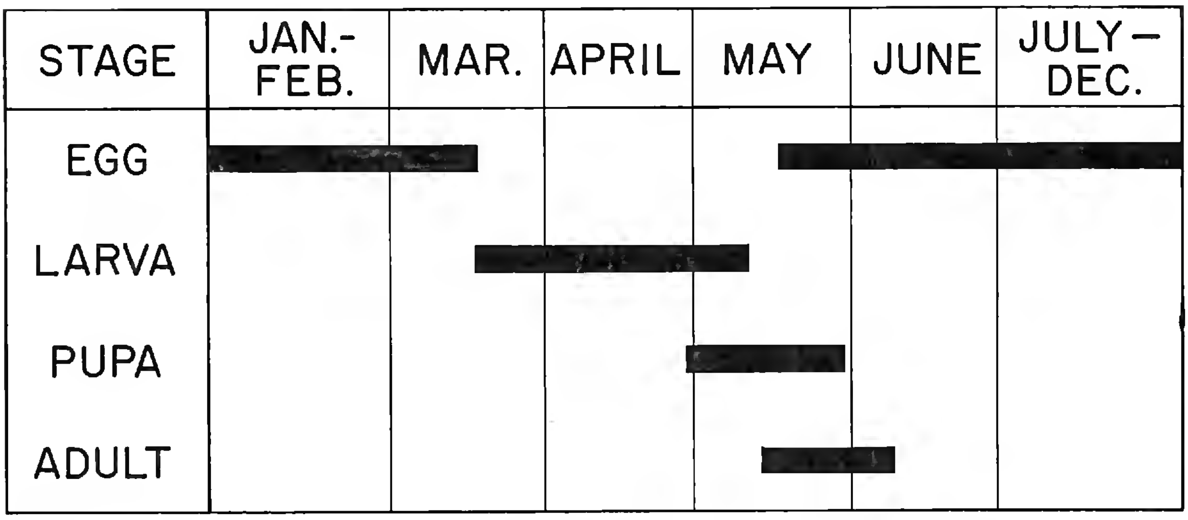


FIG. 1. Seasonal development of *Malacosoma incurvum discoloratum* on *Populus fremontii* in Zion Canyon, Utah.

1934). In Zion Park and in certain other high-use recreation areas in the arid Southwest, it is aesthetically valuable as well as being the primary source of shade. Insect collections and measurements and field observations of the Zion population were made in recent years to determine its characteristics and habits.

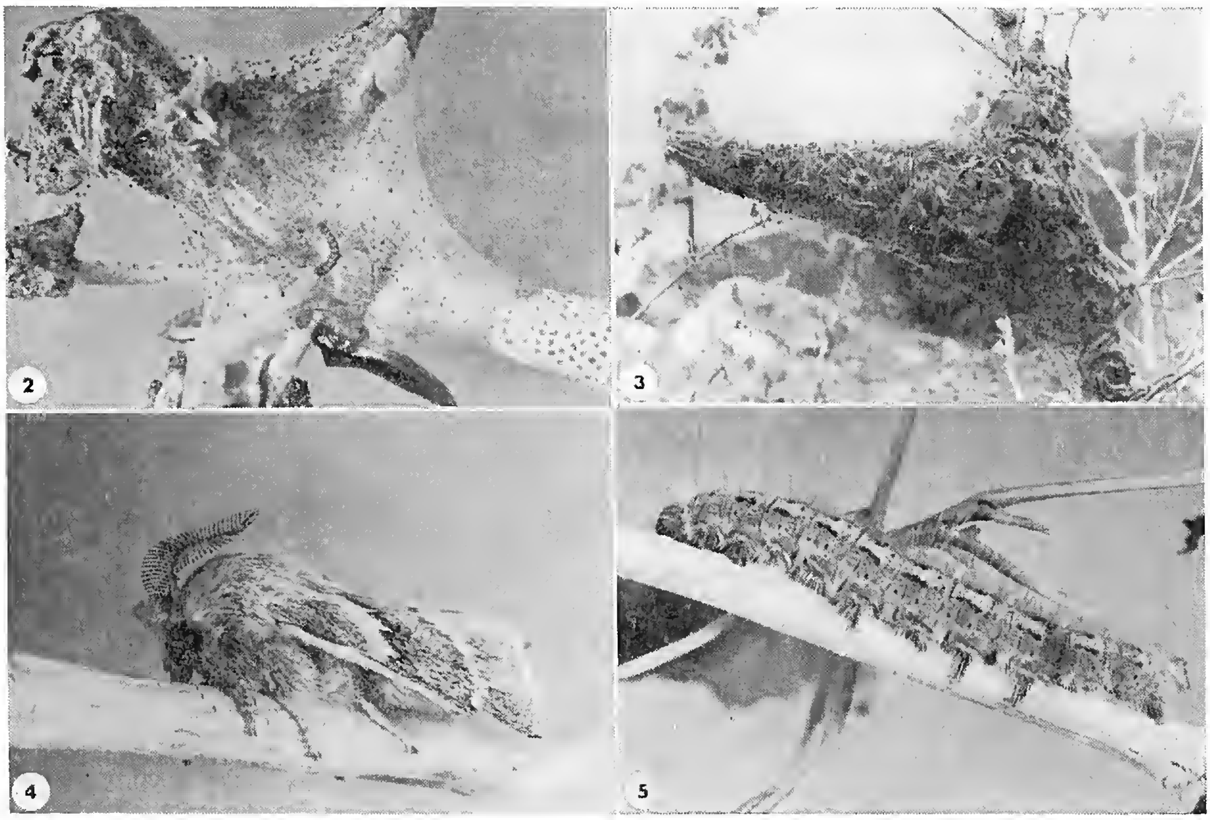
LIFE STAGES

Although embryological development is yet to be monitored in this population, it has been recognized that such development in the genus *Malacosoma* commences immediately following egg deposition and that young larvae are fully formed within two or three weeks (Stehr and Cook, 1968). Nearly 10 months are passed in the egg stage each year. Eclosion from the egg in early spring is closely associated with initial leaf expansion of the host tree. Although there is some annual variation in seasonal development, Figure 1 depicts the life cycle in a typical year. Larvae, emerging from the eggs, chew through the chorion and the

TABLE 1. Head capsule widths of *Malacosoma incurvum discoloratum* larvae.

		Head capsule width (mm)	
Larval instar	Number of specimens	Mean	Confidence interval*
1	253	0.43	0.42–0.44
2	185	0.66	0.65–0.67
3	301	1.02	1.01–1.03
4	294	1.54	1.53–1.55
5	365	2.22	2.20–2.24
6	480	3.18	3.16–3.20

* 99% probability level.



FIGS. 2–5. *Malacosoma incurvum discoloratum.* FIG. 2. Recently emerged larvae forming tent adjacent to whitish egg mass. FIG. 3. Well developed tent resulting from consolidated larval activity. FIG. 4. Male adult. FIG. 5. Late-instar larva.

spumaline, the protective adhesive layer covering the mass. Most egg masses in the same general vicinity hatch within a few days. First-instar larvae then begin building small silken tents on the host plant (Fig. 2). Tents are frequently abandoned and new ones established elsewhere. Colonies originating from individual egg masses become consolidated into larger tents as the larvae increase in size (Fig. 3).

To determine the number of instars, 1,878 larvae were collected at intervals during two field seasons and their head capsules measured (Table 1). These data and the resulting frequency histogram (Fig. 6) show that there are six instars. This is in contrast with five instars of a related tent caterpillar on *P. tremuloides* Michx. in New Mexico (Stelzer, 1968). As expected, development is most synchronized in the early instars with considerable overlap prior to pupation. By 24 April 1968, larvae were in the fifth and sixth instars (Fig. 5) and had begun the characteristic prepupational wandering. Pupation occurs in any niche or crevice, whether it be under bark, beneath rocks, on buildings, or on parked vehicles. The pupal stage lasts approximately two weeks. Cocoons containing living pupae can, however, be found over a more extended period. Adult emergence (Fig. 4) usually occurs late in May or early June with oviposition beginning in late May and continuing

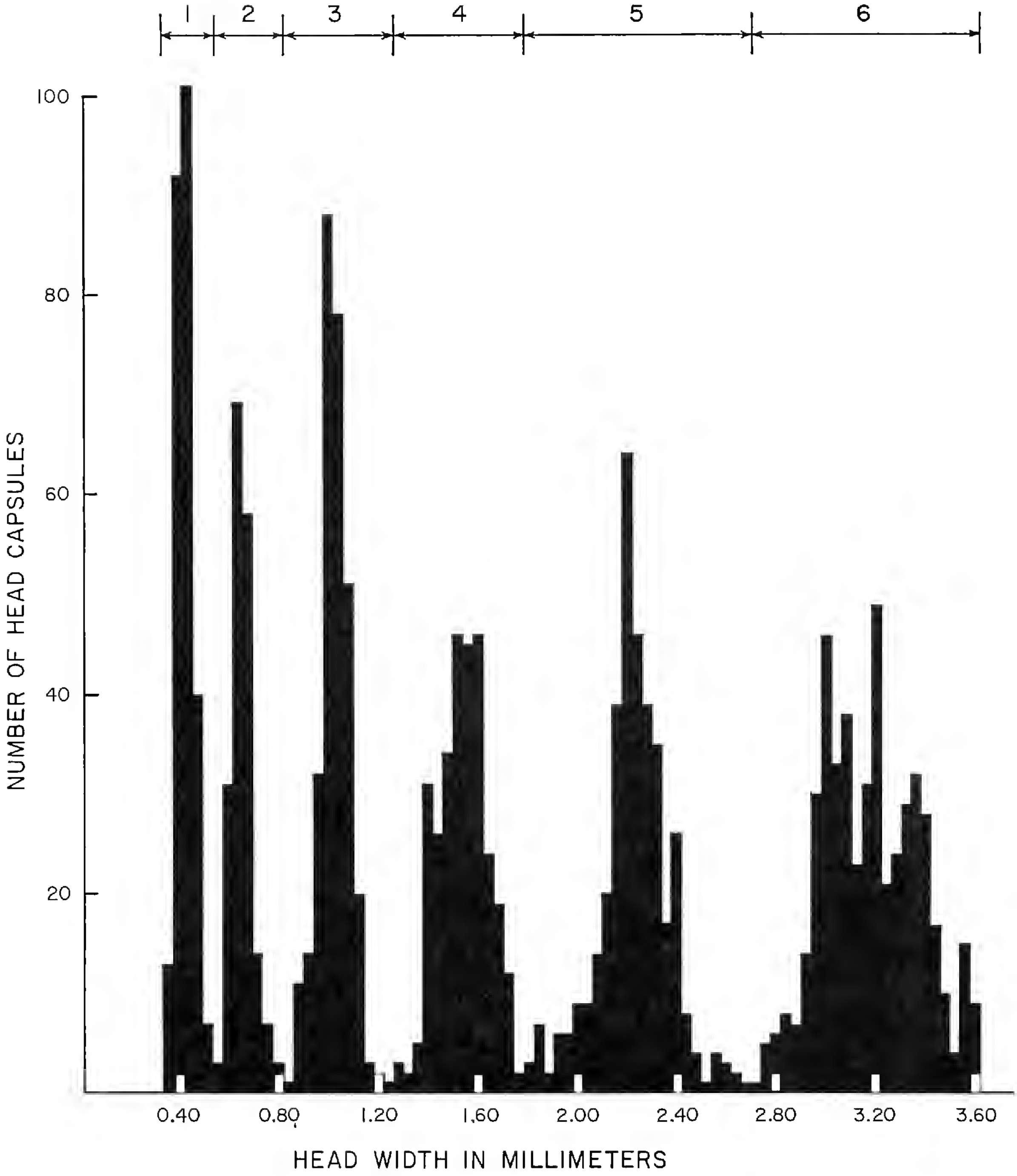


FIG. 6. Head capsule measurements of 1,878 *Malacosoma incurvum discoloratum* larvae.

through June. Seasonal development, it must be stressed, may vary considerably from year to year. Development rates are also quite localized. While the population in Zion Park (elev. 4,048 ft.) was mostly in the sixth instar and pupal stage on 16 May 1968, another population of *M. incurvum discoloratum* 54 miles away at Littlefield, Arizona (elev. 1,858 ft.) had reached the egg stage.

BIOLOGY

Egg Masses.—The white egg masses are deposited on cottonwood twigs. In the course of annual egg surveys, it has been found that egg masses are usually most abundant in the central portion of the tree crown. It was also observed that 99.7% of the egg masses are laid within 21 inches of the branch end. Examination of 42 randomly selected 1967–1968 egg masses revealed a mean twig diameter at the site of oviposition of 4.2 mm. The same egg masses were measured and the mean mass was found to be 14.5 mm long and 10.6 mm wide. The mean number of eggs was 163.8. Mean laboratory emergence was 86.8 or about 53% of the mean total number of eggs.

Colonial Behavior.—An effort was made to determine behavioral patterns of colonies on their cottonwood host. As behavioral patterns became evident, it was also apparent that separate colonies or portions of colonies followed different patterns at the same time. Field observations were made during both day and night, during both rain and clear weather, and at temperatures ranging from 46° to 80° F. Under all conditions and at all examination times, it was possible to find some of the tagged colonies either quiescent inside the tents or partially inside the tents with individuals traveling or feeding outside. One particular tent was observed to be almost entirely occupied by caterpillars but two hours later most of this aggressive colony had vacated the old tent and traveled 90 cm along adjacent twigs and had constructed the nucleus of an entirely new tent. During a record low temperature of 23° F on 20 April 1966, numerous larvae in the Zion population were found motionless but perfectly healthy on tents and on leaf and branch surfaces outside their tents. Larval activity resumed with a return to higher temperatures. The highly variable intercolonial and intracolonial behavior may possibly be explained by the individual larval differences demonstrated by Wellington (1957). In his studies, he categorized larvae under two general types of behavior, "sluggish" and "active." He found that the presence of active individuals had a definite influence on the actions of their sluggish followers. The observations recorded in Zion Canyon may be, to some measure, a function of active individuals expressing a tendency to travel or forage out of the tent under diverse conditions. Individual larval observations would be necessary to determine this possibility.

The violent anterior "jerking" exhibited by larvae (Stehr and Cook, 1968) has been repeatedly observed on Fremont cottonwood. Various disturbances have in the past been a possible explanation for this activity. No disturbances such as attacks by parasites were identified but may well have prevailed. It was impressive to note entire clusters of larvae exhibiting the jerking behavior simultaneously.

Host Damage

Early-instar larvae consume expanding leaves and catkins. In the last three instars, before prepupational wandering, damage to leaves increases considerably. Individual leaves are either partially or entirely consumed. It is questionable how much Fremont cottonwood mortality would result if the population went uncontrolled. Like other hardwoods, the cottonwood has a remarkable propensity to endure defoliation and refoliate the same season after the cessation of insect feeding. Undoubtedly, certain trees or groups of trees might succumb, but most of the host type would probably survive from year to year. Scattered branch mortality indicates some possible evidence of past tent caterpillar feeding.

Insect Mortality

Natural Factors.—Parasites that have been recovered from larvae and pupae in Zion Park over the past three years include a tachinid, *Chaetogaedia monticola* (Big.) and the chalcid, *Brachymeria ovata* (Say). Also recovered was an eulophid egg parasite, *Tetrastichus malacosomae* Girault, a common parasite of the genus *Malacosoma* throughout the Great Basin. Although a pathogenic virus has been observed, recent annual biological evaluations have not revealed any widespread occurrence of virus in the population.

Applied Factors.—Through the years the nuisance of abundant larvae has been reduced in the heavily used recreational areas of Zion Park. Records indicate that control was attempted in Zion Park as early as 1923. Applied control of portions of the Zion infestation has evolved from the use of inorganic and synthetic organic insecticides to the use of a more selective microbial insecticide. A formulation of *Bacillus thuringiensis* var. *thuringiensis* Berliner, Thuricide 90TS[2], was found in 1965 to provide desirable operational characteristics and was claimed by the manufacturer to have improved biological effectiveness (Klein and Brueck, 1965). Control results in 1965 were considered acceptable. In less than 24 hours, infected larvae had ceased feeding and had assumed a moribund appearance. Applications of *B. thuringiensis* have achieved the desired purpose.

Acknowledgments

Credit is due M. Minnoch, L. O. Sandin, D. J. Curtis, and officials of Zion National Park for their field and laboratory cooperation. Photographic credit is due W. H. Klein. F. W. Stehr was helpful in species determination and manuscript review.

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[2] Registered trademark, Bioferm Division, International Minerals Corp., Wasco, California. Does not necessarily imply endorsement by U.S.D.A.

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Immature Stages and Habits of *Spondylis upiformis* Mannerheim

(Coleoptera: Cerambycidae)

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Three species of *Spondylis* Fabricius have been recognized, one from the Palearctic Region, one from western North America, and one from Mexico (Linsley, 1962). The larva and pupa of the European species, *S. buprestoides* L., have been described (Duffy, 1953) but neither the immature stages nor food habits of the North American species have been recognized, although the adults are commonly encountered.

In 1968, several larvae and two pupae were collected by the author from two stumps of white spruce, *Picea glauca* (Moench) Voss, at the Kananaskis Forest Experiment Station, Seebe, Alberta. The stumps had been pulled from the ground for other purposes; otherwise the presence of the insects would have been unsuspected. One pupa was permitted to complete development, and the adult was identified as *S. upiformis*, the western North American species. The immature stages and habits of this species are described herein.

Descriptions of Immature Stages

Advanced Larva.—Form robust, subcylindrical, length up to 22 mm; in all respects, typically asemine.

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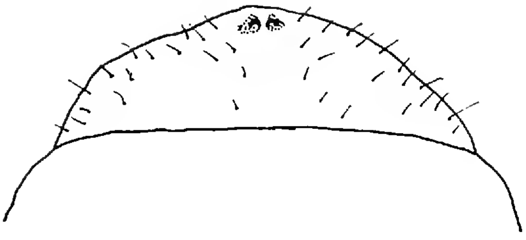

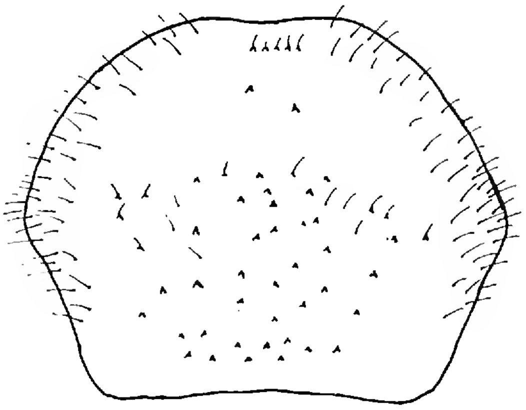

FIGS. 1–2. *Spondylis upiformis.* FIG. 1. Ninth abdominal tergum and urogomphi of larva. FIG. 2. Pronotum of pupa.

Head depressed; mouthframe, frons, ventral genal areas, and hypostomal bridge piceous to dark castaneous; epistoma shallowly declivous, bearing six to eight setae laterally, midfrontal inflection dark, frontal sutures bisecting antennal sockets; frons roughly excavated behind antennae, genae moderately densely clothed with golden setae; antennae minute, retractile, three-segmented, third segment very small, almost equalled in length by conical supplementary segment; ocelli absent; hypostoma fused with base of ventral mouthparts, gular sutures slightly raised.

Clypeus produced at sides; labrum thick, broadly rounded; densely setose, setae shorter and denser apically; mandible slender, apex depressed, shining; ventral mouthparts fleshy, cardo well defined, maxillary lobe digitate, last joint of maxillary palp shorter than second, equal to or slightly longer than last labial.

Pronotum testaceous, posterior half darker, finely asperate, lateral furrows pronounced, converging slightly anteriorly, pubescence short and sparse between furrows, lateral setae moderately dense, ferruginous; eusternum finely asperate, bearing numerous fine, reddish setae; legs three-segmented, unguiculus attenuate, imbricately spinose.

Dorsal abdominal ampullae finely asperate, very sparsely pubescent, broadly impressed on midline; spiracles small, ovate to suborbicular, peritreme thin, with two or three contiguous chambers on posterior rim; pleural tubercles not evident; ninth tergum with a pair of small, blunt urogomphi separated by less than basal width (fig. 1).

The last character readily separates this species from *S. buprestoides* in which the urogomphi are separated by at least four times their basal width (Duffy, 1953).

Pupa.—Length 18 mm, single specimen, male.

Head barely visible from above, body widest at fourth abdominal segment. Tapering rapidly posteriorly.

Vertex of head glabrous, face and mandibles with numerous, very fine, light setae; pronotum obtusely angled on sides which are thickly clothed with fine setae (fig. 2), disc with numerous small spines, some with terminal setae; scutellum with few similar spines; metatergum with broad, V-shaped band of

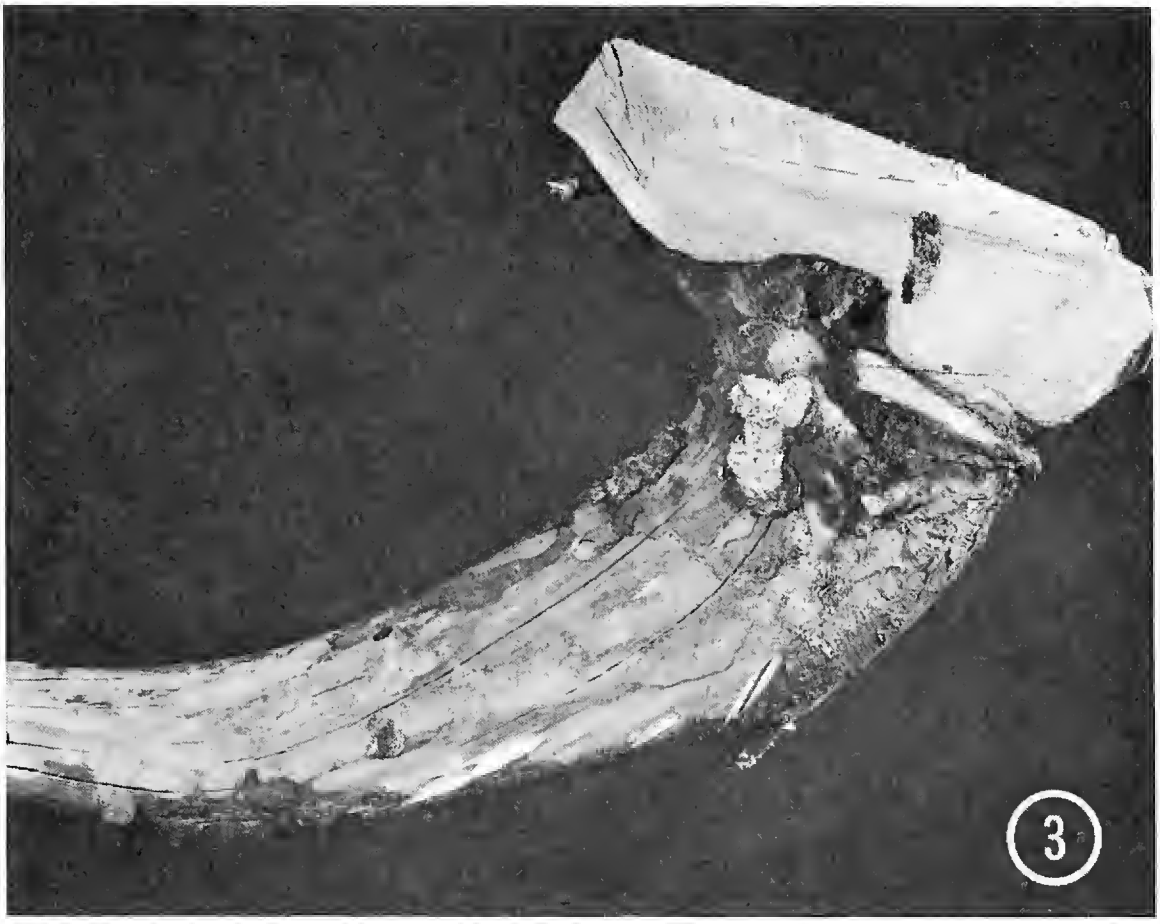

Fig. 3. Larval galleries and pupal cells of *Spondylis upiformis* in spruce root.

small spines and fine setae; femora with few small spines and a fringe of fine setae at apex, hind femora with large, fleshy basal lobe (actually developing trochanter).

Abdominal terga with transverse bands of slightly larger spines, sparsely clothed anteriorly and laterally with fine setae; ninth tergum terminating in a pair of incurved, heavily sclerotized urogomphi; third to eighth sterna with lateral groups of small spines; ninth sternum with a pair of short setae; pleura with a group of setae; functional spiracles on first seven abdominal segments.

The pupa is distinguished from that of *S. buprestoides* by the lack of stout, curved, pronotal spines described by Duffy (1953) on the latter species.

The above descriptions are based on ten larvae and one male pupa, designated as Collection No. S1.1.3 in the Cerambycid Collection, Forest Research Laboratory, Sault Ste. Marie, Ontario.

HABITS

Linsley (1962) gives the range of this species as "from Alaska southeast to the Great Lakes region, south into the Rocky Mountains, and along the Pacific Coast." As well as in Alberta, I have collected adults in mid-June in an area logged for spruce and balsam fir near Sault Ste. Marie, Ontario.

The stumps that yielded the immature stages described above were from trees cut on 15 June and 16 June 1966. Both stumps were pulled on 17 May 1968 and were examined for insects on 31 July. The larvae apparently had entered pupal cells by the time of pulling, but were prevented from achieving normal development and emergence by drying of the stump. The length of the larval feeding galleries suggests that oviposition occurred in 1966, and that this species has a 2-year life cycle in Alberta.

The method of oviposition is unknown, but the larval galleries began in the roots, sometimes more than a meter from the stump. Feeding proceeded more or less straight along the root towards the stump, the larva scoring the wood deeply and leaving the gallery filled with fibrous frass. Pupation occurred in shallow cells excavated in the sapwood of the stump or in roots near the stump (fig. 3). Feeding and pupation took place as much as 50 cm below the soil surface. The adults are, however, somewhat adapted for digging, having unusually large mandibles and terminal lamellae on the fore tibiae.

Acknowledgment

I am grateful to W. D. Johnstone, Department of Fisheries and Forestry, Calgary, Alberta for information on stump history and location.

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A New Genus in the Tribe Euplectini

(Coleoptera: Pselaphidae)

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University of California, Davis

This new genus has close affinities with the genus *Actium* of Casey. The first visible abdominal tergite of all of the species of *Actium* is essentially the same. This segment bears two basal carinae that differ between species in length and in degree of separation. A species has been discovered which differs from *Actium* mainly in that the base of

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tergite I has a densely pubescent median depression and the carinae are absent. We consider the addition of this depression and the absence of the carinate condition fundamental differences that justify placing the species in a separate genus.

Pilactium Grigarick and Schuster, new genus

TYPE OF GENUS.—*Pilactium summersi* Grigarick and Schuster, new species.

This genus has those subtribal characteristics typical of the Trimiina and is defined by the following combination of characters:

1) Ventral surface of head with capitate setae. 2) Two vertexal foveae, connected by entire U-shaped frontal sulcus. 3) Gular foveae separate. 4) Antennal segments IX to XI forming a distinct club, X nearly symmetrical, well separated from XI. 5) Pronotum with basolateral foveae connected by transverse, slightly biarcuate sulcus. 6) Elytron with 2 antebasal foveae; sutral stria entire; discal fovea with sulcoid impression about one-half length of elytron. 7) Prosternum simple, prosternal foveae large. 8) Mesosternal preplectus medianly carinate; mesosternum anteriorly with 2 lateral and 1 median foveae. 9) Metasternum with median paired foveae. 10) Profemur with row of specialized setae on basal half. 11) Meso- and metacoxae contiguous. 12) Tarsal claws consist of large primary and smaller secondary structures. 13) First visible tergite with densely pubescent, median depression; basal carinae absent. 14) Second sternite with pubescent, median depression.

Pilactium summersi Grigarick and Schuster, new species

(Figs. 1–4)

MALE.—Teneral specimen, yellow brown. Length 933[1], width 354. Head 151 long, 181 wide; vertexal foveae 77 between centers; ventral surface with 24 capitate setae; eyes moderate. Antenna 310 long; segment I 43 long, 27 wide; II 34 long, 30 wide; III to VI inclusive 57 long, 20 wide; VII 16 long, 24 wide; VIII 16 long, 27 wide; IX 17 long, 34 wide; X 24 long, 40 wide, nearly symmetrical, well separated from XI; XI 87 long, 54 wide, as long as preceding 5 segments.

Pronotum 208 long, 225 wide. Elytron 292 long, with 2 antebasal foveae. Winged. Protrochanter simple; profemur 57 wide; protibia simple. Mesotrochanter simple; mesofemur 63 wide; mesotibia with small, blunt apical spine. Postmesocoxal foveae with apodemes directed obliquely forward. Metafemur 50 wide.

First visible tergite 245 wide at base, without basal carinae but with dense setae area 100 wide (fig. 4). Sternite II with median, pubescent depression; III to V unmodified; VI deeply emarginate, with median group of broad setae (fig. 3); penial plate 125 long, setate area nearly round, 93 in diameter. Aedeagus 221 long, 128 deep (fig. 1).

FEMALE.—Segment IX as in figure 2.

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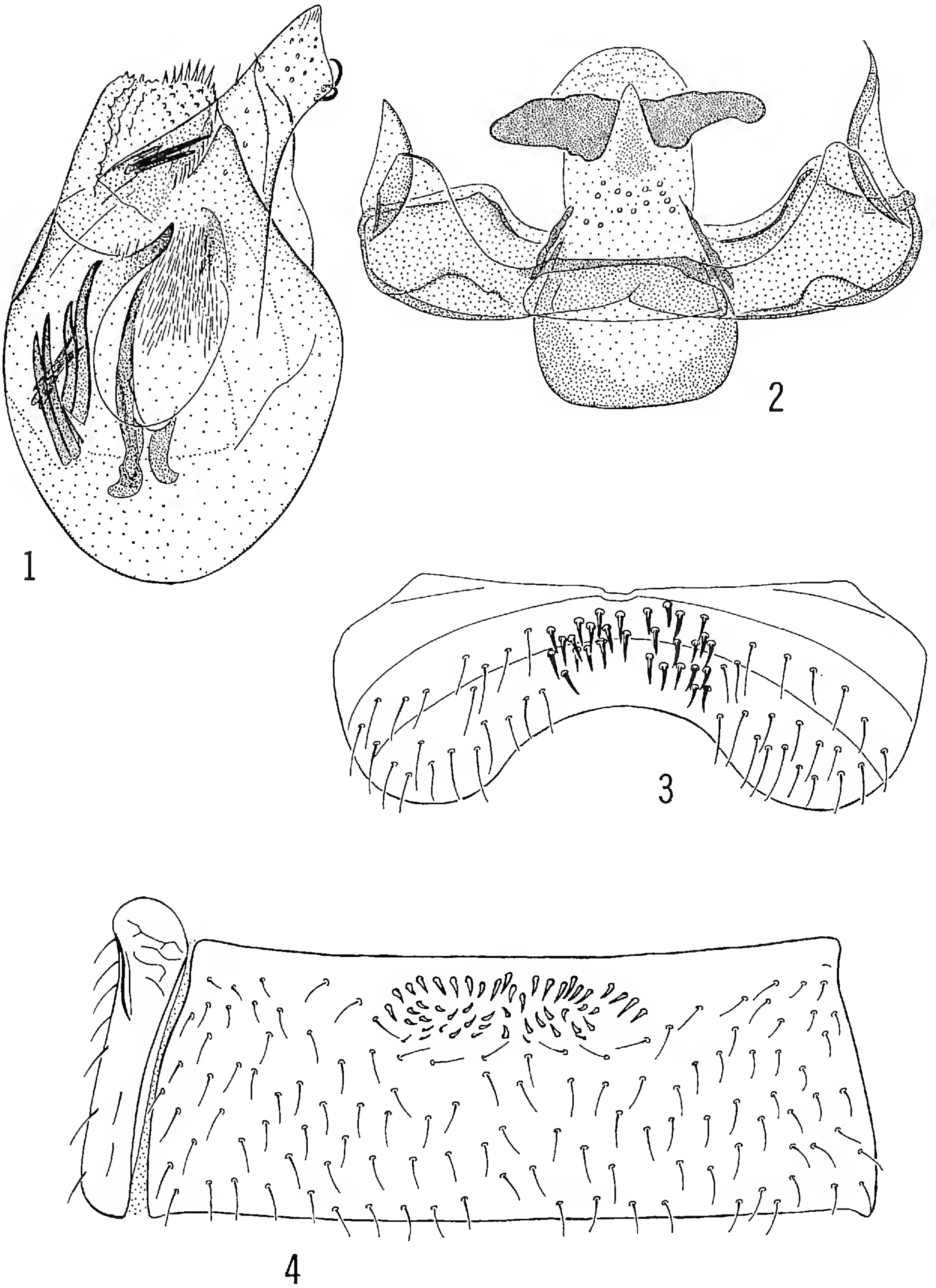
[1] All measurements in microns.



FIGS. 1–4. *Pilactium summersi* Grigarick and Schuster, new species. FIG. 1. Male genitalia, dorsal. FIG. 2. Female genitalia, mainly ninth segment, orientation not established. FIG. 3. Male sternite VI. FIG. 4. Median depression of first visible tergite.

DISTRIBUTION.—The *holotype male* was collected at QUINCY, PLUMAS COUNTY, CALIFORNIA on 1 April 1951 by F. M. Summers. A male paratype was collected at Pine Grove, Amador County, California on

12 February 1961 by D. W. Price from pine forest soil. A female paratype was collected at Dunsmuir, Mt. Bradley, Siskiyou County, California on 20 September 1961 by R. O. Schuster. The type is deposited with the Department of Entomology, University of California, Davis.

Discussion.—This uncommon montane species is known only from single specimens at three widely separate localities of northern California. Expected differences in species that may be collected in the future, as indicated by related genera, would be in the following structures: tibial spines (male); number of capitate setae on venter of head; size relationship of femora (male); setation of sternite VI (male); and genitalic differences.

Free Diurnal Foraging by the North American Nasutiform Termite, *Tenuirostritermes tenuirostris*[1]

(Isoptera : Termitidae)

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University of Arizona, Tucson

Tenuirostritermes tenuirostris (Desneux) is one of at least two species of termites possessing nasutiform soldiers which reach the extreme southern United States. It ranges from southern Mexico and perhaps Guatemala (Snyder, 1949) into the Upper Sonoran Zone of southeastern Arizona and similar areas in southwestern Texas. The other species, *T. cinereus* (Buckley), occurs in southwestern Texas and may range into south-central Mexico. Two additional species in this genus are confined to ranges of undetermined extent in Central America and perhaps the West Indies. All of the species are apparently subterranean since they are not known to build tree nests or extensive systems of tubes above ground as do many other genera of nasutiform termites. Thus, although *T. tenuirostris* and *cinereus* are unusual elements in our fauna, they are not widely known because of their cryptic habits and limited distribution in the United States.

The following notes were made on *T. tenuirostris*, incidental to a field study of termite flight behavior conducted in western Mexico, from May to October, 1964. This termite was observed foraging on exposed trails during daylight hours on four separate occasions. The

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[1] Journal Paper No. 1499 of the Arizona Agricultural Experiment Station. Supported in part by State Research Project No. 461 and a research grant from the National Pest Control Association for travel in Mexico.

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first three observations were made in the mountains directly north of the village of Ajijic, on the north shore of Lake Chapala in Jalisco. The summer rainy season had begun with traces of rain on May 18, and showers of more than 0.1 inch on 20 May and 2 June. On 6 June in a steep canyon (5800 ft.), a group of several hundred workers and soldiers were disturbed in a loose mat of dry leaves and grasses. They had been operating in an irregular column several feet from galleries under a small, deeply set stone. Although this was at 1100 hrs, and very warm, all of the activity was in the deep shade of the canyon wall.

On 29 July after several weeks of showers totalling over 14 inches of rain, a similar situation was discovered. The colony was located beneath a stone wall separating pasture from a well-traveled dirt lane (5200 ft.). A column of termites was moving to and from a hole beside the wall to a site six feet away where workers were collecting bits of dead grass and green leaves. Several workers were cutting semicircles, irregular circles and other shapes (1–2 mm on a side) from the hairy leaves of a small honeysuckle plant. Some of the leaves, up to 6 inches above the ground, had been completely removed. Soldiers were spaced at one-half-inch intervals on either side of, and about one-half inch from, the two-way traffic of workers. This activity was first seen at 1400 hrs under a complete overcast. When the foragers were disturbed they quickly moved in to the end of the column and the traffic was progressively reversed. Small groups of soldiers moved from their lateral positions to alternate with groups of workers in a remarkably orderly return to the hole under the wall. Two and one-half hours later, during a light drizzle, foragers were working about two feet from the nest in the opposite direction.

At 1045 hrs on 6 August another column was found in dense grass beside the trail on an open ridge at 5500 ft. A 50% cloud cover provided intermittent shade during the entire morning. The last encounter occurred on 21 August in a pass (3850 ft.), 5.2 road miles (Highway 110) south of Tecalitlan, Jalisco. A short column was found at 1330 hrs foraging in a stony, short-grass area in an oak-pine woodland. The sky was completely overcast. Each of the colonies north of Ajijic was checked on several other occasions, and foraging was never seen during continuous, bright sunlight.

Although these are not the first records of such activity for *T. tenuirostris*, they are the first to establish that it will attack living plants. In connection with her intensive field and laboratory work on caste development in this species, Weesner (1953) described her observations on its foraging behavior in southeastern Arizona. She saw workers actually cutting plant material only once. They were accompanied by soldiers and were operating in daylight on a large grass stalk under the cover of a small board. (1000 hrs, 3 September 1947, very hot and dry; Weesner, *in litt.*, 27 May 1969.) On another occasion at night she encountered a short, exposed column of workers guarded by soldiers. She also noted that stores of plant fragments were generally found in their chambers and galleries beneath stones. However, in all cases this consisted entirely of dry, weathered plant materials. The author has made similar observations in colonies of this species at several localities in southeastern Arizona and in Mexico.

Considerably less is known about the distribution and biology of *T. cinereus.* However, Banks and Snyder (1920) cited three early accounts in Texas where workers, accompanied by soldiers, were found foraging in the open: once for grass and weed seeds at about sunset, again for dry leaves (Buckley) and, on the third occasion "destroying living plants by sucking the juices" (Parman). Most of the observations indicated that they probably do not forage in bright sunlight.

Ebeling (1959) mentioned *Tenuirostritermes incisus* (Snyder) as having been recorded feeding on the avocado. The record comes from some locality in the West Indies, although Snyder (1949) listed it only from Spanish Honduras. The author has collected this species in Guerrero, and *Tenuirostritermes briciae* (Snyder) in Nayarit, both in southern Mexico. Apparently nothing else has been published on these two species since the original descriptions (Snyder, 1922).

Snyder (1968) has continued to update a growing bibliography on termites which damage living vegetation. The most notable among these papers is that by Harris (1962) wherein he provided a world list of 106 species of termites, from all six families, which feed on living plants. Many of them are economically important pests of crops and trees. In all of these records, reports of such damage in the New World are surprisingly few. The two termitid genera most often mentioned are *Nasutitermes* and *Syntermes*. *Syntermes* has been observed foraging from exposed trails (Emerson, 1938), while *Nasutitermes* generally works from covered runways.

Although *Tenuirostritermes* has apparently never been observed to attack crop plants, its abundance in certain agricultural areas certainly provides this potential. In foothill and mountain regions of western Mexico, *tenuinostris* was found several times in the vicinity of, and sometimes within, the "milpas" or cultivated plots (chiefly corn). In southeastern Arizona, where it occurs in areas of lower rainfall, the land is used almost exclusively as range for cattle.

I want to thank Frances M. Weesner of Colorado State University, for reviewing the manuscript and confirming my own identification of *T. tenuirostris* from several localities in Mexico.

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***Pselactus spadix* (Herbst), a European Cossonine Weevil New to California**

(Coleoptera: Curculionidae)

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International Programs in Agriculture, Purdue University

Pselactus spadix (Herbst) is a native of Great Britain and the west coast of Europe. It has been introduced into the eastern United States, Australia, and New Zealand, where specimens have been taken in wood associated with salt water. Published European records are all coastal and all directly associated with salt water. Specimens have been collected in stumps regularly covered by tide (Champion, 1871) and in England a wharf and its piles which were regularly subjected to salt spray and storm waves were severely damaged (Walker, 1879). However, in a more recent work on its presence in Argentina, Viana (1961) discusses extensive damage in *Acer negundo* Linné and *Salix babylonica* Linné in the field and also in furniture and the flooring of houses.

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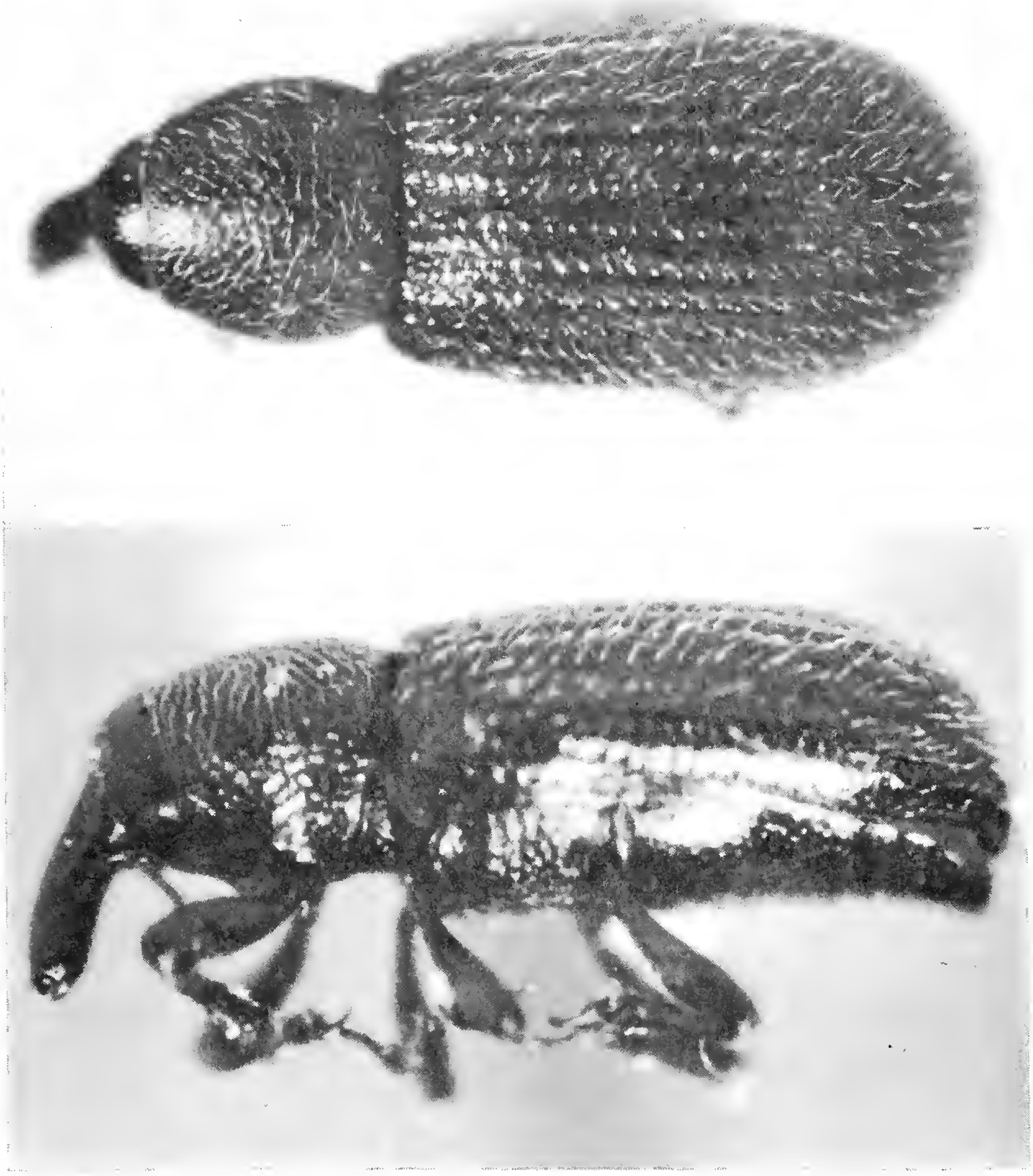

FIG. 1. *Pselactus spadix*, dorsal and lateral view. Note robust form, long fine pubescence, and elongate rostrum.

In the United States the species has been collected far from the coast as well. The economic threat is well demonstrated in the following unpublished data, courtesy of Mrs. Rose E. Warner-Spilman, U. S. National Museum: Illinois, in pine in house. Maryland, basement, furniture store. Massachusetts, larvae boring in piles in Boston Harbor; from timber in Boston and Main R.R. Pier 40 (not submerged); in pile; from cellar timber, with ex. of *Hadrobregnus*. Missouri, from pine board infested with weevils. South Carolina, under bark of dead *Morus* sp. twig; in dead *Ficus* wood; in old pinewood porch (with *Hexarthrum ulkei* Horn).

Pselactus spadix was first collected in California by Mr. William Tyson at the salt flats in Newark, California, near the southeastern end of San Francisco Bay on 2 January 1966 from beneath pieces of wood. Subsequent collections of more than 150 specimens were made in February and the late fall of 1966 at the same locality. The area is at the south end of the Newark Slough which leads directly into San Francisco Bay. The specimens were taken under and in boards and timbers on levees above salt evaporation ponds. The weevils were most common on partly buried wood where conditions were slightly more damp. Evidence of weevil infestation was found on all boards and timbers. Mr. Tyson indicated that during the wet winter season the weevils were common under most of the boards. The timbers used by the salt company to support the pipes which transport salt water to the evaporation ponds are heavily infested by the weevils and will eventually have to be replaced.

Several other genera of cossonine weevils are common along the west coast and in general damage driftwood in a similar manner. These include the New Zealand *Macrancylas littoralis* Broun, very common in the San Francisco Bay area, north at least to Point Reyes. *Ellasoptes marinus* Horn and *Rhyncholus* spp. are common from Oregon to Southern California. In the eastern United States, one may encounter *Macrancylas linearis* Leconte, *Dryotribus mimeticus* Horn, *Anchonus* spp., and *Mesites* spp. The adults and larvae may be found burrowing through the wood and the adults are often taken on the under surface of wood on the ground. *Pselactus spadix* adults may be separated from the other cossonine genera occurring in the western United States by the combination of a robust form and erect long fine dorsal pubescence (Fig. 1). Anderson (1952) presents a key to and a description of some cossonine larvae including *Pselactus*.

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A New Species of the Genus *Largus* Hahn With a Key to the Species of the Genus in the Southwestern United States

(Hemiptera: Largidae)

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During a taxonomic study carried out as part of the requirements for the Master of Arts degree in biology at San Francisco State College, I examined a series of nine female and seven male specimens representing a different form of the genus *Largus* Hahn, 1831. The specimens were found among the collections of several United States museums. A search of the literature and comparison with many determined specimens of the various established species of *Largus* found in North America led me to consider the specimens as representative of a new species. I am now publishing the following description so that the name will be available for biological studies on this genus. The measurements given below are those of the holotype or allotype followed by the range of variation exhibited by the paratypes of the appropriate sex.

Largus semipunctatus Halstead, new species

Length of holotype male 13.5 mm (12–13.5 mm), width across pronotum 5 mm (4–5 mm), width across corium 6 mm (5–6 mm).

MALE.—Elongate oval; robust. *Coloration*: Black. The following all red-orange: two small medial lines on the collum, posterior margin of pronotum, lateral margins of posterior half of pronotum, apex of scutellum, margins of clavus and claval suture, lateral margin of corium next to membrane, furrow in corium, connexivum of abdomen, base of rostrum, base of first and second antennal segments. *Pubescence*: Body and femora clothed with dense silver-gray tomentum giving a frosted appearance. *Punctation*: Posterior half of pronotum except lateral margins finely black punctate. Scutellum finely, evenly punctate. Clavus rather coarsely black punctate. Corium along claval suture and inside of lateral red-orange margin black punctate; center and posterior of corium impunctate. *Hemelytra*: Not quite reaching tip of abdomen. *Length of antennal segments*: I: 2.9 mm (2.6–2.9 mm); II: 1.8 mm (1.8–1.9 mm); III: 1.0 mm (0.9–1.0 mm); IV: 1.9 mm (1.8–1.9 mm). Total antenna 7.6 mm (7.1–7.6 mm).

FEMALE.—Length 15 mm (15–17 mm); width across pronotum 5 mm (4.5–5.5 mm); width across corium 7 mm (6–7 mm).

Similar to male in coloration except: smaller black areas of clavus and corium; first three ventral abdominal segments tinged with rose; posterior margin of metathorax very slightly tinged rose. Similar to male in punctation except smaller impunctate area of corium. Pubescence and hemelytra as in male. *Length of antennal segments*: I: 2.9 mm (2.7–3.2 mm); II: 1.9 mm (1.8–2.2 mm); III: 1.1 mm (1.0–1.2 mm); IV: 2.0 mm (1.7–2.1 mm). Total antenna 8.0 mm (7.6–8.8 mm).

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Holotype male, ATASCOSA LOOKOUT, ATASCOSA MT., SANTA CRUZ COUNTY, ARIZONA. Collected by Mr. W. L. Nutting, 9 October 1960, deposited in the University of Arizona collection. *Allotype*, Same data as holotype, in University of Arizona collection.

Paratypes.—One male, Santa Catalina Mts., Arizona, 15 July 1924; one male, Cochise Str., Arizona, Dragoon Mts., 24 March 1956; one male, Molino Basin Station, Catalina Mts., Arizona, 18 October 1961, on *Baccharis* flower; one male, Pena Blanca Spring, Tumacacori Mts., Arizona, 20 June 1940; one female, Pena Blanca, 10 miles west of Nogales, Arizona, 1 August 1961; one female, Bear Valley, Arizona, Tumacacori Mts., 28 June 1940; one female, west slope Patagonia Mts., Santa Cruz Co., Arizona, 9 August 1955; one female, Madera Canyon, Santa Rita Mts., Pima Co., Arizona, 16 February 1956, all in the University of Arizona collection. Two males and two females, Baboquivaria Mts., Arizona, with no date, in the University of Kansas collection. One female, Madera Canyon, Santa Rita Mts., Arizona, 14 October 1960, in the Oregon State University collection. One female, San Bernardino County, California, 16 November 1936, in the California Academy of Sciences collection.

In general appearance *Largus semipunctatus* most closely resembles *Largus convivus* Stal. However, it is separated from that species by the absence of punctation on the corium and the very different pubescence, as well as the coloration of the thorax and legs.

The characteristics of this new species which differentiate it from the other members of the genus *Largus* of western North America are shown in the following key:

KEY TO THE SPECIES OF THE GENUS LARGUS HAHN OF THE SOUTHWESTERN UNITED STATES

1. Membrane clear to light tan; scutellum, hemelytra, and posterior half of pronotum reddish to tan; corium with two distinct large black spots at juncture of claval suture and membrane .... *bipustulatus* Stal
Membrane and hemelytra color variable; scutellum black; corium without black spots at juncture of claval suture and membrane 2
2. Thoracic sterna around base of coxae red to orange 3
Thoracic sterna around base of coxae black 4
3. Coxae often red; trochanters and femora black .... *convivus* Stal
Coxae, trochanters, and proximal end of femora all red to yellow-orange .... *cinctus* Herrich-Schaeffer
4. Hemelytra completely covered with dense punctation; pubescence variable, but not as below; trochanters and proximal ends of femora orange to orange-red .... *succinctus* Linne
Hemelytra with corium impunctate; pubescence a dense silver tomentum over entire body giving the insect a frosted appearance; trochanters and femora all black .... *semipunctatus* Halstead, n. sp.

The Type Material in the Collection of the California Department of Agriculture

MARIUS S. WASBAUER
California Department of Agriculture, Sacramento

During the past decade, a number of primary types of insects has accumulated in the Collection of the Insect Taxonomy Laboratory, California Department of Agriculture, Sacramento.

Although there are many cogent practical reasons for any institution which maintains an insect collection to be interested in the retention of holotypes, we feel that the field of insect taxonomy could best be served by relinquishing the holotypes now housed in the California Department of Agriculture.

In the future, it will be the policy of the Insect Taxonomy Laboratory to require that holotypes based on our material be deposited in the collection of the California Academy of Sciences, San Francisco, unless it can be shown that they would be more readily accessible in an institution where active work is being done on that particular group of insects or where a specialized collection of the group is being housed.

A list of type material in the CDA Collection is presented here, arranged by order of insect. Following the family name are the initials of the institution to which the types will be transferred: CAS (California Academy of Sciences, San Francisco), UCD (University of California, Davis), USNM (United States National Museum, Washington, D. C.).

ORTHOPTERA

ACRIDIDAE (USNM)

Melanoplus buxtoni Strohecker 1963. Pan-Pac. Entomol., 39(3): 168. Holotype ♂, allotype ♀, USNM type #70510.

Melanoplus elaphrus Strohecker 1963. Pan-Pac. Entomol., 39(3): 169. Holotype ♂, allotype ♀, USNM type #70517.

Melanoplus elater Strohecker, 1963. Pan-Pac. Entomol., 39(3): 166. Holotype ♂, allotype ♀, USNM type #70509.

Melanoplus eremitus Strohecker, 1963. Pan-Pac. Entomol., 39(3): 162. Holotype ♂, allotype ♀, USNM type #70512.

Melanoplus harperi Gurney and Buxton, 1965. Bur. Entomol., Calif. Dep. Agr. Occas. Pap. No. 7, p. 4. Holotype ♂, allotype ♀, USNM type #70513.

Melanoplus siskiyou Strohecker, 1963. Pan-Pac. Entomol., 39(3): 170. Holotype ♂, allotype ♀, USNM type #70511.

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Melanoplus wintunus Strohecker and Helfer, 1963. Pan-Pac. Entomol., 39(3): 160. Holotype ♂, allotype ♀, USNM type #70508.

Aerochoreutes stenometopus Strohecker and Buxton, 1963. Pan-Pac. Entomol., 39(4): 261. Holotype ♂, allotype ♀, USNM type #70514.

Hypsalonia merga Gurney and Buxton, 1963. Bull. Brooklyn Entomol. Soc., 58(2–3): 68. Holotype ♂, USNM type #70515.

Boonacris (*Karokia*) *blanci* Rehn, 1964. Nolulae Natur., 368: 3. Holotype ♂, allotype ♀. USNM type #70516.

THYSANOPTERA

PHLAEOTHRIPIDAE (UCD)

Hoplandrothrips irretius Kono, 1964. Bur. Entomol. Calif. Dep. Agr. Occas. Pap. No. 4, p. 1. Holotype ♀, allotype ♂, UCD type #291.

Liothrips brevitubus Kono, 1964. Bur. Entomol. Calif. Dep. Agr. Occas. Pap. No. 4, p. 4. Holotype ♀, UCD type #292.

Liothrips monoensis Kono, 1964. Bur. Entomol. Calif. Dep. Agr. Occas. Pap. No. 4, p. 6. Holotype ♀, UCD type #293.

THRIPIDAE (UCD)

Chirothrips tuttlei zur Strassen, 1967. Senckenbergiana Biol., 48(5–6): 345. Holotype ♀, UCD type #294.

HOMOPTERA

ASTEROLECANIIDAE (UCD)

Sclerococcus bromeliae McKenzie 1963. Bull. Calif. Dept. Agr., 52(1):38. Holotype ♀, slide mount, UCD type #325.

DERBIDAE (CAS)

Apache californicum Wilkey 1963. Pan-Pac. Entomol., 39(2): 99. Holotype ♂, allotype ♀, CAS type #10,196.

DIASPIDIDAE (UCD)

Diaspis gilloglyi McKenzie 1963. Bull. Calif. Dep. Agr., 52(1): 33. Holotype ♀, slide mount, UCD type #326.

ERIOCOCCIDAE (UCD)

Cornoculus densus Miller 1967. Hilgardia, 38(13): 487. Holotype ♀, slide mount, UCD type #327.

PSEUDOCOCCIDAE (UCD)

Anisococcus abnormalis McKenzie 1964. Hilgardia, 35(10): 212. Holotype ♀, slide mount, UCD type #328.

Anthelococcus simondsi McKenzie 1964. Hilgardia, 35(10): 215. Holotype ♀, slide mount, UCD type #329.

Chorizococcus californicus McKenzie 1964. Hilgardia, 35(10): 221. Holotype ♀, slide mount, UCD type #330.

Chorizococcus coxindex McKenzie 1967. "Mealybugs of California," Univ. Calif. Press, Berkeley, p. 96. Holotype ♀, slide mount, UCD type #331.

Chorizococcus fistulosus McKenzie 1967. "Mealybugs of California," Univ. Calif. Press, Berkeley, p. 99. Holotype ♀, slide mount, UCD type #332.

Chorizococcus interruptus McKenzie 1964. Hilgardia, 35(10): 223. Holotype ♀, slide mount, UCD type #333.

Chorizococcus wilsoni McKenzie 1961. Hilgardia, 31(2): 19. Holotype ♀, slide mount, UCD type #334.

Chorizococcus yuccae McKenzie 1961. Hilgardia, 31(2): 21. Holotype ♀, slide mount, UCD type #335.

Cryptoripersia tubulata McKenzie 1964. Hilgardia, 35(10): 228. Holotype ♀, slide mount, UCD type #336.

Dysmicoccus vacuatus McKenzie 1967. "Mealybugs of California," Univ. Calif. Press, Berkeley, p. 174. Holotype ♀, slide mount, UCD type #337.

Heliococcus atriplicis McKenzie 1964. Hilgardia, 35(10): 235. Holotype ♀, slide mount, UCD type #338.

Humococcus ceraricus McKenzie 1964. Hilgardia, 35(10): 236. Holotype ♀, slide mount, UCD type #339.

Phenacoccus alleni McKenzie 1964. Hilgardia, 35(10): 243. Holotype ♀, slide mount, UCD type #340.

Phenacoccus nonarius McKenzie 1964. Hilgardia, 35(10): 253. Holotype ♀, slide mount, UCD type #341.

Phenacoccus aberrans McKenzie 1962. Hilgardia, 32(14): 657. Holotype ♀, slide mount, UCD type #342.

Pseudococcus diversus McKenzie 1964. Hilgardia, 35(10): 256. Holotype ♀, slide mount, UCD type #343.

Pseudococcus malacearum Ferris 1950. "Atlas of the scale insects of North America," Vol. V, The Pseudococcidae (Part I), Stanford Univ. Press, p. 185. Lectotype designated by Wilkey and McKenzie 1961, Bull. Calif. Dep. Agr., 50(4): 246, UCD type #344.

Pseudococcus prunicolus McKenzie 1964. Hilgardia, 35(10): 260. Holotype ♀, slide mount, UCD type #345.

Pseudococcus sparsus McKenzie 1962. Hilgardia, 32(14): 667. Holotype ♀, slide mount, UCD type #346.

Puto echinatus McKenzie 1961. Hilgardia, 31(2): 35. Holotype ♀, slide mount, UCD type #347.

Puto latricribellum McKenzie 1961. Hilgardia, 31(2): 37. Holotype ♀, slide mount, UCD type #348.

Rhizoecus bicirculus McKenzie 1967. "Mealybugs of California." Univ. Calif. Press, Berkeley, p. 374. Holotype ♀, slide mount, UCD type #349.

Spilococcus haigi McKenzie 1962. Hilgardia, 32(14): 679. Holotype ♀, slide mount, UCD type #350.

Trionymus frontalis McKenzie 1967. "Mealybugs of California." Univ. Calif. Press, Berkeley, p. 471. Holotype ♀, slide mount, UCD type #351.

Trionymus mocus Ferris 1953. "Atlas of the scale insects of North America," Vol. VI, The Pseudococcidae (Part II), Stanford Univ. Press, p. 490. Slide designated as TYPE, contains 2 adult ♀♀—Ferris noted on slide "Type, the larger spm." UCD type #352.

LEPIDOPTERA

GELECHIIDAE (USNM)

Periploca nigra Hodges 1962. Pan-Pac. Entomol., 38(2): 94. Holotype ♂, USNM type #70546.

DIPTERA

TEPHRITIDAE (CAS)

Aciurina trilitura Blanc and Foote 1961. Pan-Pac. Entomol., 37(2): 75. Holotype ♀, allotype ♂, CAS type #10,197.

Neaspilota wilsoni Blanc and Foote 1961. Pan-Pac. Entomol., 37(2): 78. Holotype ♂, CAS type #10,198.

LONCHAEIDAE (CAS)

Dasiops alveofrons McAlpine 1961. Can. Entomol., 93(7): 539. Holotype ♂, allotype ♀, CAS type #10,199.

HYMENOPTERA

ANDRENIDAE (CAS)

Perdita salicis tristis Timberlake 1964. Univ. Calif. Publ. Entomol. 28(2): 345. Holotype ♀, allotype ♂, CAS type #10,200.

POMPILIDAE (CAS)

Calicurgus braziliensis Dreisbach 1961. Amer. Midland Natur., 65(2): 377. Holotype ♀, CAS type #10,201.

A Revision of the Genus *Grotea*

(Hymenoptera : Ichneumonidae)

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University of California, Berkeley

Grotea is a small genus in the subfamily Xoridinae, tribe Labiini (Townes *et al.*, 1960). The genus is restricted to the Western Hemisphere, with specimens recorded from southern Canada to northern Argentina. The last revision of the genus was by Rohwer (1920), who listed four North American species. Townes *et al.* (1960) provide redescriptions and additional information concerning two of the species

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listed by Rohwer, and Townes and Townes (1966) list fives species in the Neotropical region. The present revision treats eight species, three previously undescribed.

Biological data on only two species, *G. anguina* Cresson and *G. californica* Cresson, are available at present. Both of these species parasitize the nest of bees of the genus *Ceratina.* It is probable that the other six species in the genus parasitize twig-nesting aculeates.

METHODS AND MATERIALS

All measurements were made at 40× with an American Optical Company Spencer microscope and an ocular micrometer. Drawings were made at the same magnification with an ocular grid. Holotypes of all the described species were examined at the institutions where they are deposited. The following abbreviations are used to designate collections: AMNH, American Museum of Natural History, New York, N. Y.; CAS, California Academy of Sciences, San Francisco; CIS, California Insect Survey, University of California, Berkeley; Cornell, Cornell University, Ithaca, N. Y.; Davis, University of California, Davis; MSU, Michigan State University, East Lansing; Ottawa, Canadian National Collection, Ottawa; Slobodchikoff, C. N. Slobodchikoff collection, Berkeley, Calif.; Townes, H. K. Townes collection, American Entomological Institute, Ann Arbor, Mich.; USNM, United States National Museum, Washington, D. C. The location of type specimens is indicated by parentheses in the synonymy.

Genus GROTEA CRESSON

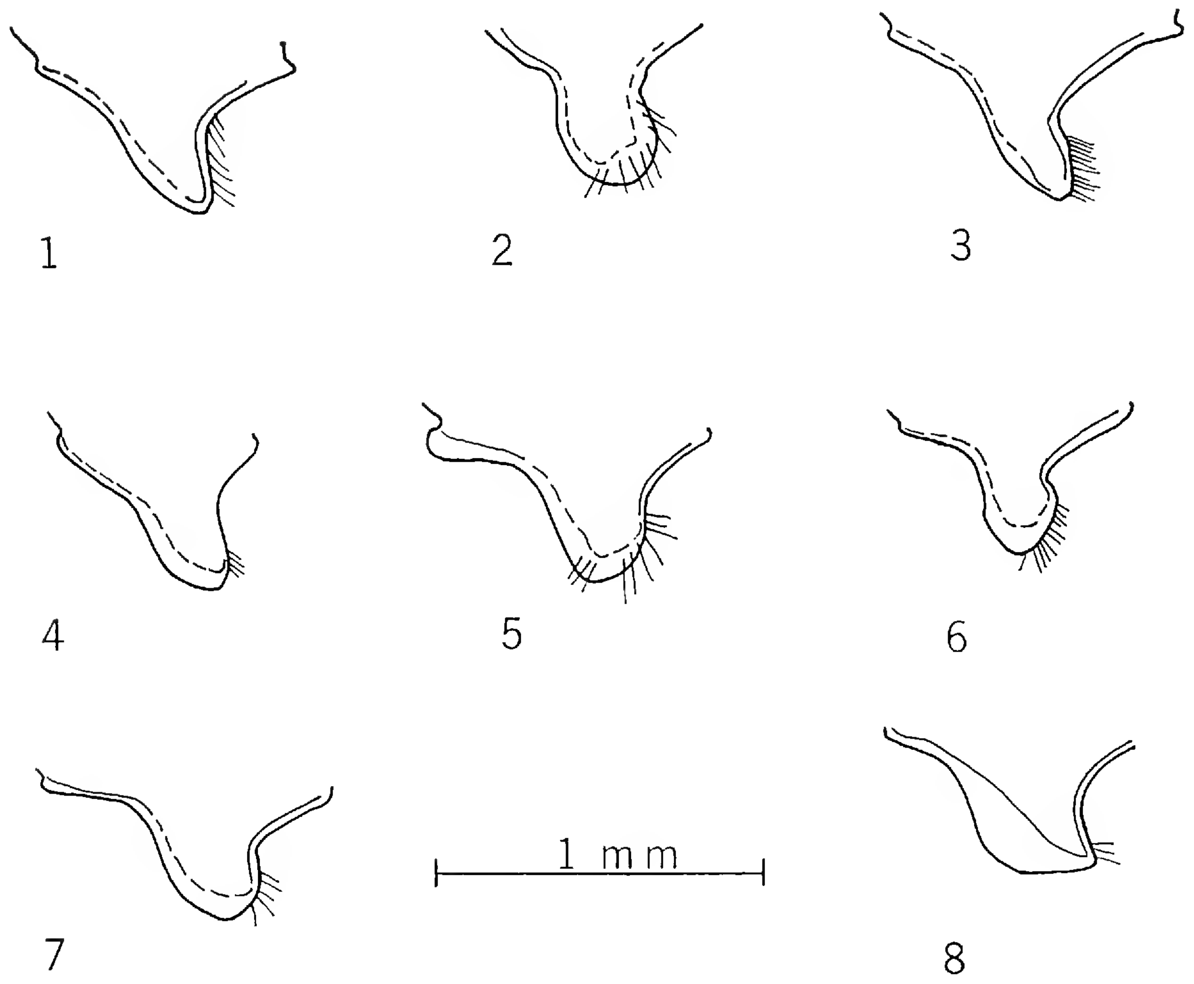
Grotea Cresson, 1864, Proc. Entomol. Soc. Philadelphia, 3: 397.

Type: *Grotea anguina* Cresson (Philadephia).

Front wing 6.0 to 14.0 mm long; frons convex; clypeus and labrum small; upper end of prepectal carina near ventral corner of pronotum; petiole long and slender, upcurved in its posterior 0.5, spiracle behind middle.

KEY TO SPECIES OF GROTEA

1. Distal tip of front wing with conspicuous brown spot 2
   Distal tip of front wing without, or with only faint brown spot 4
2. Antennal flagellum yellow on distal 0.2; mesopleuron in at least posterior 0.6 with horizontal orange-brown band; second pleural area of propodeum 2 or more times longer than wide (Figs. 10, 14) 3
   Antennal flagellum black on distal 0.2, orange proximally; mesopleuron lacking horizontal orange-brown band; second pleural area of propodeum 1.5 times as long as wide (Fig. 13) .... *G. fulva* Cameron
3. Distal end of genal hook an acute angle (Fig. 3); pleural carina of propodeum absent or incomplete (Fig. 10) .... *G. lokii* Slobodchikoff, n. sp.



FIGS. 1–8. Genal hooks of *Grotea* spp., lateral view. FIG. 1, *G. anguina*; FIG. 2, *G. californica*; FIG. 3, *G. lokii;* FIG. 4, *G. mexicana*; FIG. 5, *G. fulva*; FIG. 6, *G. athenae*; FIG. 7, *G. delicator*; FIG. 8, *G. perplexa.*

Distal end of genal hook spatulate, ellipsoid (Fig. 6) ; pleural carina of propodeum complete .... *G. athenae* Slobodchikoff, n. sp.

4. Apical transverse carina of propodeum absent 5

Apical transverse carina of propodeum present (Fig. 12) .... *G. mexicana* Cresson

5. Distal end of genal hook an acute angle (Figs. 1, 3) ; antennal flagellum yellow with black band at 0.7 its length 6

Distal end of genal hook spatulate, ellipsoid (Figs. 2, 7, 8) ; antennal flagellum otherwise 7

6. Pleural carina of propodeum absent or incomplete (Fig. 10) ; distal tip of front wing with faint brown spot .... *G. lokii* Slobodchikoff, n. sp.

Pleural carina of propodeum complete (Fig. 11) ; distal tip of front wing without faint brown spot .... *G. anguina* Cresson

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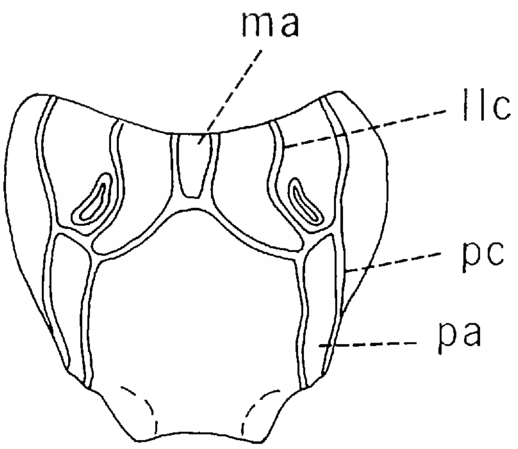
FIGS. 9–16. Propodia of *Grotea* spp., dorsal view. FIG. 9, *G. californica*; FIG. 10, *G. lokii*, FIG. 11, *G. anguina*; FIG. 12, *G. mexicana*; FIG. 13, *G. fulva;* FIG. 14, *G. athenae*; FIG. 15, *G. delicator*; FIG. 16, *G. perplexa. atc*, apical transverse carina; *llc*, lateral longitudinal carina; *ma*, 1st median area; *pa*, 2nd pleural area; *pc*, pleural carina.



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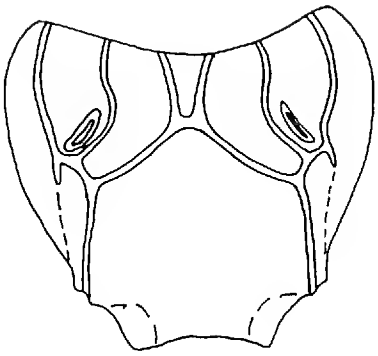

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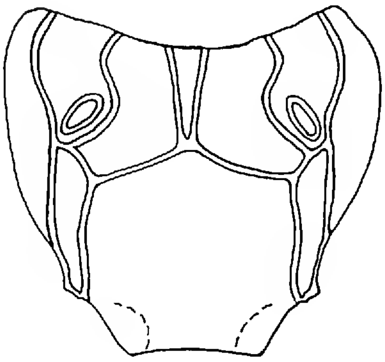

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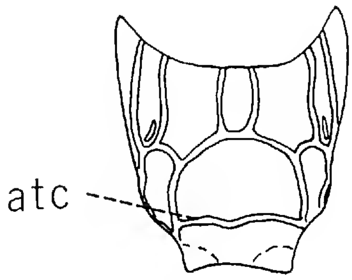

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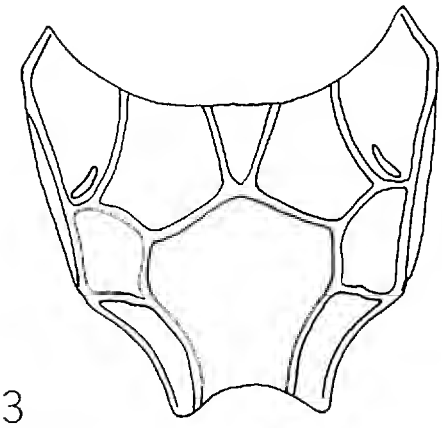

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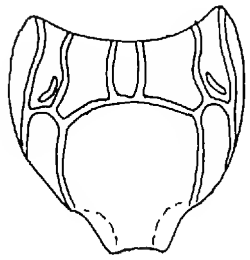

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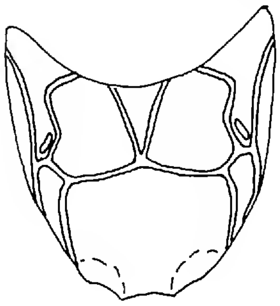
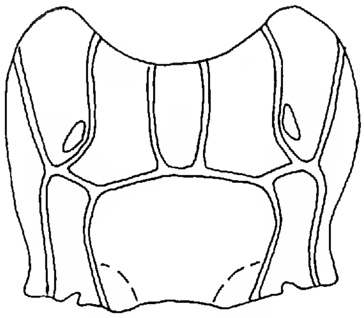


15

1 mm



16

7. Second pleural area of propodeum open posteriorly (Fig. 16); propodeum broadly quadrate in dorsal view; mesoscutum uniformly orange .... *G. perplexa* Slobodchikoff, n. sp.
   Second pleural area of propodeum closed posteriorly (Figs. 9, 15); propodeum and mesoscutum otherwise 8
8. Antennal flagellum black; second pleural area of propodeum curved upward strongly in its anterior 0.5 (Fig. 15); mesoscutum yellow with median complete and pair of submedian incomplete brown-black longitudinal stripes .... *G. delicator* (Thunberg)
   Antennal flagellum yellow; second pleural area of propodeum not curved upward strongly in its anterior 0.5 (Fig. 9); mesoscutum orange with position of notauli marked with yellow .... *G. californica* Cresson

GROTEA ANGUINA Cresson

(Figs. 1, 11)

Grotea anguina Cresson, 1864, Proc. Entomol. Soc. Philadelphia, 3: 398; ♂, ♀.
Grotea anguina; Cresson, 1916, Mem. Amer. Entomol. Soc., 1: 16. Lectotype designation. Lectotype: ♀, New Jersey (Philadelphia).

BIOLOGY.—Graenicher, 1905, Entomol. News, 16: 43–49.—Rau, 1922, Trans. Acad. Sci. St. Louis, 24: 43; 1928, Ann. Entomol. Soc. Amer., 21: 383.

FEMALE.—Front wing 9.0 to 11.0 mm long. Clypeus curving-rectangular, upper and lower margins decurved; genal hook forming an acute angle, its basal part approximately 2.5 times wider than at 0.66 the distance from base to tip. First median area of propodeum triangular, distal angle of triangle acute; lateral longitudinal carina in front of spiracle complete; second pleural area of propodeum approximately 3.5 as long as wide; pleural carina present; apical transverse carina absent.

Head yellow, suffused with orange around ocelli and behind eyes; antennal flagellum yellow-orange, with black band at 0.7 its length. Pronotum yellow, with yoke-like orange band dorsally, posterior margins black; mesopleuron yellow, with broad horizontal orange band; mesoscutum orange, its lateral margins black, with pair of median yellow stripes that form an elongate V; scutellum and postscutellum yellow. Propodeum orange, with yellow markings laterally and apically. Front and middle legs light yellow-orange; hind legs orange. Petiole brown-black dorsally and orange ventrally, with lateral yellow stripes. Abdominal sternites yellow; abdominal tergites brown-black medially and yellow laterally. Distal tip of front wing lacking conspicuous brown spot.

MALE.—Front wing 10.0 to 11.0 mm long. Similar to female in structure and color.

The habits of this widespread eastern Nearctic species have been studied by Graenicher (1905) and Rau (1922; 1928). *Grotea anguina* attacks bees of the genus *Ceratina*, which construct nests consisting of several to many cells in hollowed-out twigs with large pithy centers. The parasite egg is laid on or near the bee egg in a cell. The parasite larva consumes the bee larva, then consumes the bee-bread in that cell. Subsequently the parasite larva destroys the partitions and contents of one or more cells before it pupates in the twig and emerges the following spring.

Collection data (4♂, 44♀).—CONNECTICUT: Hartford, ♀, (USNM). INDIANA: Lafayette, ♂, 14 April 1960, and ♀, 20 July 1960, (USNM). IOWA: Sioux City, ♀, C. N. Ainslie (USNM). KENTUCKY: Golden Pond, ♀, June 1965, H. K. Townes (Slobodchikoff). MARYAND: Beltsville, ♀, 15 June 1913, J. R. Malloch (USNM); Glen Echo, ♀, 12 June 1921, R. M. Fonts (USNM); Laurel, ♀, 25 June 1933, E. B. Marshall (USNM); Meadowood, near Colesville, ♀, 22 July 1961, L. M. Walkley (USNM); Plummers Island, 2♀, 1 June 1913, H. S. Barber (USNM) and 9 June 1914, R. C. Shannon (USNM); Takoma Park, ♀, 28 May 1944, H. and M. Townes (Townes). MASSACHUSETTS: Martha's Vineyard, ♀, 20 May 1937, F. M. Jones (USNM). MICHIGAN: Ann Arbor, ♂, 6 June 1963 and 2♀, 6 June and 8 June 1963, H. and M. Townes (Townes); Cheboygan Co., 2♀, 6 July 1947, R. R. Dreisbach (MSU); E. Lansing, ♀, 3 June 1963, R. B. Willson (MSU); Gull Lk. Biological Sta., Kalamazoo Co., 3♀, 23 June 1965, 12 July 1965, and 22 July 1966, R. L. Fischer (MSU); Midland Co., ♀, 9 June 1957, R. and K. Dreisbach (MSU), ♂, 5 to 11 June 1961, and 3♀, 12 to 21 June 1961, R. R. Dreisbach (MSU); Onsted, 2♀, 16 June 1959, G. C. Eickwort (MSU) and R. A. Scheibner (MSU); Owasso, ♀, 29 June 1953, B. Wilson (MSU); Shiawasse Co., ♀, 29 May 1959, R. and K. Dreisbach (MSU). MISSISSIPPI: Stoneville, ♀, 15 May 1958, K. Peterson (USNM). MISSOURI: St. Louis, ♀, Rau (USNM). NEW JERSEY: Moorestown, 2♀, 4 June 1939 and 24 June 1939, H. and M. Townes (Townes); Ocean Grove, ♀, (USNM). NEW YORK: Buffalo, ♀, 30 June 1934, Krombein (USNM); Ithaca, ♂, 10 June 1935, H. K. Townes (Townes); New York, ♀, (USNM). NORTH CAROLINA: Wake Co., ♀, 12 June 1951, H. and M. Townes (Townes). ONTARIO: Cornwall, ♀, 29 June 1925, F. Ide (Ottawa); Wakefield, ♀, 25 June 1946, G. S. Walley (Ottawa). PENNSYLVANIA: Dauphin, ♀, May 1930, J. N. Knull (USNM); Perdix, ♀, 21 May 1911, W. S. Fisher (USNM); Stoverdale, ♀, 13 June 1916, W. S. Fisher (USNM). SOUTH CAROLINA: Greenville, ♀, 20 June 1940, H. and G. Townes (Townes); Wattacoo, near Cleveland, ?, 17 May 1959, G. F. Townes (Townes). TENNESSEE: Knoxville, ♀, 1921, C. N. Ainslie (USNM). TEXAS: Brownsville, ♀, C. H. T. Townsend (USNM); Calvert, ?, June 1961, W. W. Yothers (USNM). VIRGINIA: Arlington, ♀, 4 June 1943, R. A. C. (USNM); Falls Church, 2♀, 30 May and 5 July, N. Banks (USNM). WASHINGTON, D. C.: Metro area, ♀, summer 1966, T. J. Spilman (USNM).

Grotea athenae Slobodchikoff, new species

(Figs. 6, 14)

Female.—Front wing 10.0 mm long. Clypeus curving-rectangular, upper margin more decurved than lower margin so that clypeus appears faintly pentagonal; genal hook spatulate, its distal part broadly ellipsoid, its basal part as wide as at 0.66 the distance from base to tip. First median area of propodeum subrectangular; lateral longitudinal carina in front of spiracle complete; second pleural area of propodeum approximately 2.5 times as long as wide; pleural carina present; apical transverse carina absent.

Head yellow, suffused with orange around ocelli and behind eyes; antennal flagellum yellow-orange, with black band at 0.7 its length. Pronotum yellow with incomplete yoke-like brown band dorsolaterally; posterior margins of pronotum black; mesopleuron yellow, with broad horizontal orange-brown band; mesoscutum orange-brown, its lateral margins black, with pair of broad median yellow stripes that form an elongate V and enclose a median brown stripe between them; scutellum and postscutellum yellow. Front and middle legs yellow on anterior face, orange on posterior face. Petiole brown-black on anterior 0.7, with pair of dorsolateral yellow stripes, and orange on posterior 0.3. Abdominal sternites and tergites orange. Distal tip of front wing with conspicuous brown spot.

MALE.—Unknown.

Nothing is known about the habits or hosts of this species.

Holotype female, MONTEVERDE, COSTA RICA, 9 February 1962, C. Palmer (Townes).

Paratype female, MEXICO: Veracruz: Orizaba, 12 to 22 August 1961, R. and K. Dreisbach (MSU).

GROTEA CALIFORNICA Cresson

(Figs. 2, 9)

Grotea californica Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, 1878: 370; Type: ♀, California (Philadelphia).

BIOLOGY.—Daly *et al.*, 1967, Ann. Entomol. Soc. Amer., 60: 1273–1282.—Slobodchikoff, 1967, Pan-Pac. Entomol., 43: 161–168.

FEMALE.—Front wing 8.0 to 11.0 mm long. Clypeus curving-rectangular, upper margin slightly more decurved than lower margin so that clypeus appears faintly pentagonal; genal hook spatulate, its distal part ellipsoid, its basal part as wide as at 0.66 the distance from base to tip. First median area of propodeum rectangular or subrectangular, distance between the two median longitudinal carinae in apical part of median area greater than their combined width; lateral longitudinal carina in front of spiracle complete; second pleural area of propodeum approximately 3.3 as long as wide; pleural carina present; apical transverse carina absent.

Head yellow, suffused with orange around ocelli and behind eyes; antennal flagellum orange on proximal 0.7, yellow on distal 0.3. Pronotum yellow, with yoke-like orange-black band dorsolaterally and posterior margins black; mesopleuron yellow, with broad horizontal orange-black band; mesoscutum orange, its lateral margins black, with pair of median yellow stripes that form an elongate V. Propodeum orange, with yellow markings laterally and apically. Front and middle legs light yellow-orange; hind legs orange. Petiole brown-black dorsally and orange ventrally, with lateral yellow stripes. Abdominal sternites yellow-orange; abdominal tergites brown-black medially and yellow laterally. Distal tip of front wing with faint brown spot.

MALE.—Front wing 6.0 to 10.0 mm long. Similar to female in structure and color.

The parasitic habits of this species, studied by Daly *et al.* (1967) and Slobodchikoff (1967), are similar to those of *Grotea anguina.* The female oviposits through the wall of a twig into a cell. Usually cells in the lower third of the nest are preferred. An average of two to three cells, together with their contents, are destroy by the parasite larva. The pupal cell of the parasite consists of a membranous web and thick partitions at its upper and lower ends in the twig. Bees in cells below the parasite pupal cell are unable to penetrate the partitions and cannot escape from the nest. Often one third of the progeny in a nest may be destroyed indirectly in this manner.

COLLECTION DATA (39♂, 30♀).—BRITISH COLUMBIA: Robson, ♀, 29 June 1950, H. R. Foxlee (Ottawa); Ruskin, ♀, 1 July 1953, W. R. M. Mason (Ottawa). CALIFORNIA: *Alameda Co.*: ♂, Coquillett (USNM); Berkeley, ♂, 15 June 1933, (Davis), ♂, 27 June 1933, G. E. and R. M. Bohart (Davis), June 1939, (Townes), ♀, 17 June 1933, M. Cazier (USNM), ♀, 19 May 1966, J. K. Ryan (Slobodchikoff), ?, 27 May 1934, G. E. and R. M. Bohart (Davis), ?, 3 May 1963, D. C. Rentz (Slobodchikoff); East Oakland, ♀, 12 June 1948, L. L. Jensen (Townes); Oakland, ♂, 12 June 1933, G. E. and R. M. Bohart (Davis), ♀, 25 May 1937, E. S. Ross (Townes); San Leandro, ♂, June 1948, C. A. Downing (Townes), ?, 14 April 1948, C. A. Downing (Davis). *Amador Co.*: Volcano, 3♂, 4 June 1961, R. M. Bohart (Davis). *Contra Costa Co.*: near Orinda, 7♂, 11♀, collected over one year period, H. V. Daly (CIS). *El Dorado Co.*: Camino, ♀, 29 June 1948, H., M., G., and D. Townes (Townes). *Humboldt Co.*: Blocksburg, ♂, 19 June 1935, E. W. Baker (USNM); Blue Lake, ♀, 20 to 27 June 1907, Bradley (Townes). *Lassen Co.*: Hallelujah Jct., ♂, 4 July 1968, R. M. Bohart (Davis). *Los Angeles Co.*: Los Angeles, ♀, Coquillett (USNM). *Marin Co.*: Inverness, ♀, 24 June 1961, C. A. Toschi (Slobodchikoff); Mill Valley, 4♂, 1♀, 14 May 1961, D. Q. Cavagnaro (Davis). *Napa Co.*: Samuel Springs, ♂, 9 May 1955, R. M. Bohart (Davis), ♂, 28 April 1956, S. M. Fidel (Davis). *Orange Co.*: Green River Camp, ♂, 8 May 1933, E. P. Van Duzee (CAS). *Sacramento Co.*: Carmichael, ♂, 13 May 1961, T. Gantenbein (Davis). *San Bernardino Co.*: Snow Crest Camp, ♀, 7 July 1952, R. M. Bohart (Davis). *San Francisco Co.*: San Francisco, ♂, 1 May 1947, E. S. Ross (CAS). *San Luis Obispo Co.*: Atascadero, 2♂, 1♀, 31 May 1948, C. H. Dickenson (Townes), ♂, 17 June 1948, C. H. Dickenson (Townes). *San Mateo Co.*: Daly City, ?, 30 June 1961, A. K. Lehre (Slobodchikoff). *Santa Barbara Co.*: Santa Ynez Mts., ♂, 24 June 1928, P. M. Marsh (Davis). *Santa Clara Co.*: Alum Rock Park, ♀, 25 May 1950, J. MacSwain (Townes). *Santa Cruz Co.*: Santa Cruz, ?, 1 June 1936, G. E. and R. M. Bohart (Davis). *Siskiyou Co.*: ♂, 2 June 1911, F. W. Hunonmaches (USNM). *Solano Co.*: Putah Canyon, ♂, 20 April 1959, F. D. Parker (Davis). *Trinity Co.*: Carrville, 2♂, 15 and 27 May 1934, G. E. and R. M. Bohart (Davis). *Ventura Co.*: Ventura, ♀, 4 May 1961, Gillogley (USNM). *Yolo Co.*: Elkhorn Ferry, ♀, 12 May 1952, R. M. Bohart (Davis). IDAHO: *Banner Co.*: Sandpoint, ♂, 21 June 1955, R. M. Bohart (Davis). NEVADA: *Douglas Co.*: Valley Hot Spring, ♂, ♀, 24 May 1953, R. M. Bohart (Davis). *Washoe Co.*: Verdi, ♂, 26 June 1962, R. M. Bohart (Davis), ♀, 27 June 1966, R. L. Brumley (Davis). OREGON: *Benton Co.*: Corvallis, ♂, 9 June 1909, J. C. Bridwell (USNM), ♂, 23 May 1939, L. G. Hudson (USNM).

GROTEA DELICATOR (Thunberg)

(Figs. 7, 15)

Ichneumon delicator Thunberg, 1822, Mem. Acad. Imp. Sci. St. Petersbourg, 8: 259; 1824, *Ibid*, 9: 307, sex not given. Type: sex ? (abdomen missing), (French West Indies: Saint) Barthelemy Island (Uppsala).

Atractodes lineatus Brulle, 1846, *In* Lepeletier: Historie naturelle des insectes, Hymenopteres, 4: 167. ♀. Lectotype: ♀, "Guiana" (Paris).

Grotea lineata; Krieger, 1903, Z. syst. Hymen. Dipt., 3: 290. *New synonym.*

Grotea delicator; Roman, 1912, Zool. Bidrag Uppsala, 1: 249.

FEMALE.—Front wing 7.0 to 11.5 mm long. Upper margin of clypeus strongly decurved, clypeus appears hemispheroid; genal hook spatulate, its distal part ellipsoid, its basal part approximately 1.3 times wider than at 0.66 the distance from base to tip. First median area of propodeum subtriangular; lateral longitudinal carina in front of spiracle complete; second pleural area of propodeum curved upward strongly in anterior 0.5, approximately 2.5 times as long as wide; pleural carina present; apical transverse carina absent.

Head yellow, suffused with orange around ocelli and behind eyes; antennal flagellum black. Pronotum yellow, black along posterior margins; mesopleuron yellow; mesoscutum yellow, its lateral edges black, with median and pair of submedian longitudinal orange stripes; scutellum and postscutellum yellow. Propodeum yellow, with irregularly-shaped black band that includes first median area, second pleural areas, and portion of propodeum posterior to basal transverse carina. Front and middle legs yellow; hind legs orange. Petiole yellow, dorsally with median and pair of sublateral longitudinal black stripes on anterior 0.75 and orange on posterior 0.25. Abdominal sternites yellow; abdominal tergites orange. Distal tip of front wing lacking conspicuous brown spot.

MALE.—Front wing 7.5 to 10.0 mm long. Similar to female in structure and color.

Nothing is known about the habits or hosts of this species.

COLLECTION DATA (5♂, 19♀).—ARGENTINA: Berisso, ♀, 8 December 1965, H. and M. Townes (Townes); Entre Rios: Pronunciamiento, ♀, September 1964, and 2♀, 3♂, January 1965 (Ottawa); Jujuy: San Sebastian de Jujuy, 2♀, 14 January 1966, H. and M. Townes (Townes); Tucuman: S. Pedro d. Colalao, ♀, January 1951, Arnau (Ottawa). BRAZIL: Santa Catarina: Nova Teutonia, 27°11′ S, 52°23′ W, 4♀, 16 October 1949, 28 November 1957, 23 December 1959, and 9 October 1967, 1♂, 11 January 1957, F. Plaumann (Ottawa); Nova Teutonia, 1♂, 1♀, 1?, 24 November 1955, 29 November 1955, and 4 December 1955, F. Plaumann (Townes). SURINAM: Kwatta, ♀, 28 February to 22 March 1964, D. C. Geijskes (Townes); Paramaribo, 2♀, 26 September 1963, Broekhuizen, and 30 November 1963, D. C. Geijskes (Townes). WEST INDIES: Trinidad: Arima Valley, 2♀, 22 May 1952 and 28 December 1952, (AMNH); Arima, ♀, 23 March 1961, N. Gopaul (Ottawa); Piarce, ♀, 27 February 1961, N. Gopaul (Ottawa).

GROTEA FULVA Cameron

(Figs. 5, 13)

Grotea fulva Cameron, 1886, Biologia Centrali-Americana, Insecta, Hymenoptera, 1: 309. Type: ♀, Mexico: Presidio (London).

FEMALE.—Front wing 12.0 to 13.6 mm long. Clypeus curving-rectangular, upper margin only slightly more decurved than lower margin; genal hook spatulate, its distal part ellipsoid, its basal part approximately 1.3 times wider than at 0.66 the distance from base to tip. First median area of propodeum subrectangular; lateral longitudinal carina in front of spiracle complete; second pleural area of propodeum approximately 1.5 times as long as wide; pleural carina present; apical transverse carina absent.

Head yellow, suffused with orange around ocelli and behind eyes; antennal flagellum orange on proximal 0.8, black on distal 0.2. Pronotum uniformly yellow anteriorly, with posterior margins black; mesopleuron yellow, with black spot near posterior margin; mesoscutum yellow, its lateral margins black, with median longitudinal black stripe and pair of submedian longitudinal orange stripes; scutellum and postscutellum yellow. Propodeum yellow, with irregularly-shaped black band that includes first median area, second pleural areas, and small portion of propodeum posterior to basal transverse carina. Front and middle legs yellow, hind legs orange. Petiole yellow-orange with dorsal and pair of lateral black stripes. Abdominal sternites yellow; abdominal tergites orange medially and yellow laterially. Distal tip of front wing with conspicuous brown spot.

MALE.—Unknown.

In the material examined, one specimen from Coca, Ecuador is morphologically similar to the type but represents a color variant. Its description is as follows:

Head yellow, with black behind antennal sockets, around ocelli, and posteriorly between eyes; scape, pedicel, and first flagellar segment black dorsally, orange ventrally; antennal flagellum orange on proximal 0.8, black on distal 0.2. Pronotum yellow, posterior margins black, with incomplete black band dorsolaterally; mesopleuron yellow, with median black band on posterior 0.5; mesoscutum black, with pair of yellow median stripes marking position of notauli and pair of yellow lateral stripes anterior to tegulae; scutellum and postscutellum yellow. Propodeum yellow, with dorsal mask-like black band extending over first, second median areas, second pleural areas, second lateral areas, and portions of the first lateral areas. Front and middle legs yellow anteriorly, black with yellow markings posteriorly; hind coxae yellow with mediolateral incomplete black stripe anteriorly, black posteriorly; first hind trochanter black on proximal 0.8, yellow distally; second hind trochanter yellow; hind femora yellow with median longitudinal black stripe anteriorly, black posteriorly; hind tibiae and tarsi black. Dorsum of petiole yellow on posterior 0.1, black on anterior 0.9 with pair of dorsolateral yellow stripes. Abdominal sternites yellow; abdominal tergites black anteriorly, yellow on posterior 0.4. Distal tip of front wing with conspicuous brown spot.

Nothing is known about the habits or hosts of this species.

COLLECTION DATA (4♀, 1?).—ECUADOR: Coca, ♀, May 1965, L. Peña (Townes); Ecuador or Peru, ♀, 1963, L. E. Pena (Townes). MEXICO: Yucatan: Temax, ?, 1904, Godman-Salvin (London). PANAMA: Rovira, ♀, 4 February 1960, V. W. Brown (Townes). PERU: 10 km. S. of Chiclayo, ♀, 21 March 1951, Ross and Michelbacher (CAS).

Grotea lokii Slobodchikoff, new species

(Figs. 3, 10)

FEMALE.—Front wing 7.0 to 10.5 mm long. Clypeus curving-rectangular, upper margin slightly more decurved than lower margin so that clypeus appears faintly pentagonal; genal hook forming an acute angle, its basal part approximately 2.0 times wider than at 0.66 the distance from base to tip. First median area of propodeum subtriangular to subrectangular; lateral longitudinal carina in front of spiracle complete or incomplete; second pleural area of propodeum approximately 4.0 times as long as wide; pleural carina absent or incomplete; apical transverse carina absent.

Head yellow, suffused with orange around ocelli and behind eyes; antennal flagellum orange, with black band at 0.7 its length. Pronotum yellow, with ellipsoid black band dorsally, posterior margins black; mesopleuron yellow, with horizontal orange or orange-black band; mesopleuron yellow, with horizontal orange or orange-black band; mesoscutum orange, its lateral margins black, with pair of median yellow stripes that form an elongate V; scutellum and postscutellum yellow. Propodeum orange, with yellow markings laterally and apically. Front and middle legs yellow, hind legs yellow-orange. Petiole brown or black dorsally and orange ventrally, with lateral yellow stripes. Abdominal sternites yellow; abdominal tergites brown or black medially and yellow laterally. Distal tip of front wing with conspicuous brown spot.

MALE.—Front wing 6.5 to 11.5 mm long. Similar to female in structure and color.

The above description is based on the type specimen, but incorporates the variation found in the paratype series. This species was confused with *Grotea anguina* by Townes *et al.* (1960, pp. 538–540). Nothing is known about the habits or hosts of the species.

Holotype female, SAN PEDRO ITURBIDE, 32± KM. WEST OF LINARES, NEUVO LEON, MEXICO, 5 October 1962, H. and M. Townes (Townes).

Allotype, same data as type (Townes).

PARATYPES (12♂, 16♀).—ARIZONA: *Coconino Co.*: 10 mi. W. Jacob Lake, ♂, 6 June 1946, R. M. Bohart (Townes); Oak Creek Canyon, ♂, 18 May 1947, H. and M. Townes (Townes). *Gila Co.*: Parker Creek, Sierra Ancha, ♀, 9 May 1947, H. and M. Townes (Townes). *Santa Cruz Co.*: Sonoita, ♂, 30 August 1954, R. M. Bohart (Davis). *COLORADO*: *Boulder Co.*: Lyons, ♀, 25 June 1962, R. and K. Dreisbach (MSU). *Larimer Co.*: near Estes Pk., ♂, 14 June 1948, H., M., G., and D. Townes (Townes). *Routt Co.*: Steamboat Sprs., ♀, 5 July 1962, R. and K. Dreisbach (MSU). MEXICO: *Distrito Federal*: Atzcapolzalco, ♀, 5 July 1931 (Cornell). *Durango*: 5 mi. W. Durango, ♀, 14 May 1962, L. A. Stange (Davis); 6 mi. S. Durango, ♀, 5 July 1964, W. R. M. Mason (Ottawa); 18 mi. W. Durango, ♀, 31 July 1964, H. F. Howden (Ottawa). *Hidalgo*: Pachuca, ♂, 29 July 1954, J. G. Chillcott (Ottawa). *Jalisco*: Tamozula, ♀, 10 February 1954, R. and K. Dreisbach (MSU). *Mexico*: Teotihuacan Pyr., ♂, 7 July 1951, H. E. Evans (Townes); Tepexpan, ♂, ♀, 26 July 1963, F. D. Parker and L. A. Stange (Davis). *Michoacan*: 6 mi. N. W. Quiroga, 2♀, 11 July 1963, F. D.

Parker and L. A. Stange (Davis). *Morelos*: Cuautla, ♀, 30 October 1922, E. G. Smith (USNM); Cuernavaca, ♀, 30 May 1959, H. E. Evans (Cornell), ♂, ♀, 29 July 1961, R. and K. Dreisbach (Townes). *Nuevo Leon*: San Pedro Iturbide, 32± km. W. Linares, ♀, 5 October 1962 and 3♂, 1♀, 6 October 1962, H. and M. Townes (Townes). *Sinaloa*: 6 mi. N. E. Potrerillos, ♀, 19 March 1962, L. A. Stange (Davis). *Sonora*: Alamos, ♂, 25 February 1963, P. D. Arnaud, Jr. (CAS). *Vera Cruz*: "San Rafael Jilotepec," ♀, (USNM).

GROTEA MEXICANA Cresson

(Figs. 4, 12)

Grotea mexicana Cresson, 1874, Proc. Acad. Nat. Sci. Philadelphia 1873: 418. ♂, ♀. Lectotype: ♀, Mexico: Orizaba (Philadelphia).

Grotea mexicana; Cresson, 1916, Mem. Amer. Entomol. Soc., 1: 42. Lectotype designation.

FEMALE.—Front wing 7.0 to 9.5 mm long. Upper margin of clypeus strongly decurved, so that clypeus appears hemispheroid; genal hook forming an acute angle, its basal part approximately 1.8 times wider than at 0.66 the distance from base to tip. First median area of propodeum subtriangular; lateral longitudinal carina in front of spiracle complete; second pleural area of propodeum curved strongly upward apically, approximately 1.7 as long as wide; pleural carina present; apical transverse carina present.

Head yellow, suffused with orange around ocelli and behind eyes; antennal flagellum orange, with black band at 0.7 its length. Pronotum yellow, with ellipsoid orange-brown band dorsally; mesopleuron yellow, without distinct horizontal band; mesoscutum uniformly orange medially, its lateral margins black; scutellum and postscutellum yellow. Propodeum orange, with yellow lateral and apical markings. Front and middle legs yellow, hind legs orange. Petiole orange dorsally and ventrally, with lateral yellow stripe. Abdominal sternites yellow; abdominal tergites orange. Distal tip of front wing lacking conspicuous brown spot.

MALE.—Front wing 7.0 to 8.0 mm. Similar to female in structure and color.

Nothing is known about the habits or the hosts of this species.

COLLECTION DATA (6♂, 4♀.—MEXICO ?, (USNM). *Morelos*: 3 mi. N. Alpuyeca, ♀, 8 April 1959, H. E. Evans (Cornell). *Sinaloa*: 8 mi. S. E. Elota, ♀, 19 April 1962, L. A. Stange (Davis). *Vera Cruz*: Cordoba, ♀, 6 July 1962, J. S. Buckett, M. R. and R. C. Gardner (Davis); Jalapa, 5♂, 1 to 6 August, R. R. Dreisbach (MSU 4♂, Townes 1♂); Orizaba, ♂, 13 February 1954, R. R. Dreisbach (MSU), ♀, 13 February 1954, R. R. Dreisbach (Townes).

Grotea perplexa Slobodchikoff, new species

(Figs. 8, 16)

FEMALE.—Front wing 11.0 mm long. Clypeus pentagonal; labrum lacking dorsomedial pit; genal hook quadrate, its basal part approximately as wide as at 0.66 the distance from base to tip. First median area of propodeum subrectangular, 2 times as long as wide at its base; lateral longitudinal carina in front of spiracle incomplete; second pleural area of propodeum open, extending back to posterior margin of propodeum, approximately 2 times as long as wide; pleural carina present; apical transverse carina absent.

Head white, suffused with brown around ocelli and behind eyes; antennal flagellum black. Pronotum orange, white on anterior 0.1 and yellow along dorsoposterior margins; mesopleuron orange with yellow spot along anterodorsal margin; mesoscutum orange; metapleuron white; scutellum and postscutellum yellow. Propodeum orange, apical 0.1 white. Front legs white, femora with orange band on median 0.7 of posterior face; middle coxae white; first trochanter brown on anterior face, white on posterior; second trochanter white; anterior face of middle femora white, posterior face white on distal 0.6, orange on proximal 0.4; middle tibiae white, suffused with orange along inner faces; anterior face of hind coxae white with orange band on median 0.3, posterior face orange on proximal 0.7 and white on distal 0.3; first trochanter orange, white on distal 0.4; second trochanter white; hind femora orange, white on distal 0.2; hind tibiae grey, white on distal 0.2; middle and hind tarsi grey, white on distal 0.2. Petiole orange. Abdominal sternites white; abdominal tergites brown-black, tergites 2–6 each with median cuneate white spot near posterior margin. Distal tip of front wing lacking conspicuous brown spot.

MALE.—Unknown.

This species is known from only the type specimen. Nothing is known about its hosts or habits.

Holotype female, NOVA TEUTONIA, 27°11′ S, 52°23′ W. SANTA CATARINA, BRAZIL, 31 December 1959, F. Plaumann (Ottawa).

ACKNOWLEDGMENTS

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ZOOLOGICAL NOMENCLATURE: Announcement A. (n.s.) 85

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 names listed by case number:

(see *Bull. Zool. Nomencl.* 26, pt. 2, 8 August 1969):

1864. Suppression of *Acarus telarius* Linnaeus, 1758, and of neotype designation for that species (Acarina).
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 (Insecta, Orthoptera).
1867. Suppression of Huebner's pamphlet *Der Schmetterlinge Lepidoptera Linnaei europäisches Heer*, circa 1790–1793.
1875. Suppression of *Papilio saportae* Huebner, 1828/32 (Insecta, Lepidoptera).
1876. Type-species for *Agrotiphila* Grote, 1875 (Insecta, Lepidoptera).

(see *Bull. Zool. Nomencl.* 26, pts. 3/4, 24 October 1969):

1881. Type-species for *Platybunus* C. L. Koch, 1839 (Arachnida).
1882. Type-species for *Rybaxis* Saulcy, 1876 (Insecta, Coleoptera).
1885. Suppression of *Scaeva arcuata* Fallen, 1817 (Insecta, Diptera).

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 to the International Commission on Zoological Nomenclature.*

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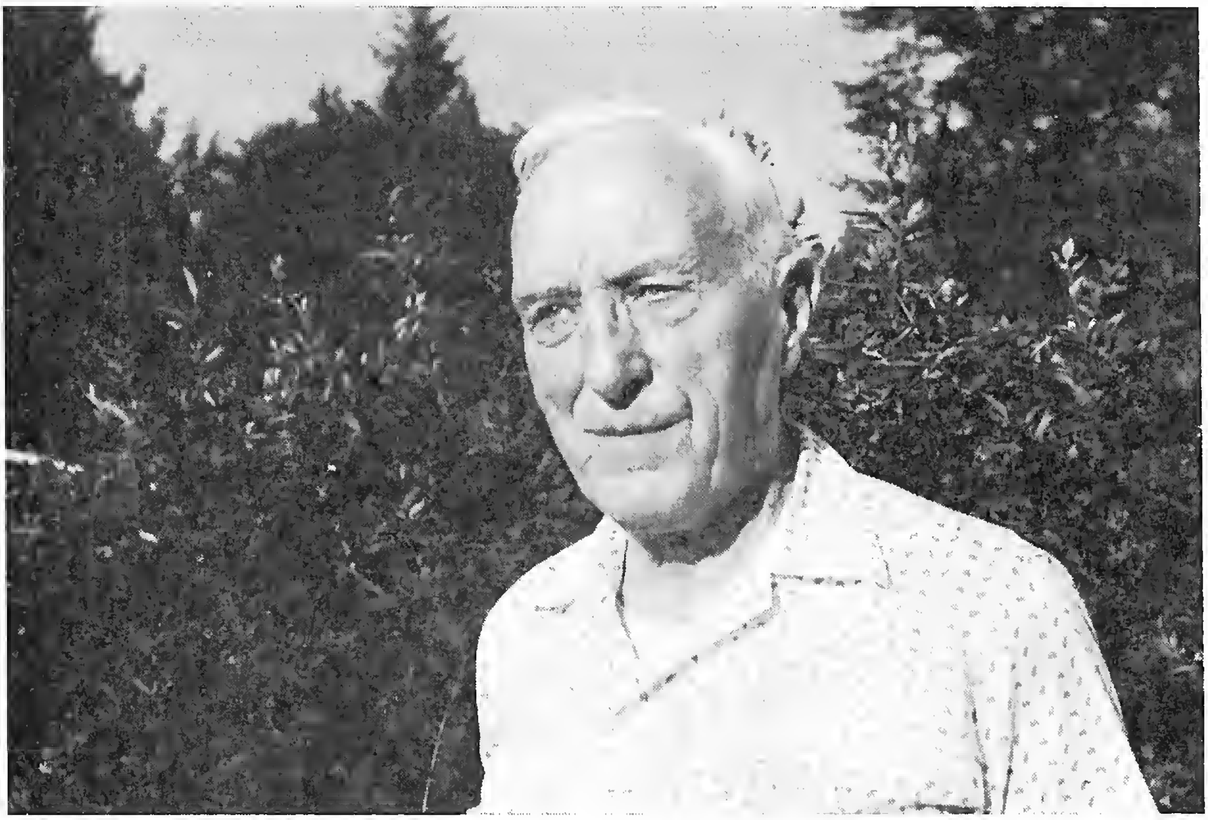
Dr. Charles P. Alexander—Honored Member.—By unanimous action of the Executive Board of the Pacific Coast Entomological Society at a meeting held on 21 November 1969, Dr. Charles Paul Alexander, distinguished student of the Tipulidae and world renowned entomologist, was elected an Honored Member of this Society.



Dr. Charles P. Alexander—Honored Member.

This honor in recognition of 60 years of work and continuous publication on the Tipulidae, also coinciding with Dr. Alexander's 80th birthday year, is but one of the many honors that Dr. Alexander has received from the world entomological fraternity.

Dr. Alexander is one of the world's most productive systematists, having described over 1% of the known insect species. As of 1 September 1969, he had published 932 papers on Diptera, totaling over 15,000 pages with over 12,500 figures (all drawn by Dr. Alexander with the exception of 180 figures). These papers have appeared in 125 separate publications in more than 30 countries and cover all regions of the world. The two leading publications containing Alexander papers are the *Philippine Journal of Science*, 1922–1969, with 89 papers (including descriptions of 2,056 new species) and the *Annals and Magazine of Natural History*, 1920–1961, with 113 papers (including descriptions of 1,891 new species). A total of

9,923 new species of Diptera (all but about 100 being in the single family Tipulidae) are described in the 932 papers mentioned above. It is believed that this figure vastly exceeds the number of new species in a single family, either in zoology or botany, ever described by a single person. One of Dr. Alexander's recent comprehensive works "The Crane Flies of California" published in the *Bulletin of the California Insect Survey*, volume 8, pages 1–269, text figs. 1–524, 1967, is of great value to western entomologists.

Dr. Alexander was elected to membership in the Pacific Coast Entomological Society at the meeting of 9 November 1951. He had previously subscribed to the *Pan-Pacific Entomologist* with the beginning of volume 3, in July 1926, and contributed two papers to that volume. Dr. Alexander is the nineteenth person to be elected an Honored Member of the Society during the past 58 years. The name, of previously elected Honored Members, listed alphabetically, with year of election, are as follows: F. E. Blaisdell (1938), Lawrence Bruner (1935), C. D. Duncan (1966), Alice Eastwood (1912), E. O. Essig (1948), G. F. Ferris (1948), L. O. Howard (1912), O. B. Johnston (1911), Vernon Kellogg (1912), E. G. Linsley (1968), E. R. Leach (1948), A. E. Michelbacher (1968), R. C. Miller (1968), J. J. Rivers (1911), R. L. Usinger (1968), E. P. Van Duzee (1938), E. C. Van Dyke (1938) and C. W. Woodworth (1912).—P. H. ARNAUD, JR., *California Academy of Sciences, San Francisco.*

PROCEEDINGS

THREE HUNDRED AND TWENTY-FOURTH MEETING

The 324th meeting was held Friday, 10 January 1969 at 7:45 p.m. in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Hagen presiding.

Members present (49): R. P. Allen, P. H. Arnaud, Jr., J. Benet, F. L. Blanc, I. Boussy, T. Briggs, R. G. Brownlee, G. R. Buckingham, D. Burdick, L. E. Caltagirone, P. Cammer, J. A. Chemsak, J. Cope, H. V. Daly, D. G. Denning, J. G. Edwards, W. E. Furguson, M. R. Gardner, P. R. Grimstad, J. Guggolz, J. F. Gustafson, J. D. Haddock, K. S. Hagen, T. E. Hewton, K. Hom, D. S. Horning, W. H. Lange, H. B. Leech, R. Lem, K. Lorenzen, J. W. MacSwain, A. R. Moldenke, J. A. Powell, D. Rentz, D. Ribble, E. S. Ross, F. J. Santana, T. A. Schultz, T. A. Sears, J. E. Slansky, C. N. Slobodchikoff, R. E. Stecker, R. L. Tassan, J. W. Tilden, W. J. Turner, D. Ubick, M. S. Wasbauer, S. P. Welles, Jr., R. F. Wilkey, S. C. Williams.

Visitors present (32): C. Adamson, Ana Caltagirone, K. Chen, Renae Cottam, C. Cushner, Janie Cushner, Mr. and Mrs. P. Dana, Loretta Denning, Alice and Janie Edwards, R. Fujii, R. Gardner, C. Glaser, Katie Henry, J. Hjelle, Carol Horning, G. Leung, Shari Lewis, Alison Moldenke, R. Papp, W. Rausden, Kathy Rentz, T. Rycraft, R. Smith, Anne Suguitan, Sharon Tanner, Cathy Tassan, D. Tiemann, B. Tilden, R. M. Vierhus, Judy Weller.

The minutes of the meeting held 20 December 1968 were summarized.

The following names were proposed for membership: Renae Cottam, William A. Clark, John G. Franclemont; and for student membership, Bob Lem and Darrell Ubick.

President Hagen called for introductions. Mike Gardner introduced Mr. Darwin

Tiemann from China Lake, California, who has worked on Phengodidae, especially the genus *Zarhipis.*

President Hagen called for notes and exhibits. Mr. Leech showed slides of a common lampyrid beetle usually found early in the spring near streams and in damp places. The immature stages have never been described. Just recently, what appears to be the fully mature larva was brought in. When disturbed it rolls up very much like a cutworm. It feeds on snails.

Mr. Leech also showed slides of Mr. Jack Balfour-Browne, the world specialist on water beetles, who just retired from the British Museum and stopped by the Academy on his way to Australia. He has been deaf since birth but is an accomplished lip reader.

Dr. J. F. Gustafson showed slides of a fire damaged Yellow Pine tree. The tree had a fire scar about 15 ft. long and 3 ft. wide at the base. (Buprestid and Cerambycid beetles had tunneled in the scar.) Woodpeckers then made holes in the scar in attempting to get the boring beetles and a *Peromyscus* mouse enlarged one of the woodpecker holes to make its nest, an interesting case of succession.

Dr. Edwards showed some slides portraying the effects of blackfly bites on the hand of one of the members of a recent expedition to Yucatan.

The principal speaker of the evening was DR. EVERT I. SCHLINGER, Chairman, Department of Entomology, University of California at Riverside. His illustrated talk was entitled "An Entomologist's View of Chile—The University of California—University of Chile Cooperative Project."

A social hour was held in the entomology rooms following the meeting.—M. S. WASBAUER, *Secretary.*

THREE HUNDRED AND TWENTY-FIFTH MEETING

The 325th meeting was held Friday, 21 February 1969 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Hagen presiding.

Members present (29): R. P. Allen, P. H. Arnaud, Jr., J. Benet, I. Boussy, T. Briggs, G. Buckingham, D. Burdick, P. Cammer, J. A. Chemsak, J. G. Edwards, J. F. Emmel, W. Gagne, F. Gustafson, T. E. Hewton, Jr., R. L. Langston, H. B. Leech, R. Lem, K. Lorenzen, R. Main, D. Munroe, P. Opler, D. W. Ribble, E. S. Ross, S. B. Ruth, F. J. Santana, Oakley Shields, Joanne E. Slansky, R. L. Tassan, J. W. Tilden, W. J. Turner, D. Ubick, M. S. Wasbauer.

Guests present (20): C. Adamson, C. Baum, E. E. Bedecanax, Alice Edwards, R. C. Gardner, G. D. Hanna, R. B. Hewitt, R. Huek, M. Marquis, J. Milstead, W. Pitcher, C. E. Reiner, Bessie D. Ruth, Suriya Sampunth, Phyllis Stecker, Emily Stobbe, L. E. Stotelmyre, R. P. Swartzell, Cathy Tassan, Betty White.

The minutes of the meeting held 10 January were summarized.

Four new members were elected: Walter G. Goodman, Robert B. Hewitt, David R. Meissner, Oakley Shields.

Dr. Joel Gustafson reported that the salt marsh investigations are progressing very well. Two salt marsh investigations are being carried on locally at present. One of these is being conducted by Guy Cameron, a graduate student at U.C. Davis. His study area is next to Petaluma Creek on San Pablo Bay. The other is being done by Robert Lane of San Francisco State College. His area is next to the Dumbarton Bridge on the south bay. The two investigators have compared notes and find that their areas are very different in faunal composition. For example, Cameron's area has no tipulids, whereas Lane's has many. Cameron's has anthicid beetles, but Lane's has none. Cameron's has many thrips and Lane's has only one. Cameron's has a few staphylinids and Lane has found none. Cameron has found no dolichopodid flies and Lane's area has many. As far as possibilities for fruitful investigation are concerned, the surface has only been scratched in these two areas.

Mr. J. S. Buckett, Program Chairman, announced that in the interest of uniformity, future meetings, at least for the remainder of year, will be held insofar as possible on the third Friday of each month.

The following notes were presented:

"Flying mouse" identified as *Cerogenes auricoma* (Burmeister) (Homoptera: Fulgoridae).—Dr. Dennis Breedlove presented to the Academy in early 1967 a series of Fulgoridae that he and an associate collected in Chiapas, Mexico. They have recently been identified by Dr. Lois O'Brien as *Cerogenes auricoma* (Burmeister). This attractive species was described in 1835 (Handbuch der Entomologie 2(1):168) from a specimen or specimens collected "Aus Mexiko, zwischen Villaalla und Oaxaka im Walde von Herrn Deppe entdeckt." On 1 September 1966, while D. E. Breedlove and John Emmel were traveling in the state of Chiapas, near Amates, 13 mi. SE. of Tapanatepec, at an elevation of 3,300 feet, the *Cerogenes auricoma* were observed on the trunk and branches of *Quercus conspersa* Bentham. To prevent breakage of the long wax tails the collectors injected the specimens with alcohol to kill them *in situ.* As can be noted in the display, some specimens of the series of nine specimens have white wax tails over four inches in length. The name "flying mouse" seemed to be an appropriate pseudonym to describe the appearance of these large bodied and long-tailed fulgorids. They readily took to flight when disturbed.—PAUL H. ARNAUD, JR., *California Academy of Sciences, San Francisco.*

Giant Margarodid Scales from Yucatan.—J. Gordon Edwards exhibited preserved specimens of female scale insects, *Llaveia axin* (Llave) from Valladolid, Yucatan. These huge scale insects have been used for centuries by mesoamerican Indians for various purposes. The bright orange females, each more than an inch long, are mashed together and kneaded into a wax-like ball which forms the base for cosmetics, has certain medicinal values, and is the major ingredient of hard waxy finishes applied to pottery and gourds by the early Maya and Aztec Indians. Mrs. Katherine D. Jenkins (Berkeley, California) has done more research on these insects and their uses than anyone else, and has reared both male and female adults in captivity, feeding them on *Erythrina crista-galli* ("Coral Tree"). Under field conditions they usually live on *Spondias purpurea* ("Hog-plum") in southern Mexico and Central America, and are also sometimes found on *Acacia* trunks. Mrs. Jenkins cites the name "Ni-in" or "Nije" (used by the ancient Maya) and "Axin" or "Aji" (used by the Nahua or Aztec Indians), but Edwards questioned dozens of Indians in Yucatan and Quintana Roo and found none who were familiar with those names. Instead, they referred to them only as "Tuch Mucuy" ("Tuch" = "protruding navel"; "Mucuy" = "little dove"). The Indians questioned were unanimous in the opinion that the wax has NO current usage in Yucatan. They once used it on cuts and tick-bites, but they say it "itches too much," and they now prefer commercial medications, instead.—J. G. EDWARDS, *San Jose State College, San Jose.*

The principal speaker of the evening was MR. RON STECKER, San Jose State College. His illustrated talk was entitled "An Illustrated Tour to the Top of a Living Giant Sequoia."

A social hour was held in the entomology rooms following the meeting.—M. S. WASBAUER, *Secretary.*

THREE HUNDRED AND TWENTY-SIXTH MEETING

The 326th meeting was held Friday, 21 March 1969 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Hagen presiding.

Members present (45): R. J. Adams, C. Armin, P. H. Arnaud, Jr., J. Benet, F. L. Blanc, R. M. Bohart, I. Boussy, G. Brady, D. Briggs, T. Calvert, P. Cammer, D. Carlson, R. V. Cottam, C. Dailey, T. W. Davies, R. L. Doutt, J. G. Edwards, J. Guggolz, T. E. Hewton, Jr., K. Hom, W. H. Lange, R. Langston, R. Lem, K. Lorenzen, R. Main, W. W. Middlekauff, R. R. Pinger, Jr., D. W. Ribble, E. S. Ross, F. Santana, T. A. Schulz, H. Scudder, J. H. Shepard, Joanne E. Slansky, Carolee Start, R. E. Stecker, L. Stotelmyre, D. Ubick, M. S. Wasbauer, D. L. Wilson.

Visitors present (40): C. Adamson, Mrs. Betty Armin, H. W. Bourne, Tina Calvert, Carolyn and Michelle Dailey, Lucinda Doutt, Alice and Janie Edwards, Peggy Ann Ewart, Barb Glaser, R. Graatman, A. Hamblin, Katie Henry, S. R. Husted, Katharine D. Jenkins, Ruth M. Jones, P. Jump, T. Lucas, Laurel Main, Ruth J. Maund, M. Montgomery, M. Ogden, R. W. Pinger, W. W. Pitcher, D. A. Ramsey, Susan Rickman, Suriya Sampunth, E. A. Schwarz, Muriel R. Sheehy, Mrs. J. H. Shepard, F. R. Smith, Phyllis Stecker, Anne Suguitan, Richard and Kathy Swartzell, Sharon D. Tanner, R. M. Vierhus, Betty White, Mrs. David Wilson.

The minutes of the meeting held 21 February were summarized.

Four new members were elected: Dave Carlson, Franklin Ennik, Stan Husted and Betty White.

President Hagen announced his appointees to the standing committees as follows: Publication Committee (1971); P. D. Hurd, Jr., Chairman and R. F. Wilkey; Historical Committee, R. L. Doutt to replace the late R. L. Usinger.

Dr. Wasbauer announced that because the circulation of the membership book during the meeting has been considered a somewhat disruptive influence, the book will be placed on a stand outside the meeting room for members and guests to sign as they enter.

Dr. Edwards introduced Mrs. Katherine Jenkins of Berkeley. Mrs. Jenkins showed an excellent series of kodachrome slides taken in Mexico of the large coccoid, *Llaveia.* The fatty body contents of this insect are used for medicinal purposes, for waterproofing boards and wood products and in the manufacture of the traditional lacquer ware of Mexico.

The following notes were presented:

***Chlaenius tomentosus zunianus* (Coleoptera: Carabidae) preying on an adult *Lacinipolia spiculosa* (Lepidoptera: Noctuidae).**—On 26 September 1966, while I walked across a cut grass field at about 12:30 p.m., west of the dining hall of the Southwestern Research Station, 8 km. W. of Portal, Cochise County, Arizona, a noctuid moth and carabid were observed to be in a fluttering struggle in the grass. The carabid, as an examination of the moth now indicates, had captured the noctuid with its mandibles by the apical third of the right fore and hind wings. Both wings show damage across their entire widths. The pair of specimens were quickly captured in a cyanide bottle to prevent their escape; this however precluded further observations. The moth has been determined by W. R. Bauer as a male *Lacinipolia spiculosa* Grote and the carabid by Dr. R. T. Bell as a male *Chlaenius tomentosus zunianus* (Casey). Only fifteen specimens of *C. tomentosus zunianus* were available to Dr. Bell at the time of the publication of his revision of the North American species of *Chlaenius* (1960, Miscellaneous Publications of the Entomological Society of America, Vol. 1, No. 3, pp. 97–166, figs. 1–142). This subspecies was reported as collected at Fort Wingate (type locality) in New Mexico, and the Catalina Mountains, Santa Rita Mountains, Sonoita, and Fort Huachuca in Arizona. My thanks to these specialists for their determinations. This pair of specimens is now deposited in the carabid collection of the Academy.—P. H. ARNAUD, JR., *California Academy of Sciences, San Francisco.*

The principal speaker of the evening was DR. J. GORDON EDWARDS, Department of Biology, San Jose State College. His illustrated talk was entitled "Entomology in Yucatan."

A social hour was held in the entomology rooms following the meeting.—M. S. WASBAUER, *Secretary.*

THREE HUNDRED AND TWENTY-SEVENTH MEETING

The 327th meeting was held Friday, 18 April 1969, in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Hagen presiding.

Members present (25): R. L. Adlakha, P. H. Arnaud, Jr., I. Boussy, D. L. Briggs, R. Bushnell, D. Carlson, J. A. Chemsak, B. J. Donovan, J. F. Emmel, J. J. Guggolz, M. R. Gardner, G. A. Gorelick, K. S. Hagen, E. L. Kessel, R. L. Langston, V. Lee, H. B. Leech, C. D. MacNeill, Kathleen Meehan, P. A. Opler, D. C. Rentz, D. W. Ribble, F. Santana, R. W. Thorp, W. J. Turner.

Visitors present (15): D. Cigston, D. Gunther, Katherine D. Jenkins, Berta Kessel, K. McClenaghan, Irene McClenaghan, R. Miller, D. M. Muir, Phyllis L. Pasqualli, Kathy Rentz, Kathleen Sakai, Paula Schaller, J. Shimizu, Joyce Thorp, Peggy Ward.

The minutes of the meeting held 21 March were summarized.

The following new members were elected: Brunson P. Bliven, Jean Marie Cadiou, Kathleen Meehan, John F. Emmel (Student Member).

President Hagen announced that the Society's Annual Picnic and Field Day will be held on Saturday, 10 May, at the Recreation Beach at Monticello Dam, ten miles west of Winters.

President Hagen asked for introductions from the floor. Dr. E. S. Ross introduced Dr. Dyrce Lacombe of Rio de Janeiro, who is interested in the histology of barnacles, in kissing bugs of the genus *Triatoma* and in the internal anatomy of the Embioptera. He also introduced Dr. E. S. Kessel, a charter member of the Society, whom some of the newer members may not have met.

Mr. Paul Opler introduced the principal speaker of the evening, DR. CLYDE D. WILLSON, Miller Fellow, Division of Entomology, University of California, Berkeley. His illustrated talk was entitled "Scanning Electron Microscopy: Some Entomological Applications."

A social hour was held in the entomology rooms following the meeting—M. S. WASBAUER, *Secretary.*

Three Hundred and Twenty-Eighth Meeting

The 328th meeting, the annual picnic and field day, was held Saturday, 10 May 1969 at Recreation Beach, below Monticello Dam, Yolo County.

Members present (12): P. H. Arnaud, Jr., I. Boussy, J. S. Buckett, G. Buxton, T. W. Davies, M. R. Gardner, K. S. Hagen, W. W. Middlekauff, R. R. Pinger, Jr., E. S. Ross, R. W. Thorp, R. F. Wilkey.

Visitors present (17): Nancy Barker, Davies family, R. Gardner, R. Good, Hagen family, L. O. Otero, Harriet V. Reinhard, Suriya Sampunth, Paula Schatter, Taly Slay, Thorp family, Wilkey family.

The day was quite warm and collecting was good on the chaparral slopes and along the margins of Putah Creek. Some members took advantage of the trout fishing in the creek, and some swimming was noted.—M. S. Wasbauer, *Secretary.*

Three Hundred and Twenty-Ninth Meeting

The 329th meeting was held Friday, 17 October 1969 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco. President Hagen presided.

Members present (39): P. H. Arnaud, Jr., F. L. Blanc, I. A. Boussy, R. Bushnell, P. Cammer, Helen Court, D. G. Denning, J. G. Edwards, J. F. Emmel, F. Ennik, W. Gagne, M. R. Gardner, J. F. Gustafson, J. D. Haddock, K. S. Hagen, T. P. Heck, T. E. Hewton, W. H. Lange, R. L. Langston, H. B. Leech, D. D. Linsdale, R. F. Luck, P. Opler, J. A. Powell, J. Prine, D. Rentz, D. W. Ribble, C. Rogers, R. Schoeppner, T. A. Schultz, H. I. Scudder, T. A. Sears, R. Stecker, L. Stotelmyre, W. J. Turner, S. C. Williams, Barbara A. Wilson, Joanne Wasbauer, M. Wasbauer.

Visitors present (38): Nancy Blair, R. Blair, J. E. Court, Angele Dacosta, Charlotte Davis, Loretta Denning, D. F. and F. L. Dunn, Alice and Janie Edwards, J. R. Gabel, C. S. Glaser, L. Gormley, L. Green, J. T. Hjelle, Katharine D. Jenkins, Sandy Jordan, Mr. and Mrs. Peter Jump, Ellen M. Lange, Shari Lewis, D. Merrill, S. R. Montague, D. D. Munroe, G. Nichols, Sandra Opler, Judy Oppenheim, R. R. Papp, P. Pasqualli, Roberta Pfadt, J. A. Scott, T. Slery, J. A. Smith, Phyllis Stecker, B. Tilden, Marilyn Trockman, Jill Vandergrift, Judy Weller.

The minutes of the meetings held 18 April and 10 May 1969 were summarized.

Ten new members were elected: William E. Azevedo, Bruce H. Baker, Michael M. Benzien, J. Russel Gabel, Thomas Heck, Sandy Jordan, Robert Luck, LeRoy C. Olson, Fred Punzo, Torolf R. Torgerson.

Mr. Leech announced on behalf of the Historical Committee, a gift from Mrs. Roxanna Ferris of individual photographs of six entomologists: J. H. Comstock, V. Kellogg, K. Jordan, J. Waterston, A. D. Imms, F. Sylvestri, prints of H. W. Bates and G. H. F. Nuttall and a group photograph of Dipterists at the Fourth International Congress of Entomology, Ithaca, New York, 1928. All the pictures are framed.

The following notes were presented:

***Gnophaela latipennis* trapped by flowers of milkweed (Lepidoptera: Pericopidae).**—*Gnophaela latipennis* Boisduval is a common day-flying moth of the southwestern United States and adjacent Mexico. Constrastingly marked in black and white, with a wing span of 35 to 55 mm., it attracts attention from a distance. On 5 July 1969 I was collecting beetles in Estell Creek, Logan Basin, at the southwestern foot of Bearwallow Ridge in the mountains west of Elk Creek, Glenn County, California, and saw a number of specimens of *G. latipennis* trapped by the flowers of milkweed *Asclepias* sp. Some moths were still in nearly perfect condition, constantly fluttering in attempts to escape, others were hanging limply; the rest were dead, and tattered from being blown by the wind. In each case the moth was caught by the tarsi of one or more legs in the floral parts of the milkweed, and I was unable to release them without breaking the legs.—HUGH B. LEECH, *California Academy of Sciences, San Francisco.*

Status of the Oriental fruit fly in California.—On 11 September 1969, a single male Oriental fruit fly, *Dacus dorsalis* Hendel, was caught in one of the regular statewide multiple-purpose fruit fly traps in a grapefruit tree at El Monte, Los Angeles County. Additional traps were immediately deployed in the area at a concentration of 100 per square mile, with peripheral range of 50 and 20 per square mile over a 64 square mile area. By 1 October a total of 18 male flies were trapped, all within a radius of 0.92 miles which could be contained in a circle of 2.65 square mile area. No flies have been taken since 1 October. (Colored slides of adults and larvae were shown and pinned adult specimens were passed among the members and guests.)—F. L. BLANC, *Program Supervisor, Bureau of Entomology, California Department of Agriculture.*

Flight of *Hilara* sp. (family Empididae) at Webber Lake, California.—Webber Lake, at an altitude of 6774 feet in Sierra County, California (located northwest of Truckee) is an historical collecting area for Dipterists. The pioneer Dipterist, Baron Osten Sacken, collected there in the summer of 1876. Webber Lake was on the early stage coach route over the Sierra Nevada and the hotel built over 100 years ago is still in existence, though not in use. On 23 and 24 August 1969, I drove to Webber Lake in my camper for a weekend of collecting.

On the evening of 23 August at 1930 hours, daylight saving time, as I walked to the western shore of the lake it was immediately evident that there was a tremendous flight of insects over the waters of the lake. The insects were flying close to the water as though they were just skimming the surface. They were so numerous that they produced an audible buzzing sound with their flight. They were not concentrated in any one spot, but they were generally dispersed with possibly one or more specimens flying over every square foot of water. They were flying over the water as far out as I could see them (about 20 feet from shore). I collected a few specimens and they were immediately identifiable as specimens of a *Hilara* sp. There was some wind, and when the water surface became choppy, they probably flew a little higher. They were much more difficult to see in the dimming light of the approaching night. I walked northward along the shore of the lake for 490 paces and they were as abundant there as where first observed. I found a small floating dock about 35 feet in length and walked to its end. The hilaras were flying over the lake at that distance from shore. Returning to my camp at 2010, they were still in flight, even though it was almost dark and a large moon was rising. A total of 34 males and 22 females was collected at various points along the shore of the lake. The hilaras were attracted to an 8 watt safari black light set on the sand and gravel near the edge of the lake. Hundreds of specimens were attracted to the black light, including mating pairs. Eighty-eight males and 79 females were collected as a sample. By 2040 they no longer flew to the black light. In four insect flight traps operated near the shore of the lake only a few specimens of this

Hilara were collected during portions of two days and one night of trap operation (1 male, 2 females on the 23rd; 2 males, 1 female on the 24th). It would be of interest to discover the resting places of such large numbers of hilaras.

The following morning, at 0745, some hilaras were seen flying over the lake. Fifty minutes later none were seen. The lake surface was very choppy due to strong winds.

Trichoptera were exceedingly scarce during the time of the evening flight of hilaras as only two specimens (a male *Dicosmoecus unicolor* (Banks) and a female *Hesperophylax* sp., both kindly determined by Dr. D. G. Denning) were attracted to the black light and none were swept from over the water's surface. The abundant silver flashes from jumping fish in the late afternoon probably indicated their feeding on the *Hilara* since Trichoptera and other conspicuous Diptera were lacking. The fish could be seen feeding up to several hundred feet from shore, possibly indicating the distance of the *Hilara* flight from shore.—P. H. ARNAUD, JR., *California Academy of Sciences, San Francisco.*

The principal speaker of the evening was DR. RICHARD GARCIA, University of California, Berkeley. His illustrated talk was entitled "Entomology in Western Malaysia."

A social hour was held in the entomology rooms following the meeting.—M. S. WASBAUER, *Secretary.*

THREE HUNDRED AND THIRTIETH MEETING

The 330th meeting was held at 7:45 p.m. on Friday, 21 November 1969 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco. President Hagen presided.

Members present (45): P. H. Arnaud, Jr., W. E. Azevedo, J. Benet, M. M. Bentzien, R. G. Blair, I. Boussy, R. G. Blair, D. Briggs, T. Briggs, P. Cammer, J. A. Chemsak, H. V. Daly, T. W. Davies, J. G. Edwards, W. E. Ferguson, J. R. Gabel, W. Gagne, Lauren Green, P. Grimstad, J. F. Gustafson, K. S. Hagen, J. L. Joos, P. Jump, R. L. Langston, V. Lee, H. B. Leech, P. Lem, K. Lorenzen, R. Main, P. A. Opler, W. Pitcher, D. C. Rentz, D. W. Ribble, E. I. Schlinger, T. Schultz, R. O. Schuster, R. Stecker, L. Stotelmyre, R. W. Thorp, D. Ubick, Joanne S. Wasbauer, M. S. Wasbauer, S. P. Welles, S. C. Williams, D. Wilson.

Visitors present (24): Kathy Beeby, J. G. Brandon, A. Dacosta, W. H. Dana, R. E. Dietz, Alice and Janie Edwards, L. A. Gormley, Mrs. J. L. Joos, Sandy Jordan, D. Merrill, R. Montagna, S. Nelson, Gay Nichols, Judy Oppenheim, Gayle Ray, Avis Reeves, B. Reeves, S. Sims, J. Smith, Joyce Thorp, Mrs. D. Wilson, Kathy Waeny.

The minutes of the meeting held 17 October 1969 were summarized.

Six new members were elected: Mr. Randall G. Blair, Miss Lauren Green, Mr. Peter M. Jump, Mr. William W. Pitcher, Mr. John T. Polhemus and Mr. Gary L. Seghi.

President Hagen called for notes and exhibits. Mr. David Rentz announced the recent naming of a mountain peak in California after an insect—Acrodectes Peak. It was named last year by a U. S. Government commission to provide names for unnamed mountain peaks. The peak is in the southern Sierra Nevada Mountains. The name *Acrodectes* is of Greek origin and means "summit climber."

Mr. Leech announced two books which have just been published. The first, entitled *The Kodiak Island Refugium,* is an interdisciplinary approach to the flora and fauna of Kodiak Island. It contains a couple of chapters by entomologists and includes a complete list of all the insects which were found during the course of a study of the island. The second is *The Distributional History of the Biota of the Southern Appalachians, Part I, Invertebrates.* It contains two entomological papers, "The Evolution of the Carabidae of the Southern Appalachians" by Thomas Barr and "The Ecological and Geographical Relations of the Southern Appalachian Mecoptera" by George Byers.

The following notes were presented:

Habitat of *Atypoides riversi* (Araneida: Antrodiaetidae).—A colony of the turret-building spider *Atypoides riversi* Pickard-Cambridge was discovered at Laurel Dell, Mt. Tamalpais, two miles north of Stinson Beach, Marin County, California on 8 August 1969. The colony was located on a north-facing slope heavily forested with Douglas fir (*Pseudotsuga taxifolia*) and California laurel (*Umbellularia californica*). The ground was covered with several inches of leaf litter but lacked low plant cover.

The colony covered an area 100 feet wide by 300 feet long. The spiders' burrows were located at the base of trees or near fallen logs. The turrets extended as high as two inches above the surface litter and the burrows were about 8 inches deep. Only females were present in a sample of 8 spiders collected. One female had several first instar young in her burrow.—MICHAEL M. BENTZIEN, *San Francisco State College, California.*

***Philotes enoptes bayensis* and *tildeni* Langston—Four New Localities.**—Both subspecies are found in definite colonies associated with their *Eriogonum* foodplants. Since my original 1964 and 1965 publications, additional colonies have not been generally found by collectors. Therefore, it is of interest to note these records: 1) *P. e. bayensis*—Camp Meeker, 2 mi. N., Sonoma Co., 3 July 1965, a single female among about a dozen *Plebejus acmon*; Benecia State Park, Solano Co., 15 June 1969, a single badly worn male with at least 50 *P. acmon*—farthest east (and inland) record. 2) *P. e. tildeni*—Keene, 4 mi. SE., Kern Co., 5 September 1965, 1 female, yellow-flowered *Eriogonum*—new county record (since the pubs.) and farthest south; Polonio Pass, Hwy. 46, S.L.O. Co., 8 September 1969, 5 males, 5 females among more than 100 *P. acmon* (appears to be a stronger colony than nearby Cottonwood Pass, both for the blue and for *Apodemia mormo* intermed. to *A. langei* which was present in the hundreds). 3) *P. e. smithi*—examples exhibited from the type locality for comparison. 4) *P. e. enoptes*—examples shown from the Sierra Nevada for comparison.—ROBERT L. LANGSTON.

A Naturalist Returns to Tesla Canyon.—I visited Tesla Canyon of 9 November 1951 to collect living specimens for courses in Forest Entomology and beginning Entomology. This canyon, at that time, was desolate except for the one no trespassing sign where the owner insisted on permission to collect on his land. On previous trips many groups of us had driven out Tesla Road, at the south edge of Livermore, and crawled under the fence with its bullet-riddled sign to collect many kinds of insects which had their most northern representatives in this dry canyon.

Traveling alone in 1951, I collected large numbers of the drywood termite, *Incisitermes* (*Kalotermes*) *minor* (Hagen), from a solitary, wind-felled, digger pine on the floor of the valley. At the same time, hundreds of the rare hemipterous species *Patapius spinosa* (Ross) (Leptopodidae) were found around the same tree.

Usinger had previously recorded one specimen of this species (1941h)[1] as a probable immigrant into California from its only previously known home in the Canary Islands. Numerous specimens of the California violin spider, *Loxosceles unicolor* Keyserling, were also found around or in the sides of the canyon.

This year another solitary trip on 26 October 1969 revealed a vastly changed environment. The original sign was obliterated by rust and holes. Other fences on the south, upper end of the canyon had many new signs, and bullet holes in the fences and signs while the northwestern side was fenced and has signs in a somewhat similar condition. Farther down the valley it was open on the south side of the canyon, and many hundreds of motorcyclists were carrying on their denuding of the valley floor and north-facing slopes. On the northeast side of the valley, it is protected by a stout fence and signs of the Atomic Energy Commission (with fewer bullet holes) but this section is patrolled by federal agents and farther down is a guard station and many new buildings.

Otherwise (with exceptions) the fauna and flora was the same. The digger pine had been reduced to a long reddish brown streak of decayed wood but the termite is surviving, in large numbers, in numerous stumps of cottonwood which had been downed for firewood but the stumps were too large to move and were almost impossible to break into with my axe and hatchet. Each had a number of termite colonies.

Leptopodids and the violin spider were still there, but another curious arthropod can now be added to any faunal list of this unique canyon. After crawling under an (anonymous) fence I found two large nymphs of the famous kissing bug, *Reduvius personatus* L. This species was recorded as rare in California by Usinger (1946h) and again by he and Wygodzinsky (from one pinned male, from Kern County) in (1964b). Nevertheless the species is not included in Essig's revised edition of "Insects of Western North America" (1958) nor does Usinger et al. (1964b) cite Usinger's previous paper (1946h) in its Bibliography. Further the 1969 edition of Herm's Medical Entomology lists this species as occurring only as far west as the Middle West.

The two nymphs are now feeding on *Blatella germanica* L. nymphs; while the dirt cave, from which they were removed on the south-facing slope, is heavily populated by several species of spiders and a very large number of lepismids. Access to another intriguing cave could not be investigated.—J. W. MacSwain, *University of California, Berkeley.*

Mr. Paul Opler announced that the annual Christmas dance of the Department of Entomology, University of California, Berkeley, would be held on 13 December at the Veterans Memorial Hall, Albany. Tickets are $2.00 and will be available at the door.

President Hagen announced the temporary committees for the year. The nominating committee will be Dr. J. A. Powell, Chairman, Mr. D. G. Denning and Dr. J. W. Tilden. The auditing committee will be Mr. D. C. Rentz, Chairman, Mr. R. L. Langston and Mr. H. B. Leech. These committees will report at the December meeting.

The principal speaker of the evening was Dr. Stanley C. Williams, whose illustrated talk was entitled "Behavior of Scorpions in Relation to the Birth Process."

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[1] From: R. L. Usinger's Bibliography by P. D. Ashlock, 1969, Pan-Pac. Entomol., 45(3): 185–203.

A social hour was held in the entomology rooms following the meeting.—M. S. Wasbauer, *Secretary.*

Three Hundred and Thirty-First Meeting

The 331st meeting was held at 7:45 p.m. on Friday, 19 December 1969 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco. President Hagen presided.

Members present (23): P. H. Arnaud, Jr., R. G. Blair, D. E. Bragg, P. Cammer, T. W. Davies, J. G. Edwards, J. F. Emmel, J. R. Gabel, M. R. Gardner, J. D. Haddock, P. Jump, R. L. Langston, H. B. Leech, W. W. Pitcher, J. A. Powell, D. W. Ribble, T. A. Schultz, T. A. Sears, R. E. Stecker, L. Stotelmyre, R. W. Thorp, M. S. Wasbauer, S. C. Williams.

Visitors present (16): F. G. Andrews, J. L. Bath, G. S. Benham, Jr., Beatrice Berry, Nancy Blair, E. A. Cameron, Alice Edwards, Marilyn Hamaker, Katharine D. Jenkins, Harriette Jump, A. D. Moscioni, Judith Oppenheim, J. A. Smith, Joyce Thorp, R. M. and Sharon Vierhus.

The minutes of the meeting held 21 November were summarized.

Four new members were elected: G. S. Benham, R. L. Dunn, J. E. McPherson, Jr., K. Smith.

The following notes were presented:

Thrips "biting" man.—The purpose of this note is to present several "biting" thrips' records encountered in central California this fall. Bailey (1936, Canad. ent., 68(5):95–98) has published a resume of some of the articles reporting thrips as attacking man in the United States and other world areas. It is of interest to note that thrips which are ordinarily considered phytophagous and to some extent predaceous, would attack man. The first two species recorded below appear to be new records.

While collecting in the area of Frank Raines Park, Del Puerto Canyon, Stanislaus County, on a field trip on 26 and 27 September 1969, with Drs. Williams' and Gustafson's entomology classes from San Francisco State College, four insect flight traps were operated in the creek bed. While operating these traps, I was annoyed by "biting" insects on both my arms and neck which I finally detected to be thrips. None were collected at that time. On a later field trip, on 1 November, to the exact locality with Mr. Thomas Davies, in the mid-day, a number of sharp "bites" were felt on my arms and three culprit thrips were successfully collected in alcohol. The specimens were determined as presenting two species—one specimen of *Frankliniella occidentalis* (Pergande) (the western flower thrips) and two specimens of "prob[ably] *Anaphothrips* sp., probably undescribed." It is thought that the latter species feeds on oaks. More recently, on 28 November 1969, in the Entomology Department, California Academy of Sciences, San Francisco, LaVerne Trautz, our Entomology Department technician, felt a "bite" on her arm. It was a thrips and this specimen was determined as *Thrips tabaci* Lindeman (the onion thrips). This species has previously been reported by Bailey (1936:97) in California as "biting." My thanks are extended to Mr. Tokuwo Kono, of the California Department of Agriculture, Sacramento, for his interest and prompt determination of these thrips. —Paul H. Arnaud, Jr., *California Academy of Sciences, San Francisco.*

Grooved Entomology.—Glancing through a recent issue of *Systematic Zoology*, I was upset to find only two articles which I could read with real understanding.

Doubtless this is a personal failure and problem. Soon after, I chanced to read "Living nature and the knowledge gap," by Dr. Paul A. Weiss (*Saturday Review* for 29 November 1969, pp. 19–22, 56). Though written for a much broader viewpoint, it is possible that some of his comments could be applied to entomology.

Having in mind a noticeable trend in articles in *Systematic Zoology* over the past few years, I would like to quote a few lines from Dr. Weiss.[1]

> (p. 19) "One of the drawbacks [of modern science] is that, by its sheer momentum, a mass of single-tracked workers tends to amplify any trend once that trend has started rolling. A fashionable course thus becomes grooved ever more deeply, draining interest, attention, encouragement, and talent away from solitary prospecting ventures. As a result of these social dynamics, the research scenery is gradually becoming converted, metaphorically speaking, from a lush mountain meadow evenly irrigated by a profusion of anastomosing rivulets into a landscape of deep canyons with raging rivers, separated by wastelands of arid mesas."
> (p. 21) "Education can give him [a young investigator] scope for self-direction and creativity or it can mold him into a mere cog in a mass production machine. Society needs the latter kind, well-trained for practice, in increasing numbers, but here we are concerned primarily with those aiming at the advancement, rather than the application, of knowledge . . . if the incipient investigator is enticed to keep on riding currents of fashion, instead of being challenged to chart his own course toward self-chosen destinations, it is his education that has been at fault. So what is needed is certainly not 'planned research,' but sounder plans for '*education for research.*' "—HUGH B. LEECH, *California Academy of Sciences.*

The effects on man of a natural sting by the scorpion *Vejovis confusus* Stahnke.—The sting of *Vejovis confusus* Stahnke was experienced accidentally while conducting field studies on the ecology of this species in the Sonoran desert near Phoenix, Maricopa County, Arizona, during 1966. The sting occurred at 10:00 AM (MST), some 10 minutes after the capture of the mature specimen. The sting was inflicted on the middle segment of the third finger of the right hand. An immediate, intense burning sensation occurred, which lasted at the site of the sting for some 20 minutes before beginning to lessen in intensity. Fifteen minutes after the initial sting, swelling became visible around the knuckle above the wound. This swelling gradually progressed over the entire finger and spread downward into the other fingers of the same hand within one hour. Within three hours the entire hand had become very swollen as compared to the left hand. This swelling was sufficient to prevent effective bending of fingers and wrist. Within five hours, the swelling had progressed up the arm to the elbow. The swelling lasted approximately 24 hours before beginning to subside. Within 48 hours the right arm and fingers had returned to almost normal size. Within 72 hours the hand had fully recovered from the sting with no apparent after effects. During the period of increased swelling the intense burning sensation gradually subsided while a general numbness of sensation developed in the fingers and spread to the elbow of the affected hand. As the swelling began to disappear, normal sensitivity gradually returned. No indica-

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[1] Copyright 1969 *Saturday Review*, Inc. Quoted with the permission of Saturday Review.

tion of convulsions or other significant systemic actions of the venom were apparent. No therapy was used to counter the effects of the venom, however, use of the right hand was essentially discontinued for some 20 hours because of the extreme swelling. The speed and pattern of travel of the swelling indicated that the lymphatic circulation was primarily responsible for the distribution of the venom.—STANLEY C. WILLIAMS, *San Francisco State College.*

President Hagen called for reports from the chairmen of the standing committees.

Prof. J. G. Edwards, membership committee, reported that 36 new members were elected and one member, Dr. C. P. Alexander, was elected to honored status during the year.

Dr. R. W. Thorp reported on behalf of the publication committee that two manuscripts were under consideration for the Memoirs series during 1969, the autobiography of the late Prof. R. L. Usinger, and a revision of andrognathid millipeds by M. R. Gardner. The publication dates have not been set on these papers, but they will appear in 1970.

President Hagen then expressed thanks to the program committee and its chairman, Mr. J. S. Buckett, for a successful year of programs.

Dr. P. H. Arnaud, Jr. read the treasurer's financial report, and Mr. R. L. Langston of the auditing committee reported that the financial records of the Society for 1969 are in good order.

Mr. H. B. Leech, chairman of the historical committee, reported that the file cases are now upstairs on the main floor of the entomology department, but 2 or 3 more file cases are needed before all the material on hand can be sorted-classified and filed. Accessions during the year have been noted at earlier meetings. The most recent acquisition is over 1000 glass lantern slides used in the past at Stanford University to illustrate lectures. Most are of entomological subjects and some are of strictly historical interest.

President Hagen announced appointment to the publication committee for 1972 of Dr. Howell V. Daly and Dr. Albert A. Gregarick.

Dr. J. A. Powell, chairman of the nominating committee, presented the following slate of nominees for offices in the Society for 1970: Dr. R. W. Thorp, President; Mr. F. L. Blanc, President-Elect; Dr. M. S. Wasbauer, Secretary; Dr. P. H. Arnaud, Jr., Treasurer. There were no nominations from the floor. The nominees were elected to office for 1970 by unanimous vote.

The principal speakers of the evening and their topics are as follows:

G. R. BUCKINGHAM—**Searching for a Parasite of the Walnut Husk Fly, *Rhagoletis completa* Cresson.**—The walnut husk fly, *Rhagoletis completa* Cressen, was accidentally introduced into California from the Southwestern United States in the 1920's. The maggots eat the walnut husk, which results in staining of the shell in English walnuts. A native parasite, *Opius juglandis* Mues. (Hym. Braconidae), has been reared for several years at the Division of Biological Control, University of California at Albany. In September 1969 I traveled to Arizona and New Mexico to obtain more parasite individuals and to make field observations on the parasite and its hosts. Many parasites were observed on wild black walnut trees in the Chiricahua Mountains of Southern Arizona. Since *Rhagoletis completa* does not occur there, two other husk flies, *Rhagoletis juglandis* Cresson and *Rhagoletis boycei* Cresson, serve as hosts. Ants and a salticid spider were observed preying upon parasite adults and ants were very often found carrying maggots. This area of Arizona is very similar to the parasite release areas in California except that it has frequent summer thunder showers. How much effect the dry summers of California will have on the parasite is unknown. In Southern New Mexico, parasites were found associated with both *Rhagoletis juglandis* and *Rhagoletis completa.*

JAMES D. HADDOCK—**Biological traits of two species of *Leptocella*.**—The caddis fly genus *Leptocella* (Leptoceridae) consists of a number of primarily whitish colored species of insects whose larvae construct elongate, tubular, portable cases. They are distributed throughout the western hemisphere, occurring from Alaska to Argentina.

Species limits, based on the morphology of the adults, have been open to considerable conjecture and debate. A study of the immature stages, however, has helped to clarify speciation in the genus in North America; two species will be briefly discussed to illustrate this point.

The adults of *Leptocella intervena* and *L. albida* are remarkably similar in regard to wing pattern, head structures, male genitalia and a number of other structures. Larval morphology, case-making behavior and ecology, however, clearly separate the two species. *Leptocella intervena* has a well developed swimming and feeding brush that is located on the hind tibia, has a number of tubular tracheal gills located on the anterior segments of the abdomen and has a characteristic color pattern found on the dorsal portion of the head and thorax. In contrast, *L. albida* has no brush, has an absence of tracheal gills and has different color patterns. *Leptocella intervena* constructs a larval case composed primarily of minutely cut plant fragments, while the case of *L. albida* is composed almost entirely of sand grains. *Leptocella intervena* is found in the western U. S. in lowland, highly silted slow flowing rivers with midsummer water temperatures ranging from 60–102 degrees Fahrenheit. *Leptocella albida* appears to be restricted to the cooler waters of the past-glaciated midwest and east. It is apparently isolated from the western U. S. by the head waters of the Mississippi River.

It is anticipated that a study of this nature will be useful in the applicability of insects as indicators of thermal and organic water pollution and erosion.

KATHARINE D. JENKINS—**The fat-yielding coccid, *Llaveia*, a monophlebine of the Margarodidae.**—This very large soft-scale insect of the American tropics and subtropics, which has been exploited (sometimes cultivated) for its fat by peoples of Meso-America since before the Spanish Conquest, has not been systematically collected and studied by entomologists, and the literature on it is meagre and unsatisfactory.[1]

The material here presented was accumulated in the course of ethno-historical research and field work—directed toward finding the sources of the fatty substance used in Mexican lacquer-work, gourd-painting and related techniques, and recording surviving practices in the exploitation of the insect—and personal experience in rearing progeny of insects collected.

The fat, extracted from the bodies of mature females, has remarkable properties in forming a tough impermeable film on any surface to which it is applied and has had many uses, not only in native arts (in waterproofing wood and gourds and binding pigments to surfaces in a lacquer-like coating, and as a base for face- and

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[1] Pertinent references are cited in K. D. Jenkins, "*Aje* or *Ni-in* (the fat of a scale insect): Painting Medium and Unguent," XXXV Congreso Internacional de Americanistas, Mexico, 1962, *Actas y Memorias* 1 (Mexico, 1964): pp. 625–636.

body-paint), but also in folk medicine (particularly as applied to wounds, swellings, skin afflictions, or, combined with herbs or other materials, taken internally to cure a variety of ailments).

Both the insect and the fatty product are generally called *aje*, from the Nahua (Aztec) name *axin*; but there are other locally used names such as *ni-in*, *nij*, or *nije*, from areas of Maya influence, or *kŭrrón*, among the Guaymi of Panama.

Although the substance has been a widely distributed trade item for centuries, it has never gained economic importance and production has remained an obscure native industry carried on by a few persons in isolated communities, where the coccids may be cultivated or gathered from the wild. The occurrence of the insect has been reported from widely separated localities in "hot country" (i.e., at elevations of less than 4,500 feet), from western Mexico to Panama; but the actual distribution of the genus *Llaveia* is not known; and it is not known whether the coccids of different areas are of one or several species.

The insect was first described in 1830 by Pablo de la Llave, who examined specimens from Tlacotalpan in southern Veracruz, and named it *Coccus axin.* In 1875, the French entomologist Signoret erected a new genus for it, naming it *Llaveia*, and he put specimens from Guatemala in a new species, *Llaveia bouvari.* In 1928 the late Dr. Harold Morrison, of the USDA Bureau of Entomology, suggested that *L. bouvari* and *L. axin* were identical but, lacking adequate material for comparative study, left the question open.

These *Llaveia* coccids produce only one generation a year and have a long overwintering egg stage. The adult females are oblong-oval in shape, usually coral-red in color (sometimes yellow), but are covered with a powdery white wax. In the fall, when they have attained full size (1.5 to 2.5 cms in length), they produce a more flocculent wax and, under natural conditions, leave the host plant to go into the ground, each female encasing herself in a cottony-looking ball in which the salmon-colored eggs are laid. Crawlers begin to emerge in early spring, hatching out in separate batches over a period of about two months, so that, in any colony, several stages of development may be seen at the same time. Females molt three times, at intervals of about a month. After the second molt, the males no longer feed on the host, but find protected places, in the bark of the tree, the undersides of leaves, the detritus under the trees, where they form "pseudococoons" of a soft white wax, in which they spend the next two stages of development, to emerge as winged adults about two months later (July to early September), when the females have completed their third molt and are ready for mating. The winged males live only a few days, but the females continue to feed and fatten on the host plant for several weeks and, by the time they are large enough to be worth gathering and processing (late September, October or November), all males have disappeared.

Cultivation is a simple matter of setting aside a number of the fattest females at harvest time, storing them in a gourd or other container during the dry season, and placing them on a suitable host tree when the crawlers begin to appear in the spring.

In field trips in the fall seasons of 1966, 1967 and 1968,[2] to places where the insects had been exploited in the past, colonies of the coccids were found in five distinct areas, growing under different conditions:

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[2] Field work made possible by two grants from the American Philosophical Society, in 1966 and 1968.

1. In the wet climate of southern Veracruz, at San Andrés Tuxtla, where they were being cultivated by tradition on *Erythrina americana*, a species of *Spondias*, and *Jatropha curcas*—all trees which are commonly cultivated.
2. In the drier climate of the Río Balsas Basin, at Ziritzicuaro (about 20 kms. south of Huetamo, Michoacán), where they flourished naturally on *Acacia cochliacantha*, in a "thorn forest" situation, and were gathered by persons from Huetamo.
3. In the similarly dry climate of south-central Chiapas, near Venustiano Carranza, where they were gathered from *Acacia angustissima* and *A. pennatula*.
4. In the Department of Baja Verapaz, Guatemala, with semi-dry climate, at Rabinal, where they were being cultivated on *Spondias* and *Jatropha* trees, and at nearby Salamá, where they grew untended on *Jatropha* planted in hedgerows around houses.
5. In Yucatán, with its Gulf Coast-Caribbean climate, at Valladolid, where they covered the branches of a large *Spondias* tree, growing behind a house—again, untended, probable survivors of earlier cultivation.

These findings do not fill the gaps in our knowledge of the distribution of *Llaveia*, but they raise interesting questions about the history of the insect's cultivation, which must have affected the natural distribution patterns of the genus.

Colorslides shown depict the *Llaveia* coccids—adult male and female, and some of the earlier instars—and the several habitats in which they were found, as well as the techniques used to extract the fat and prepare it for market.

J. A. Powell—**Moths of the Humboldt Bay area.**—Since the insect fauna of the north coast area of California has been poorly known, we made an effort to collect thoroughly last summer during the field course in entomology of the University of California, held at Humboldt State College, Arcata. The two principal habitats worked were the second growth redwood forest back of campus and the beach dunes south of Samoa. Black light trapping was carried out only at Arcata, in mixed vegetation marginal to the redwoods and in the forest. Weather conditions were generally better than anticipated; fogs were intermitent and did not prove to be a strong deterrent. Nightly temperatures ranged in the mid to low 50's °F.

Moth collecting was not rich in quantity or diversity (50–60 species per night maximum), with noctuids and larger macros poor, geometrids relatively good, tortrcoids fair, and pyraloids and smaller micros poor. Nor surprisingly, many represented range extensions of species previously known further north. The 33 species of Tortricidae (s.l.) and Phaloniidae may shed some light on distributional affinities of the fauna of the area: only 39% are widespread Nearctic Boreal species (opposed to 55% of Tortricinae in California as a whole), while 36% range along the coast in a Vancouveran distribution pattern (only 10% of the California Tortricinae).

Illustrated species included: *Acleris gloverana* (Wlsm.) four polymorphs taken in late August near Big Lagoon on *Picea sitchensis*, indicating the California populations probably will prove as variable as those to the north; *A. britannia* Kft., dark forms previously only known to the north prevalent at Arcata; *A. maccana* (Tr.), taken at Arcata in February, 1968, the first record in California for this Holarctic, boreal species; *Cnephasia longana* (Haw.), collected at four localities from beach dunes to 2000′ east of Kneeland, an European species previously known to be established in the San Francisco Bay area and in Oregon and Washington; *Batodes angustiorana* (Haw.), another European species introduced around the Puget Sound and San Francisco Bay areas, but not recorded in California since 1943, abundant on cultivated *Taxus* at Arcata in late July; *Xenotemna pallorana* (Rob.), flying at Samoa dunes during the latter half of June, not previously recorded south of northeastern Oregon; *Pandemis limitata* (Rob.), at lights during most of July at Arcata, confirming two isolated records along the California coast ten years ago; *Epinotia cruciana* (L.), netted in the redwoods on July 4, an Holarctic species not known south of Washington; *Zeiraphera ratzeburgiana* (Ratz.) (=*pacifica* Free. or *canadensis* Mut. & Free.), a single male at light in late July of this Canadian species; *Apotomis capreana* (Hbn.), at lights in late July, also a southward extension from Washington; *Epimartyria pardella* (Wlsm.), at four sites around Arcata and west of Kneeland, the first collected since the type series taken in southern Oregon in 1872; and *Arctia caja* L., at light in late July.

T. A. SEARS—**A possible explanation for seasonal emergence peaks of Macrolepidoptera in southwestern Chihuahua.**—My recent collecting with black light traps (funded in part by American Philosophical Society grant #5192, Penrose fund) in the Barranca del Cobre region of the Sierra Madre Occidental of southwestern Chihuahua has revealed a distinctive emergence pattern for Macrolepidoptera of the area, probably as a result of adaptive ecological strategies for survival in a wet-dry climatic regime. There are no specific weather data for this area as it is so remote, but, in general, there is a wet season of 60 to 80 days extending from the first of July to mid-September. During the remainder of the year, humidity is extremely low. Temperatures, of course, vary with locality and season; but in all cases the annual variation is considerable.

In 1968 my collecting commenced 4 July, two days before the rains began, at Choix, Sinaloa, 900 feet elevation. By 10 July, the extremely rapid budbreak and development of vegetation so characteristic of this region of Mexico had rendered the area verdant. From 8 July through 25 July, moth collecting was extremely good both in numbers and diversity. However, shortly thereafter and throughout the remainder of the summer, collecting dropped off markedly and was, in general, unprofitable. The same pattern was also evident at Creel, Chihuahua, elevation 7,600 feet. Around 10 September diversity and numbers of Macrolepidoptera increased and collecting was again excellent. Since the intensity of collecting was not consistent throughout the summer, no conclusions were drawn at that time; and I attributed the poor collecting to a combination of moon phase and weather factors.

With consistent and continuous collecting throughout the summer of 1969 a general emergence pattern was confirmed. We collected almost continuously in all weather at two localities—Cuiteco, Chihuahua, elevation 5,200 feet and Temoris, Chihuahua, elevation 4,500 feet. Rough counts of the numbers of species and total numbers reveal distinctly bimodal distribution with peaks around 20 July and 10 September. Representative counts for diversity are as follows in numbers of species per trap: 20 July, 150–170; 15 August, 40–60; and 10 September, 100–150. The figure for 15 August was typical for the period from 25 July to 1 September. The comparison shows that there is roughly a two- to threefold increase in diversity at the beginning and again at the end of the summer. The total numbers of Macrolepidoptera taken follow a similar distribution with an estimated 2,000 to 3,000 per trap/night at the beginning of the season, decreasing to approximately 250 to 300 per trap/night during the middle period, and increasing to 1,000 to 2,000 per trap/night at the end of the season.

The following interpretation is offered for these data. My collecting in the area during the dry months of March and December indicates little insect activity during the dry period. One would expect the beginning of the rainy season to trigger emergence, as food plants are only then generally available. It might be assumed that as the rains begin to decrease at the end of the season, other species would emerge. However, in both years the precipitation during the month of September was fully as great as it was during the rest of the summer; so I do not feel that decreasing humidity is the most important factor leading to this second emergence peak.

In most areas of the United States emergence of insects and budbreak of plants is correlated with accumulated day-degrees. There tends to be a relatively constant turnover of species throughout the spring and summer, with attenuated emergence peaks. However, in this region of Mexico, temperature is not the limiting factor; and, therefore, day-degrees are of lesser importance in determining emergence. With the addition of water to the environment, development of plants and emergence of insects is instantaneously initiated. Hence, the gradual turnover of species is not as evident. I speculate that the two emergence peaks noted arise from the use of two ecological strategies for survival during the dry season.

These two strategies operate as follows. As the stages of the life cycle most resistant to desiccation are the egg and pupal stages, most moths would be expected to pass the dry months in these states. With sufficient moisture insects in both stages emerge. The first peak of adult emergence would then be due to the hatching of the pupae. These adults lay their eggs at the beginning of the season, the resultant larvae develop, and pupation until the following year takes place. The second emergence peak is composed of the species which overwinter as eggs. The eggs hatch with the coming of the rains, the larvae develop, there is a short pupal stage, and the adults emerge late in the season, laying their eggs which then overwinter.

In summary it should be emphasized that the data and conclusions apply only to Macrolepidoptera. However, it might be expected that other obligately phytophagous insect groups might utilize the same ecological strategies. Secondly, as this study covered a relatively small region of Mexico subject to the climatic regime described (the most distant collecting localities being separated by 150 miles), it cannot be said in how large a geographic area one would obtain the same observations. However, the same emergence pattern might be found in general throughout parts of the southwestern United States and northwestern Mexico where such climatic conditions prevail.

A social hour was held in the entomology rooms following the meeting.—M. S. WASBAUER, *Secretary*.

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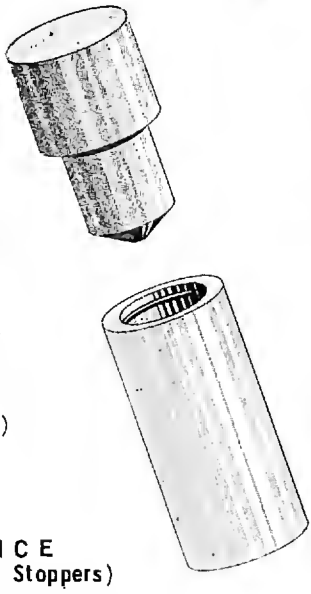

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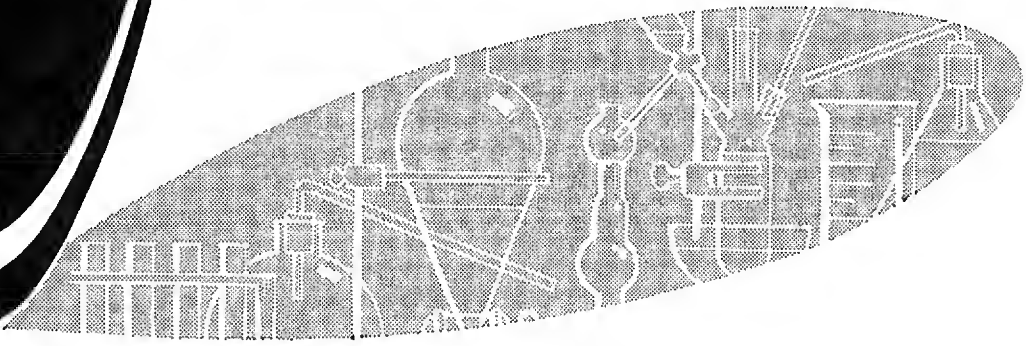

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THE PAN-PACIFIC ENTOMOLOGIST

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Vol. 46 APRIL 1970 No. 2

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The Pan-Pacific Entomologist

Vol. 46 APRIL 1970 No. 2

Ratios: An Intuitive vs. A Quantitative Approch in *Grotea*
(Hymenoptera : Ichneumonidae)

C. N. SLOBODCHIKOFF
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The genus *Grotea* contains eight species, all from the Western Hemisphere (Slobodchikoff, 1970). Prior to revision, only five species were described. Descriptions of these five species were based entirely on color. When a revision was undertaken, it appeared that several characters other than color would be useful for separating species. The intuitive taxonomic approach indicated that the shape and dimensions of the first median area of the propodeum, the second pleural area of the propodeum, and the genal hook (the process ventral to the lower end of the occipital carina) were good, definitive characters. It seemed useful to convert the dimensions into ratios, and to use these ratios in the descriptions and the keys to species.

Taxonomic keys often present characters in the form of ratios. For example, a key may state that structure x is 0.6 the length of structure y, or structure a is 1.5 the width of structure b. Such ratios often do not have any accompanying statement of the degree of variation that one may expect to find. It is implicit that some variation does occur, but a non-specialist working a key often may not know just how much variation he should compensate for and still correctly identify a given species. The purpose of this present study was to find the degree of variation in each of the characters mentioned above, and to test the validity of using ratios as diagnostic characters.

The ratios were computed on the basis of the following sets of measurements: the length of the second pleural area of the propodeum vs. its width at midpoint; the width of the genal hook at its base vs. its width at 0.66 the distance from base to tip; and the anteroposterior length of the first median area vs. its anterior width. All measurements were made at 40× with an American Optical Company Spencer microscope and an ocular micrometer. Means, standard deviations, and correlation coefficients were calculated using the University of California Computer Center Statpak program and an IBM 7094 computer. The

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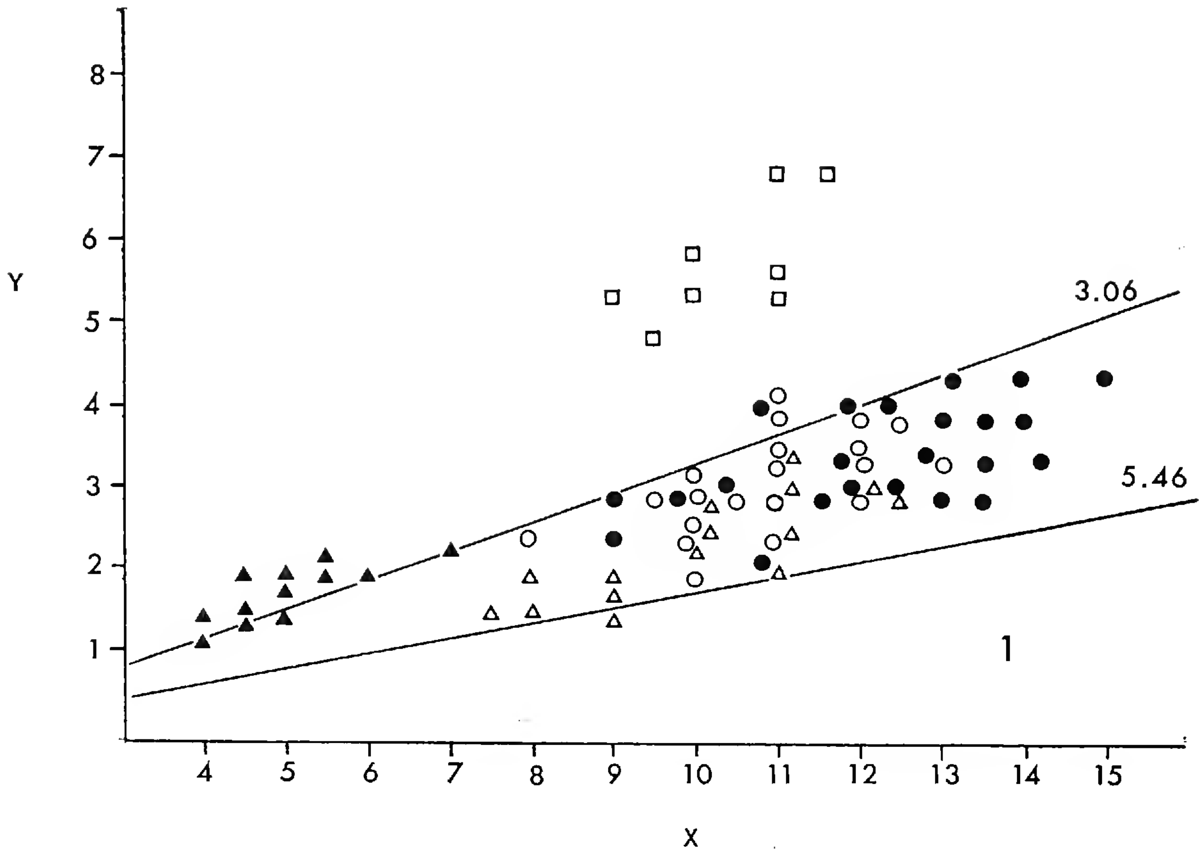
TABLE 1. Means, standard deviations, and variances for three characters of *Grotea* spp.

Species	*Pleural area*	*Median area*	*Genal hook*
G. anguina	$\bar{x} = 3.66$	$\bar{x} = 2.06$	$\bar{x} = 2.59$
	$N = 25$	$N = 25$	$N = 25$
	$s = 0.580$	$s = 0.539$	$s = 0.323$
	$s^2 = 0.3388$	$s^2 = 0.2916$	$s^2 = 0.1024$
G. lokii	$\bar{x} = 4.38$	$\bar{x} = 1.79$	$\bar{x} = 1.88$
	$N = 21$	$N = 21$	$N = 21$
	$s = 0.659$	$s = 0.471$	$s = 0.383$
	$s^2 = 0.4356$	$s^2 = 0.2209$	$s^2 = 0.1444$
G. californica	$\bar{x} = 3.25$	$\bar{x} = 1.28$	$\bar{x} = 1.26$
	$N = 25$	$N = 25$	$N = 25$
	$s = 0.725$	$s = 0.254$	$s = 0.190$
	$s^2 = 0.5329$	$s^2 = 0.0625$	$s^2 = 0.0361$
G. californica	$\bar{x} = 3.04$	$\bar{x} = 1.14$	$\bar{x} = 1.26$
local population	$N = 18$	$N = 18$	$N = 18$
	$s = 0.424$	$s = 0.249$	$s = 0.130$
	$s^2 = 0.1764$	$s^2 = 0.0623$	$s^2 = 0.0169$
G. mexicana	$\bar{x} = 1.76$	$\bar{x} = 1.34$	$\bar{x} = 1.80$
	$N = 10$	$N = 10$	$N = 10$
	$s = 0.144$	$s = 0.691$	$s = 0.391$
	$s^2 = 0.0207$	$s^2 = 0.4774$	$s^2 = 0.1529$
G. delicator	$\bar{x} = 2.83$	$\bar{x} = 2.78$	$\bar{x} = 1.49$
	$N = 25$	$N = 25$	$N = 25$
	$s = 0.272$	$s = 0.606$	$s = 0.162$
	$s^2 = 0.74$	$s^2 = 0.366$	$s^2 = 0.026$

characters of only five species were analyzed. Three species, *Grotea fulva*, *G. athenae*, and *G. perplexa* were excluded due to the lack of a sufficient number of specimens.

The pertinent data for the degree of variation for each character are presented in Table 1. Correlation-coefficient analysis indicated that each character varies independently of the other two. The actual measurements (in absolute units) and the resultant ratios are shown in



FIGS. 1–6: solid circle, *Grotea anguina*; open circle, *G. californica*; solid square, *G. californica*, Orinda population; open square, *G. mexicana*; solid triangle, *G. delicator*; open triangle, *G. lokii.* Measurements are in absolute units. FIG. 1. Second pleural area of propodeum; y-axis, width at midpoint, x-axis, antero-posterior length.

figures 1–3. Figure 1 shows the scatter of ratios for the second pleural area, figure 2 shows the ratios for the genal hook, and figure 3 shows the ratios for the first median area.

Inspection of figure 1 shows that three species, *Grotea anguina*, *G. lokii*, and *G. californica* clearly fall into a band of ratios between 3.06 and 5.46 and cannot be distinguished from one another on this basis. *Grotea mexicana*, with a mean ratio of 1.76 and a standard deviation of 0.144, clearly falls ouside this band ($\bar{x} + s = 1.904$), while *Grotea delicator*, with a mean ratio of 2.83 and a standard deviation of 0.272, falls mostly, yet with some overlap, outside this band ($\bar{x} + s = 3.102$). It may be concluded that second pleural area ratios are useful for separating *Grotea mexicana* from the other four species, less useful for separating *Grotea delicator*, and useless for separating *Grotea anguina*, *G. lokii*, and *G. californica* from one another.

Inspection of figure 2 shows that three species, *Grotea delicator*, *G. lokii*, and *G. mexicana* fall mostly into a band of ratios between 1.37 and 2.16, while *Grotea californica* ($\bar{x} + s = 1.45$) and *G. anguina*

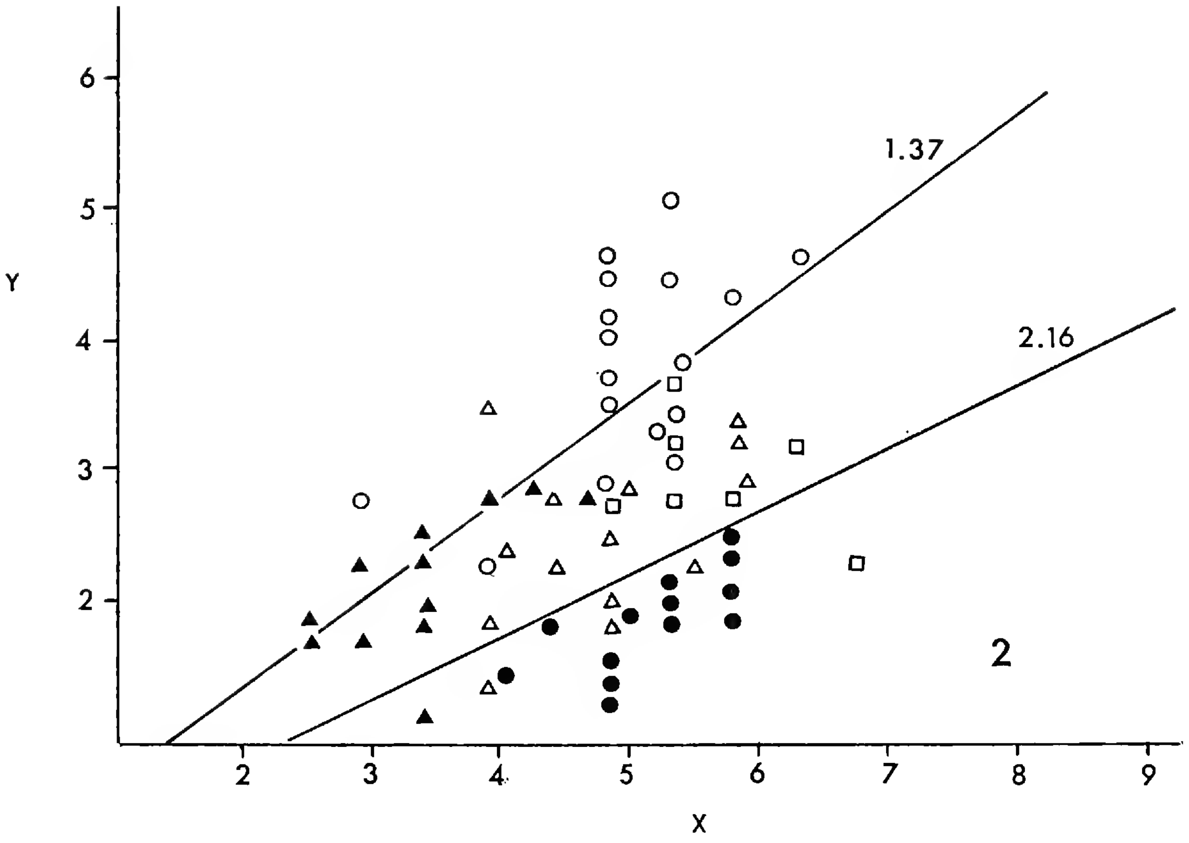


FIG. 2. Genal hook; y-axis, 0.66 the length from base to tip, x-axis, basal width. (See Fig. 1 for explanation of symbols).

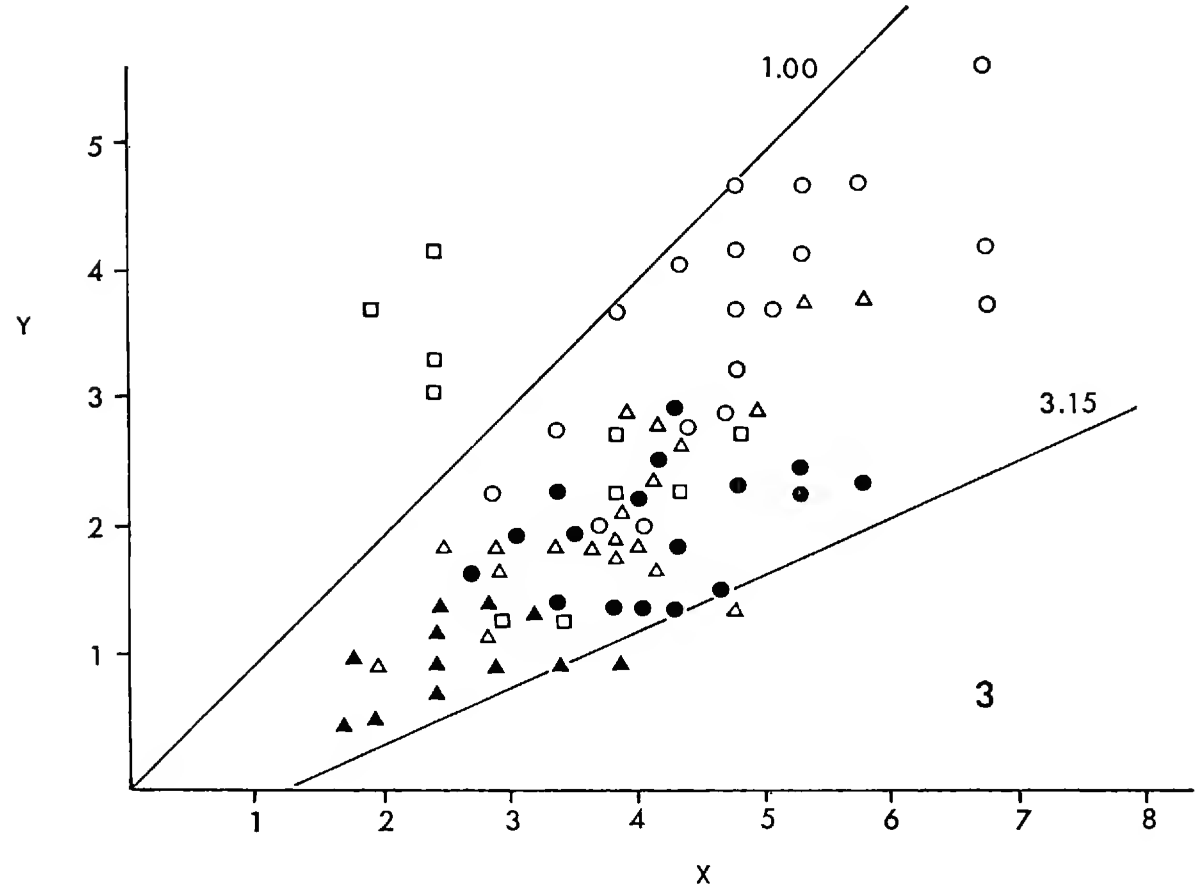


FIG. 3. First median area of propodeum; y-axis, posterior width, x-axis, anterior width. (See Fig. 1 for explanation of symbols).

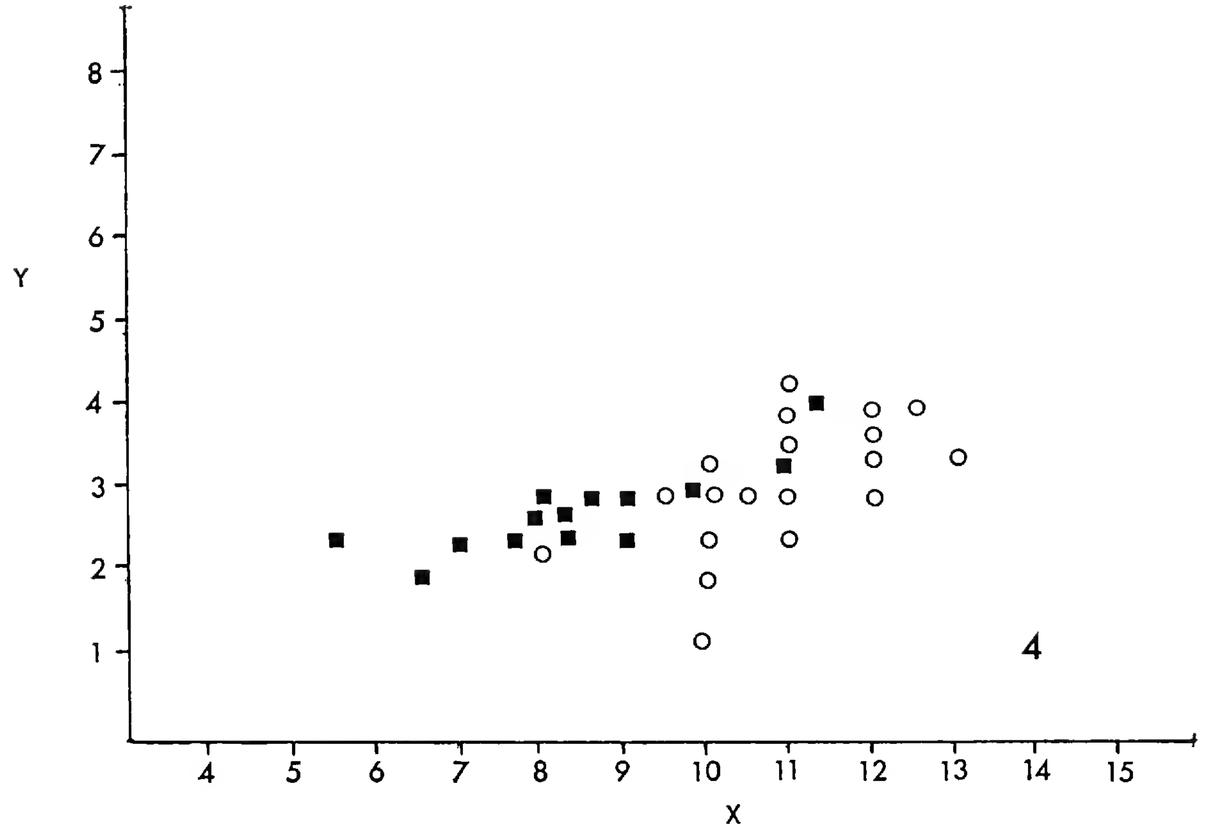


FIG. 4. Second pleural area of propodeum; y-axis, width at midpoint, x-axis, anteroposterior length. (See Fig. 1 for explanation of symobls).

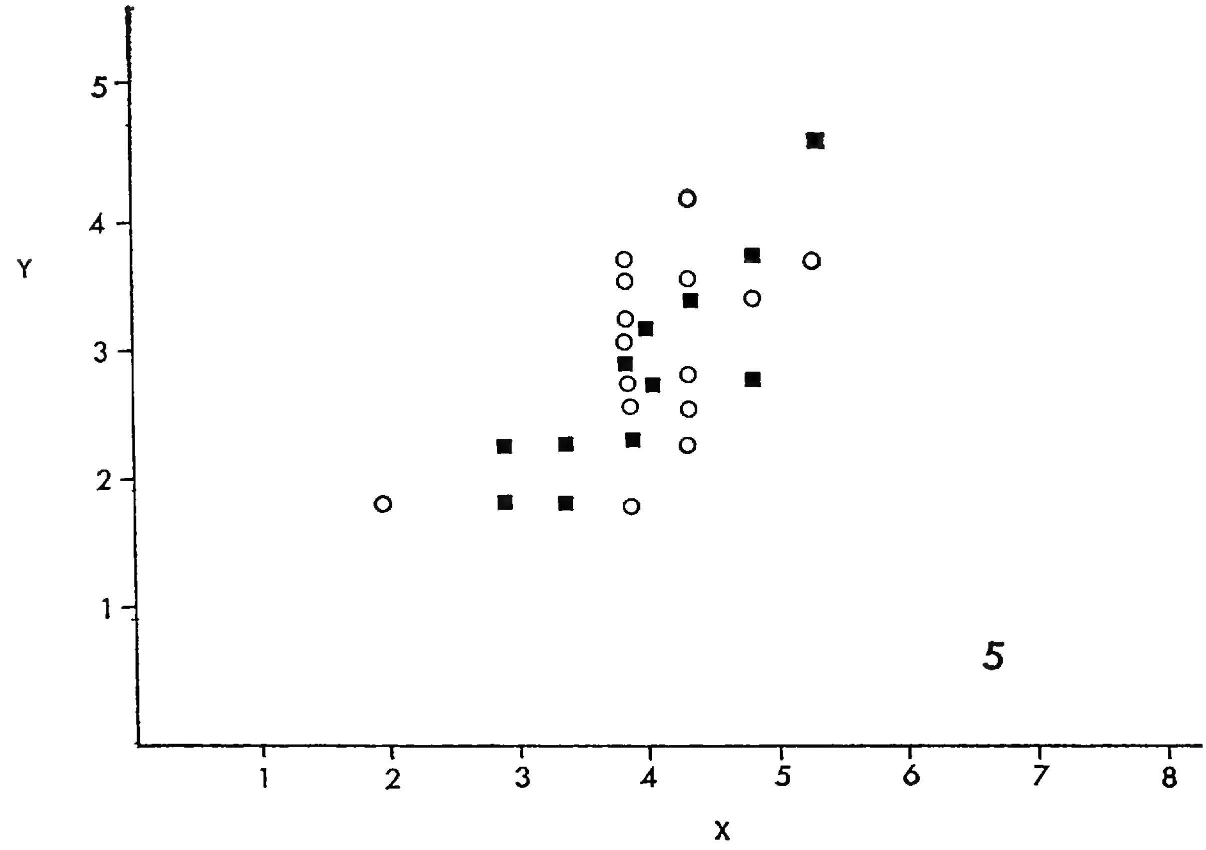


FIG. 5. Genal hook; y-axis, 0.66 the length from base to tip, x-axis, basal width. (See Fig. 1 for explanation of symbols).

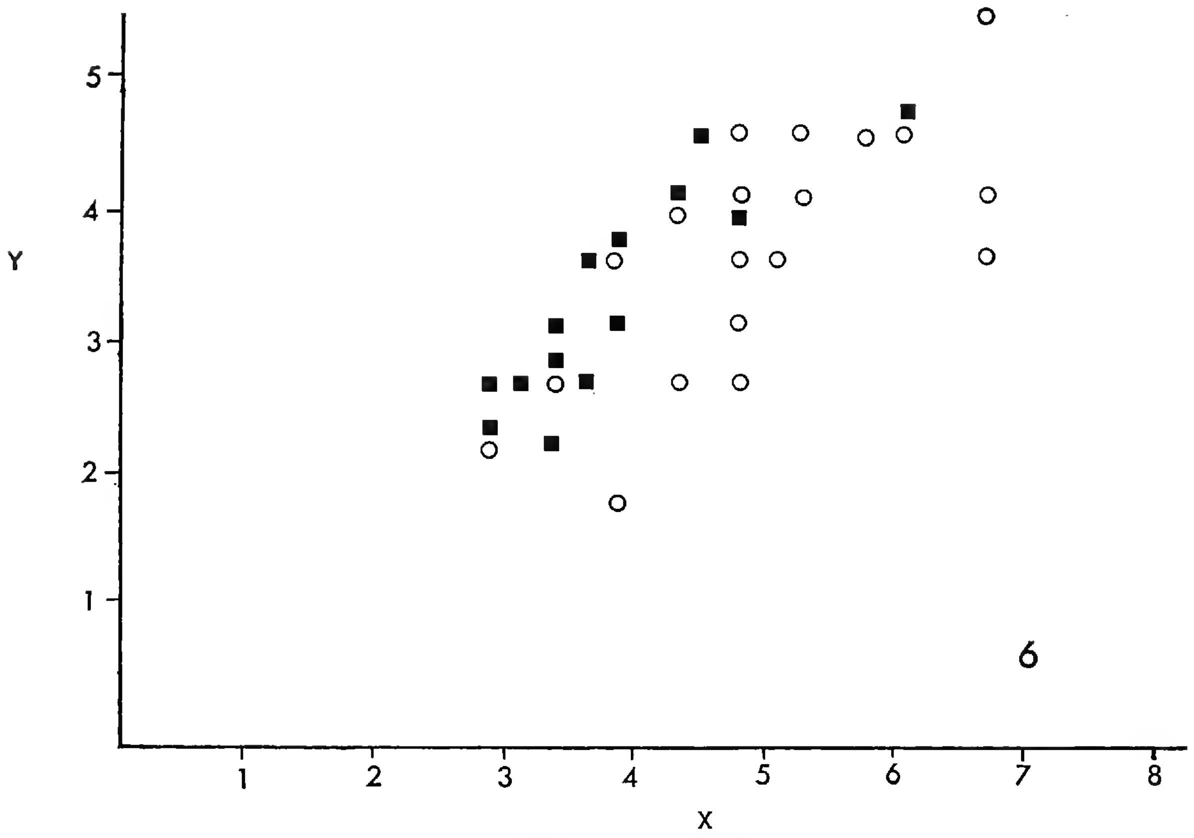


FIG. 6. First median area of propodeum; y-axis, posterior width, x-axis, anterior width. (See Fig. 1 for explanation of symbols).

($\bar{x} + s = 2.267$) mostly fall above and below the band, respectively. It may be readily seen that the genal hook ratios are useful for separating *Grotea californica* from *G. anguina*, but are not useful for separating either species from the other three.

Inspection of figure 3 shows that there is no distinct clustering of ratios, most ratios falling into a broad band between 1.00 and 3.15. *Grotea mexicana* seems to have a bimodal distribution of ratios that does not appear to be correlated with either geographical location or sexual dimorphism. It may be concluded that first median area ratios are of no value in separating any of the five species.

A population of *Grotea californica* from the vicinity of Orinda, California, was available for sampling, and the scatter of ratios from that population was superimposed upon the scatter of *G. californica* ratios from the entire geographical range of the species to see how much local variation may be expected. Figures 4–6 show the resulting scatters. Interestingly enough, there is almost a complete overlap of the Orinda population ratios and the entire-range ratios for the genal hook (Fig. 5) and the first median area (Fig. 6). The second pleural area ratios (Fig. 4) indicate a slight separation into two groups based on the magnitude of the individual measurements rather than on the actual ratios.

Thus, it may be concluded that the degree of intraspecific variation is quite large, and that, for one species at least, the degree of local variation in the above three characters is as great as the degree of variation found in the entire geographical range of the species. It may be further concluded that ratios have a considerably more limited utility, both in the key to the species and in the descriptions of the species, than was first apparent. The intuitive taxonomic approach indicated that the above ratios could be used for separating each of the species discussed. A quantitative approach, however, showed that premise to be fallacious.

ACKNOWLEDGMENTS

The author would like to thank Mr. Andre K. Lehre, University of California, Berkeley, for his help in computer programming and statistical techniques, Dr. Howell V. Daly, University of California, Berkeley, for the loan of specimens from the vicinity of Orinda, California, and the University of California Computer Center at Berkeley for proving computer time.

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A New Genus of Celaenopsidae from California with a Key to the Genera[1]

(Acari : Mesostigmata)

D. N. KINN
Division of Biological Control, University of California, Berkeley

Mites of the family Celaenopsidae are encountered under the bark of dead trees, often in association with insects. In the course of a survey of mite associates of California Scolytidae, a new genus and species belonging to this family was found under the bark of *Pinus monophylla* Torr. and Frém. killed by *Ips confusus* (LeConte). However, this species of mite is probably not associated with this insect.

The Celaenopsidae, until now, has consisted of four genera which Trägårdh (1951) reviewed and keyed. Like *Celaenopsis* Berlese and

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[1] This work has been supported in part by the California State Division of Forestry, the T. B. Walker Foundation, the Surdna Foundation and various forest industries.

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Brachycelaenopsis Trägårdh, the new genus, *Schizocyrtillus*, possesses a postanal shield, whereas in the other two genera the postanal shield is coalesced with the ventrianal shield.

KEY TO THE GENERA OF THE CELAENOPSIDAE, BASED UPON FEMALES (after Trägårdh, 1951).

1. Postanal shield present 2
   Postanal shield absent 4
2. Metasternal shields large; irregularly rectangular 3
   Metasternal shields narrow; triangular in shape .... *Schizocyrtillus*
3. Postanal shield well defined .... *Celaenopsis*
   Postanal shield narrow; weakly sclerotized .... *Brachycelaenopsis*
4. Median incision on anterior margin of ventrianal shield shorter than half the width of the anterior margin, obscure, or located between two anteriorly projecting lobes .... *Pleuronectocelaeno*
   Median incision on anterior margin of ventrianal shield as long as half the width of the anterior margin .... *Ceratocelaenopsis*

Schizocyrtillus Kinn, new genus

DIAGNOSIS.—Ventral and anal shields fused; postanal shield present between ventrianal shield and posterior margin of the body. Female with narrow, slightly triangular-shaped metasternal shields. Anterior margin of ventrianal shield with a notched protuberance. Medial margin of ventrimarginal shield with a curved slit-like fissure posterior to coxa IV, from which the genus takes its name. Corniculi of female elongate, bifurcate; bearing a seta-like projection medially. Gnathosomal chaetotaxy of male altered with only subcapitular setae distinct; distal hypostomal setae articulated, rod-shaped.

Type species: *S. lathrius* Kinn, new species.

Schizocyrtillus lathrius Kinn, new species

FEMALE.—*Idiosomal dorsum*: Length 514.1μ, mean of five specimens 516.5μ (490.2–541.6); width 340.7μ, mean of three specimens 338.2μ (336–340.7). Shape oblong, oval; broadly rounded posteriorly, more pointed anteriorly; widest above coxae IV; markedly convex; covered by single shield with more than 100 simple setae, which increase in length toward posterior part of body. Six pairs of slit-shaped pores present. Pores I lie anterolaterally on podosoma; pores II to VI lie on opisthosoma (Fig. 1C). Marginal plate fused with dorsal plate between coxae II and III. Marginal plate with single row of simple setae; rounded posteriorly. *Idiosomal venter*: Tritosternal base adjacent to anterior margin of sternal plate; laciniae free and pilose (Fig. 1A and 1B). Sternal shield wider than long; both anterior and posterior margins concave. Sternal setae simple. Setae I located submarginally on anterior angles of shield; setae II and III situated between coxae II. Setae III directly posterior to setae I and setae II mesad of setae I and III. Pores I posterolateral to setae I on margin of plate; pores II located laterally and slightly anterior to setae III. Posterolateral intercoxal projections of sternal plate without points. Metasternal plates narrow, lying between coxae II and III and bearing setae IV. Setae IV short, less than half length of setae I to III. Pore III slit-shaped; located lateral

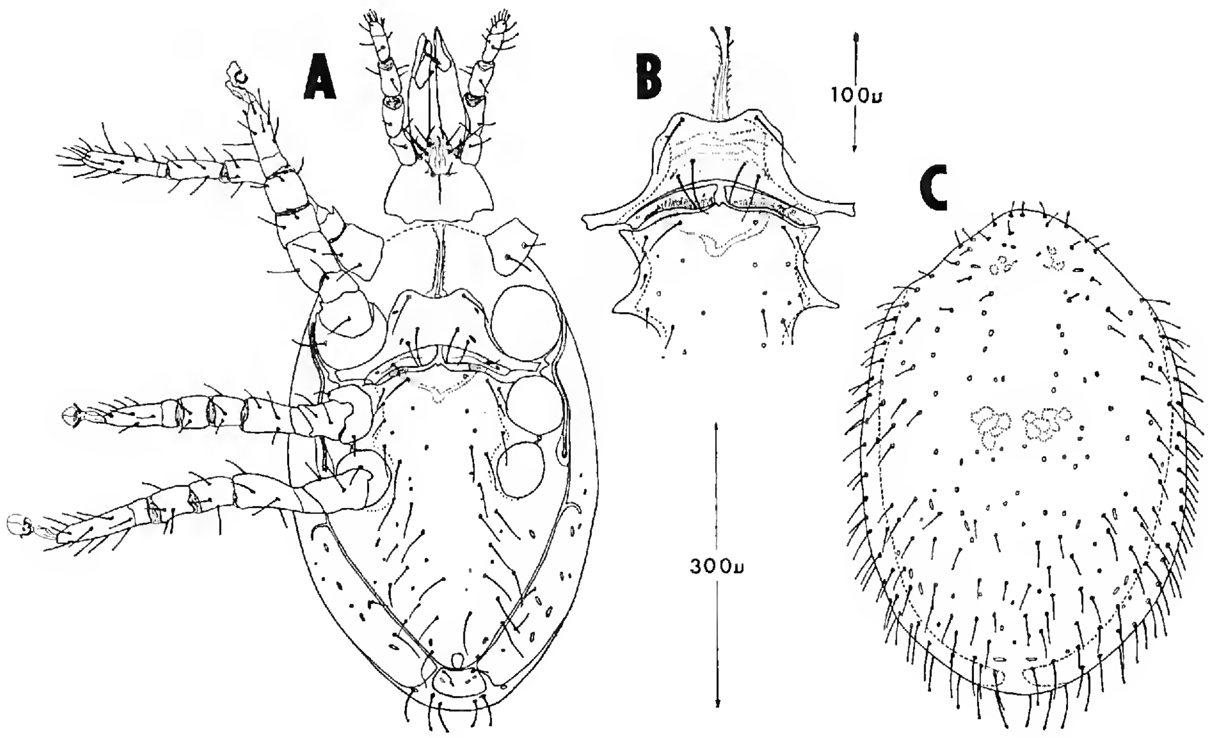
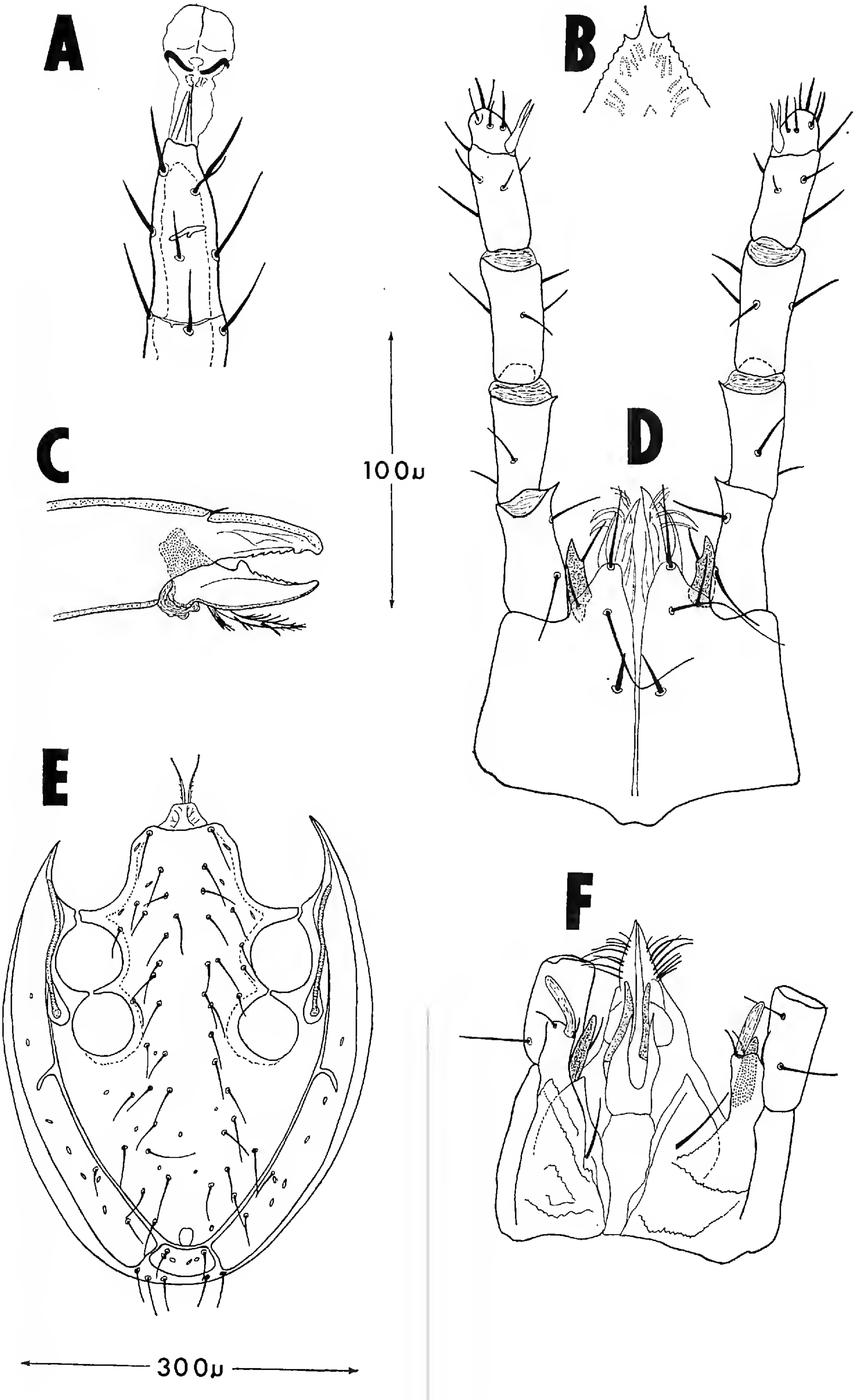


FIG. 1. *Schizocyrtillus lathrius*, paratype. A. Ventral aspect of female. B. Sterno-genital region of female. C. Dorsal aspect of female.

to setae IV. Posterior margins of metasternal shields sinuous, with heavily sclerotized indentations to accommodate heads of vaginal sclerites. Ventral, anal, parapodal, peritremal, and metapodal shields fused. Anterior margin of ventrianal shield convex, with a notched protuberance medially (Fig. 1B). Vaginal sclerites with ribbed clubs lie internally. Shield with 17 pairs of setae; with numerous irregularly placed circular pores and two pairs of slit-shaped pores (one posterior to coxae IV and the other anterolateral to anal orifice). Stigmata lateral to coxae IV; peritremes sinuous, extending to anterior margin of coxae II. Ventrimarginal shields border ventrianal shield from level of coxae II to posterior margin; shields posteriorly separated from one another by postanal plate. Each ventrimarginal shield with two simple setae, both setae anterior to anal orifice; with five slit-shaped pores posterior to coxae IV, and a slit-like fissure immediately posterior to hind margin of coxae IV. Postanal shield with one pair of setae and two pairs of slit-shaped pores (Fig. 1A). *Legs*: Armed with simple setae; chaetotaxy given in Table 1 (using system of Evans, 1963). Leg I without claws; leg II stouter than others. Tarsi II to IV with dorsal slit-shaped pores (Fig. 2A). *Gnathosoma*:

TABLE 1. Leg chaetotaxy, exclusive of coxa and tarsus, of adult *Schizocyrtillus lathrius*.

	I	II	III	IV
Trochanter	(1-1/1,1/2-0)	(1-0/1,0/2-1)	(1-1/2,0/1-0)	(1-1/2,0/1-0)
Femur	(1-2/1,2/3-1)	(2-2/1,2/2-1)	(1-2/1,2/1-0)	(1-2/1,3/1-0)
Genu	(1-3/1,2/1-1)	(1-3/1,2/1-1)	(1-2/1,2/1-1)	(1-2/1,3/1-1)
Tibia	(2-3/2,2/2-2)	(1-1/1,2/1-1)	(1-1/1,2/1-1)	(1-1/2,2/1-1)


A
B
C
100µ
D
E
F
300µ

Tectum triangular; terminating in an elongated point (Fig. 2B). Digitus fixus with 7 to 9 small, posteriorly directed teeth. Digitus mobilis with about 10 teeth, last tooth much larger than others; with two pilose appendages ventrally, anterior appendage longer, but not extending beyond chela (Fig. 2C). Deutosternum narrow. Median hypostomal setae longest and lateral shortest. Subcapitular setae short, very stout. Corniculi bifurcate; hypopharyngeal processes pilose (Fig. 2D). Chaetotaxy of palpal trochanter, femur and genu: 2, 5, 7. Proximal end of genu with a slit-shaped pore on dorsal surface; palpal claw 2-tined.

MALE.—*Idiosomal dorsum*: Length 493.0μ, mean of two specimens 486.0μ; width 320.3μ, mean 322.0μ. Shape like that of female. *Idiosomal venter*: Tritosternal base contiguous with anterior margin of holoventral plate; laciniae free, pilose. Holoventral plate with simple setae; sternal setae I in anterior angles of plate and setae II and III situated more medially. Sternal pore I as in female; pore II located posterolaterally to setae II and pore III near intercoxal projection between coxae II and III (Fig. 2E). Ventral and anal pores as in female. Ventrimarginal and postanal plates as in female. *Legs*: As in female. *Gnathosoma*: Tectum and chelicerae like those of female. Deutosternum much wider than in female. Subcapitular setae longer and finer than in female. Hypostomal setae reduced or modified; paired rods, each bordered by two short setae, probably homologous with distal hypostomal setae of female. Corniculi not as heavily sclerotized as in female (Fig. 2F).

TYPE MATERIAL.—*Holotype female*, SCHEIDECK, VENTURA COUNTY, CALIFORNIA, 3 January 1969, D. N. Kinn and Y. L. Kinn, from under the bark of *Pinus monophylla* Torr. and Frém. killed by *Ips confusus* (LeConte). Allotype same collection data. Paratypes: 1 female (24 April 1966), same host and locality, D. N. Kinn, Y. L. Kinn and N. D. Kinn; 1 female, 1 male (30 April 1966), same host and location, D. N. Kinn and Y. L. Kinn; 1 female, 1 male (3 January 1969), same host, location and collectors; 1 female (11 January 1969), same host, location and collectors.

Holotype and allotype are deposited in the United States National Museum, Washington, D. C. Paratypes are deposited in the author's collection.

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FIG. 2. *Schizocyrtillus lathrius*, paratype. A. Leg III of female. B. Tectum of female. C. Chelicera of female. D. Gnathosome of female. E. Venter of male. F. Gnathosome of male.

A New *Scenopinus* from the 1964 Galapagos International Scientific Project[1]

(Diptera : Scenopinidae)

L. P. KELSEY

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As records of Scenopinidae from the Islands of the Pacific are uncommon, it was of particular interest to the author to be able to study three specimens collected on the 1964 Galapagos International Scientific Project.

These proved to be a new species in the Velutinus Group of the genus *Scenopinus*, common to North and South America and some of the Pacific islands. In the keys to the Neotropical species (Kelsey, 1969) it would terminate at *S. schulzei* Enderlein. However, it differs from that species primarily in size, being only half as large; in the shape and color of the antennae; in the shape of the 8th sternum; though both species have a bump just proximal to the posterior margin; and in the shape of the 9th sternum and bursal cavity.

Scenopinus galapagosensis Kelsey, new species

(Fig. 1)

FEMALE.—Head black-brown to red-brown; eyes brown to red-brown, with a narrow postocular ridge; frons moderately wide, flattened, with sharply sloping sides, produced above the antennae, transversely striated, and with a median depression on lower fourth; ocellar tubercle prominent; ocelli brown; mouthparts well developed, filling oral cavity, and with the rostrum brown; palpi dark brown, flattened, and nearly as long as the rostrum; antennae black-brown, second segment lighter distally, third segment pear-shaped, a little over twice as long as wide. (See figures.)

Thorax dorsum black-brown to red-brown, transversely striated, with a silvery pilose patch above the humeral callus; humeral callus red-brown, supra-alar callus tan; pleural areas red-brown; halter stem red-brown, knob red-brown; wing hyaline, veins brown, R4 branching from beyond the middle of the cell, cell R5 open to the tip of the wing; legs with coxae to tibiae red-brown, tarsi yellow-brown.

Abdomen red-brown, 8th sternum subequal to tergum, and with a bulge on midline anterior to distal margin; bursal pocket small, triangular. (See figures for details.)

Length: ♀ body 2.5 mm., wing 1.9–2.0 mm.

MALE.—Unknown.

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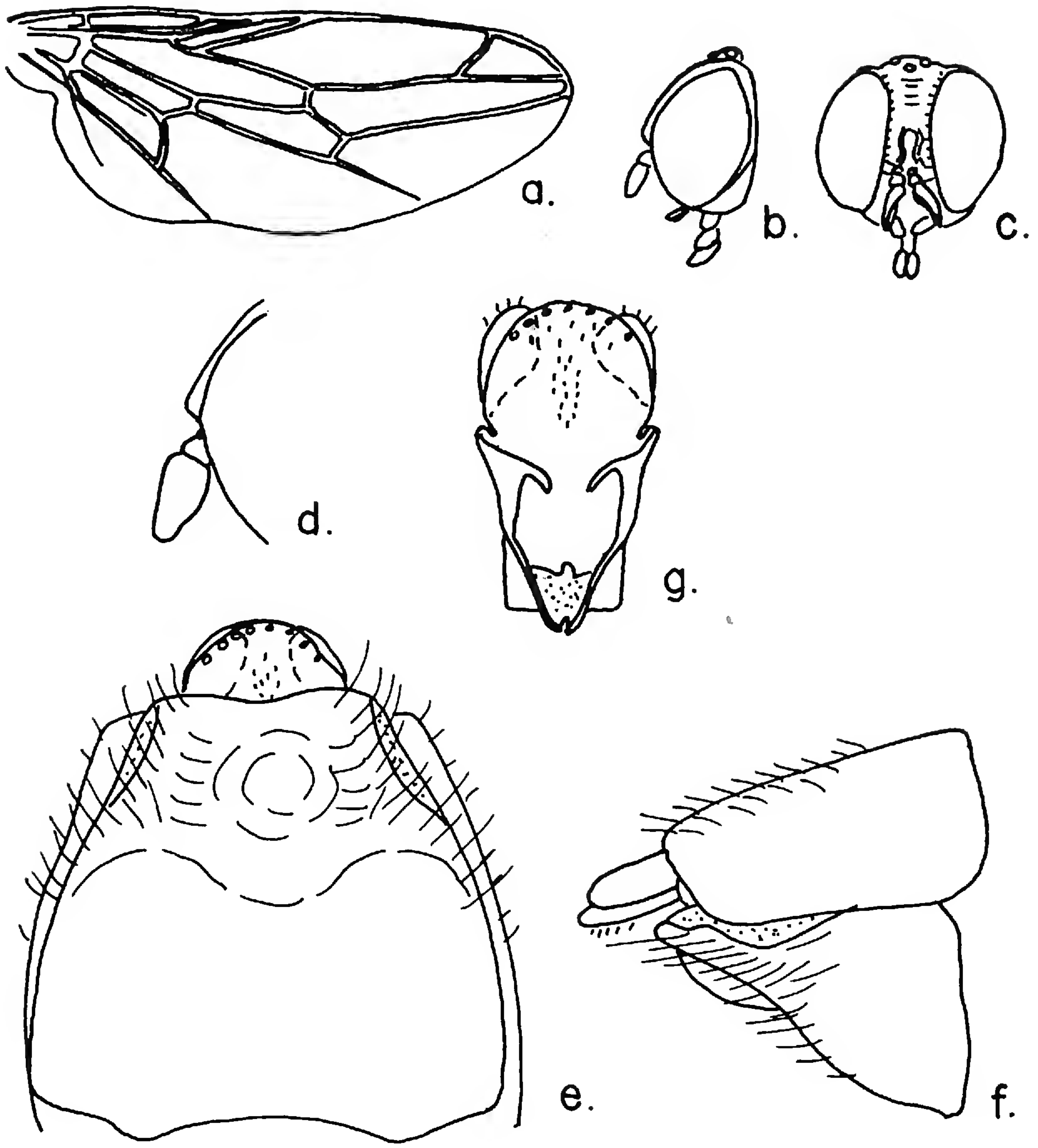

FIG. 1. *Scenopinus galagpagosensis* Kelsey female; a. wing; b. c. lateral and frontal aspects of head; d. enlarged detail of antennae; e. ventral aspect of 8th and 9th sternites; f. lateral aspect of 8th and 9th segments; g. 9th sternum and bursa.

Holotype female, GALAPAGOS ARCHIPELIGO, ISLA SANTA CRUZ, HORNEMAN FARM, 220 M. 5 April 1964 (D. Q. Cavagnaro).

Holotype ♀ Deposited in California Academy of Sciences # 9305.

Paratypes ♀ ♀ Same data except 18 March 1964. One in California Academy of Sciences, one in the U. S. National Museum.

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KELSEY, L. P. 1969. A Revision of the Scenopinidae (Diptera) of the World. U. S. Nat. Mus. Bull., 277, pp. 336, 208 figs.

Variability of Linear Measurements Throughout the Life Cycle of the Mayfly *Leptophlebia cupida* (Say)

(Ephemeroptera : Leptophlebiidae)

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INTRODUCTION

Mayfly nymphs of most species undergo a variable number of molts; instars cannot be determined from head capsule measurements; and, because of environmental factors, increase in size cannot be strictly related to development, larger nymphs sometimes being physiologically younger than smaller nymphs. Pleskot (1962) advocated that mayfly life history data be based on developmental stages instead of or in addition to total length measurements. Developmental stage analysis has been used for mayflies as early as the 19th Century by Vayssiére (1882), utilized successfully in the 1930's by Ide (1935) and Rawlinson (1939), and recently employed by several workers. Still, today, most mayfly life history studies are based on linear measurements. In this respect total length is the most common linear dimension, although occasionally other dimensions are used, e.g. head width (Britt, 1962; Levanidova and Rubanenkova, 1965), head length (Bretschko, 1965), length of wing pads in combination with abdominal tergite width (Ide, 1935) and total length extrapolated from mandible length (Corbet, 1957).

Britt (1953) concluded that, for *Ephemera simulans* Walker nymphs preserved in alcohol, head width was a more reliable index of growth than total length, especially if the specimens had been injured. The variability of linear measurements with age would be a useful criterion for evaluating which measurement gives the best indication of the mayfly's progress through its life cycle. However, one cannot determine absolute age of nymphs from field samples, and without empirical evidence age cannot be strictly correlated with total length. In fact total length should be evaluated along with the other linear measurements. By utilizing developmental stages (each stage representing a different physiological age) and measurements of relative variability, I examined statistically how six linear measurements varied throughout the life cycle of the mayfly *Leptophlebia cupida* (Say). With these procedures it was also possible to evaluate the homogeneity of arbitrarily chosen developmental stages.

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METHODS

Specimens of *L. cupida* used for this study were originally collected as part of a continuing limnological program on the Bigoray River, a subarctic brown-water stream of west-central Alberta (Clifford, 1969). The nymphs, initially used for an allometry study (Clifford, 1970), were first grouped into mm size classes (between 10 and 20 nymphs per size class) based on total length excluding the cerci; nymphs 5.0 mm and longer were further separated into males and females. Each nymph was then placed into one of four arbitrarily chosen developmental stages by the appearance and development of the mesothoracic wing pads: Stage I nymphs had no wing pads; Stage II nymphs had small wing pads, their length being shorter than the distance between the two wing pads; Stage III nymphs had a wing pad length greater than the distance separating the two wing pads; Stage IV nymphs had darkened wing pads indicating impending emergence. Stage IV nymphs were in the last nymphal instar; the other stages each represented several instars. Using an ocular eyepiece and dissecting microscope, the following measurements were made to the nearest 0.01 mm on the nymphs of each stage: total length, head length, pronotum width, mesonotum width, mesonotum length, and width of the fourth abdominal tergite. Subimagos and imagos were also measured as above.

The relative variability of each of the six linear measurements throughout *L. cupida*'s life cycle was determined by calculating the coefficient of variation (CV) for each dimension of each developmental stage, where CV is 100 times the standard deviation(s) divided by the mean ($\bar{x}$). The CVs of Stage IV nymphs, subimagos and imagos are comparable to those of other animals; they are homogeneous samples in respect to age and sex. The CV values of the other nymphal stages are only meaningful for comparing the relative variability of the dimensions within a particular stage. However, since each stage represents a progressively older developmental age and collectively all stages represent the entire life span, it is felt this sort of analysis is a valid way to evaluate the variability of the dimensional measurements throughout *L. cupida*'s life cycle.

RESULTS AND CONCLUSIONS

Homogeneity of developmental stages.—Figure 1 shows the seasonal developmental cycle of *L. cupida* when large numbers of nymphs were gathered throughout the year and separated into the four developmental stages. How precise are the arbitrarily chosen stages for inter-

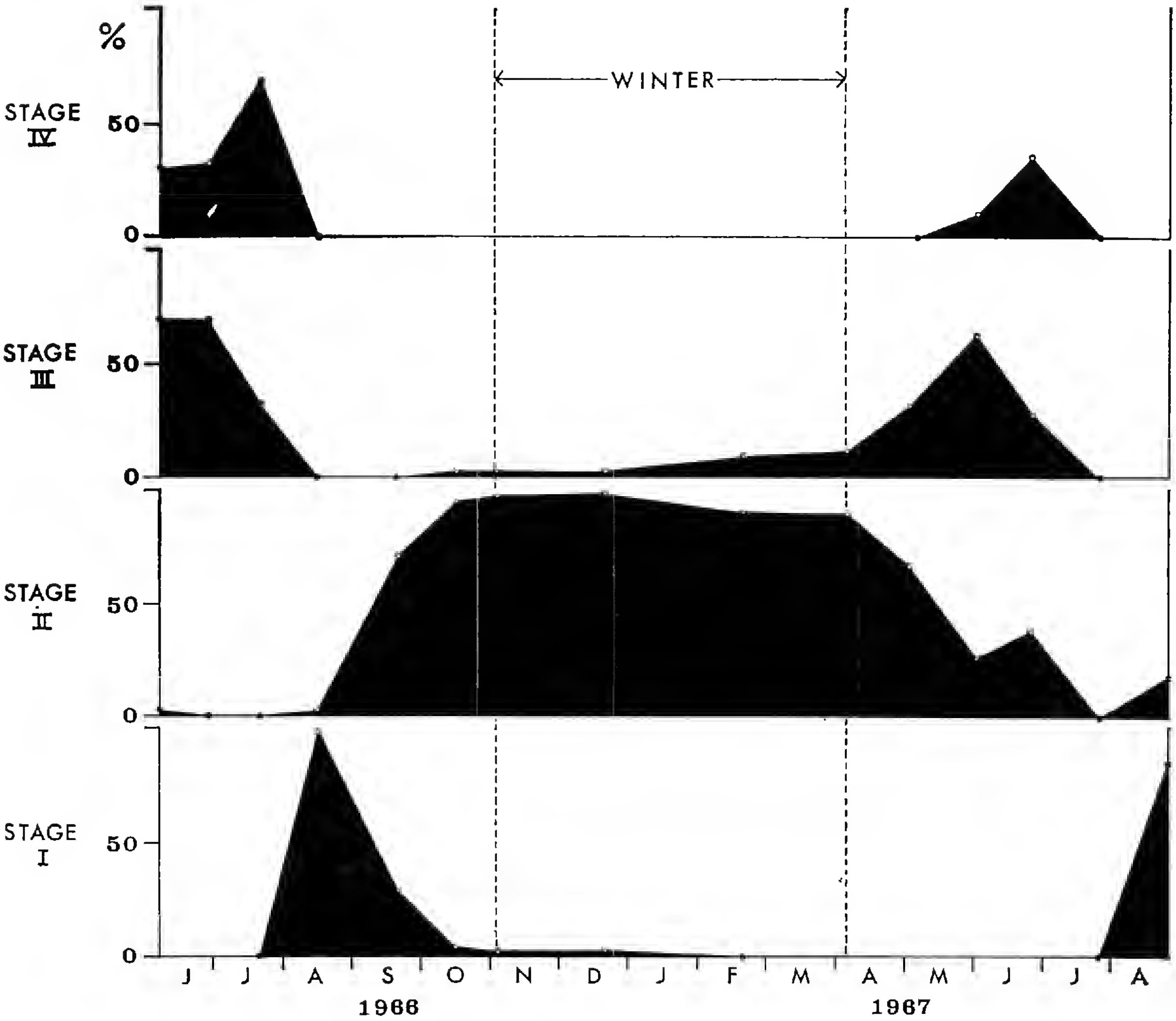

FIG. 1. Seasonal developmental cycle of *L. cupida* nymphs from the Bigoray River; total number of specimens per sampling date (except July 1967) ranged from 94 to 1,302.

preting *L. cupida*'s developmental cycle? The CVs of subimagos and imagos (and Stage IV nymphs except for the small sample size) can be used as a yardstick for judging the homogeneity of the other stages (Table 1). Stages III CVs agree well with those of the winged stages; the CVs of Stage I and especially Stage II are somewhat higher than those of winged stages. For Stage I it was necessary to determine CVs without regard to sex; Stage II included unsexed nymphs (juveniles) as well as nymphs whose sex could be determined, and for this reason the same Stage II juveniles were used to calculate Stage II male CVs as were used to calculate the Stage II female CVs. Even considering the heterogeneity due to the mixing of juveniles with males and females, the high CV values of Stage II, when compared to the other stages, suggest that more accurate information on *L. cupida*'s developmental cycle would be obtained if Stage II nymphs were further subdivided by additional developmental criteria. Although it is obvious from Figure 1 that development is much slower during the long winter than in other seasons, one should, without further subdividing Stage II, use caution in interpreting the precise nature of winter development.

Variability of linear measurements.—Certain nymphal dimensions did have consistently lower CV values (e.g. head length) than other dimensions (e.g. mesonotum length). A clearer picture is obtained by ranking the CV values of each dimension from 1 to 6 within each nymphal stage and each sex. Rank 1 represents the lowest CV value for a given dimension and 6 the highest. Then for a particular body part the rank numbers by sex for the four nymphal stages are added up (including Stage I in summations for both males and females). There was a slightly different sequence for the two sexes (Table 2). For females, both head length and pronotum width had much lower total rank values than the other measurements; for males, abdomen width and head length would be the best linear measurement throughout the entire nymphal life span. For both sexes, mesonotum length was the most variable measurement. Total length was near the middle of each range when the sexes were considered separately.

When the CV of each body part is calculated for each stage without regards to sex (actual tabulated CV values not shown) and then ranked as above, total length has a much higher total rank position, the sequence being head length (8 total rank numbers), pronotum width (12), abdomen width (13), mesonotum width (13), total length (19), and mesonotum length (19).

It would be instructive to know if any of the CVs of Table 1 indicate dimensional measurements statistically more variable than others within a particular stage. Lewontin (1966) shows that the variance of the logarithms (common or natural) of measurements gives a measure of relative variability that is invariant under a multiplicative change, and hence can be used for statistical tests; he also points out for CVs of about 30 or less that the square of the CV (in percentage form) closely approximates the variances of natural logarithms. For *L. cupida* each of the dimensional CVs of Table 1 was squared, and then two null hypotheses were tested. (1) Within a particular stage none of the squared CVs *regardless of sex* is significantly larger (one-sided "F" test, 95% level) than the smallest squared CV of that stage. (2) Within a particular stage none of the squared CVs of a *particular sex* is significantly larger (same test) than the smallest squared CV of that sex.

Certain dimensional measurements of female nymphs and subimagos were significantly more variable than those of males (Hypothesis 1,

TABLE 1. Essential statistics (in mm) and coefficients of variation (CV) of the six dimensional measurements of juvenile (J), male and female nymphs, subimagos and imagos.

	Stage I	Stage II		Stage III		Stage IV		Subimagos		Imagos
	J	J+♂	J+♀	♂	♀	♂	♀	♂	♀	♀
Number	17[1]	45	47	19	29	4	4	17	17	19
Total Length										
x̄	2.40	5.81	5.80	9.95	10.44	9.71	13.00	10.89	11.79	12.21
s	0.50	1.64	1.58	1.06	1.74	0.50	0.91	1.36	1.32	1.33
CV	20.89	28.17	27.18	10.68	16.67	5.15	6.98	12.52	11.16	10.90
Head length										
x̄	0.44	0.97	0.95	1.58	1.58	1.45	1.62	1.03	1.02	1.02
s	0.09	0.24	0.23	0.18	0.17	0.06	0.12	0.09	0.13	0.15
CV	20.45	24.96	23.80	11.35	10.57	3.96	7.12	9.11	12.97	14.96
Pronotum width										
x̄	0.65	1.38	1.41	2.24	2.32	1.96	2.35	1.83	1.85	1.82
s	0.13	0.34	0.36	0.26	0.28	0.16	0.17	0.20	0.26	0.27
CV	20.35	24.50	25.31	11.72	11.91	8.34	7.23	11.10	13.78	14.71

[1] Except mesonotum length where there were 13 specimens for Stage I.

TABLE 1. Cont.

	Stage I	Stage II		Stage III		Stage IV		Subimagos		Imagos
	J	J + ♂	J + ♀	♂	♀	♂	♀	♂	♀	♀
Mesonotum width										
x̄	0.66	1.38	1.40	2.36	2.41	2.38	2.67	2.11	2.04	2.05
s	0.15	0.32	0.35	0.33	0.32	0.22	0.24	0.24	0.30	0.26
CV	23.38	23.10	24.67	13.91	13.10	9.08	8.92	11.18	14.50	12.49
Mesonotum length										
x̄	0.34	0.92	0.93	2.18	2.10	2.60	2.60	2.78	2.79	2.94
s	0.34	0.32	0.33	0.44	0.43	0.14	0.15	0.28	0.46	0.34
CV	99.38	34.46	35.27	20.06	20.42	5.44	5.87	9.89	16.38	11.39
Abdomen width										
x̄	0.58	1.41	1.42	2.37	2.62	2.40	2.79	1.97	2.18	2.15
s	0.12	0.36	0.43	0.22	0.32	0.10	0.15	0.18	0.35	0.30
CV	20.26	25.46	29.97	9.43	12.24	4.17	14.03	9.07	16.14	13.73

TABLE 2. Total rank number variabliity of male and female nymphs for the four developmental stages

Body part	Females	Males
Head length	8	10
Pronotum width	11	13
Abdomen width	15	8
Total length	15	14
Mesonotum width	16	17
Mesonotum length	19	22

Table 3). The variability was especially striking for female adbomen width, even in the discrete instars, and possibly reflects egg development in the abdominal region. Considering the sexes separately, mesonotum length (for both males and females) and total length (for females of Stage III) were the only measurements significantly larger than the dimension having the smallest relative variability (Hypothesis 2, Table 4).

In brief, and considering both the rank tabulation and the above statistical tests, one can conclude that no single linear dimension is

TABLE 3. Body parts of a particular stage that had squared CVs significantly larger[1] than the body part[2] with the smallest squared CV of that stage and regardless of sex

Body part	F	D.F.
Stage I (Abdomen width)		
Mesonotum length	4.87	16,16
Stage II (♂ Mesonotum width)		
♀ Mesonotum length	2.33	44,46
♂ Mesonotum length	2.23	44,44
♀ Abdomen width	1.69	44,46
Stage III (♂ Abdomen width)		
♀ Mesonotum length	4.68	18,28
♂ Mesonotum length	4.54	18,18
♀ Total length	3.17	18,28
Stage IV (♂ Head length)		
♀ Abdomen width	12.25	3,3
Subimagos (♂ Abdomen width)		
♀ Mesonotum length	3.28	16,16
♀ Abdomen width	3.16	16,16
♀ Mesonotum width	2.56	16,16

[1] One-sided "F" test, 95% level

[2] In parentheses

TABLE 4. Body parts of a particular stage that had squared CVs significantly larger[1] than the body part[2] with the smallest squared CV of that stage and of the same sex

Body part		F	D.F.
Stage II	Males (Mesonotum width)		
	Mesonotum length	2.23	44,44
	Females (head length)		
	Mesonotum length	2.20	46,46
Stage III	Males (Abdomen width)		
	Mesonotum length	4.54	18,18
	Females (head length)		
	Mesonotum length	3.71	28,28
	Total length	2.52	28,28

[1] One-sided "F" test, 95% level
[2] In parentheses

both least variable for males and least variable for females. Considering the *L. cupida* nymphal population without regards to sex, the usual procedure for interpreting mayfly life history phenomena, head length (or in all likelihood, head width) and pronotum width would be most desirable linear measurements, and mesonotum length would be the least desirable measurement. When the sexes are treated separately, total length is, for most purposes, a seemingly justifiable measurement throughout most of the nymphal life span. But for the larger female nymphs or when the nymphs are treated without regards to sex, several of the other dimensional measurements exhibit much less variability. Finally it is suggested that, because certain females dimensions are significantly more variable than those of males, the most accurate interpretations of size-frequency data would be made when nymphs are separated into males and females, regardless of the linear dimension used.

ACKNOWLEDGMENTS

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A New Species of *Pleocoma* from Southern California

(Coleoptera : Scarabaeidae)

JAMES ROBERTSON
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Literature has been sparse and little is known of the habits and distribution of the elusive beetles of the genus *Pleocoma.* However, with the encroachment of civilization into our more primitive areas, more locations of occurrence are being found and more material is available for study. The fact that the adult beetles are active during rains requires greater than average perseverity on the collector's part, especially in regards to those species inhabiting remote mountainous areas. Severe flooding, frequent landslides, and roads blocked by trees, make access to these areas impossible at times. The author on several occasions has been forced to dig through a landslide in order to return home after a collecting excursion. Female *Pleocoma* must be diligently sought after, for being flightless they remain on or in the ground. Searching

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for burrows, or following males to the abode of the female is the normal method of collecting.

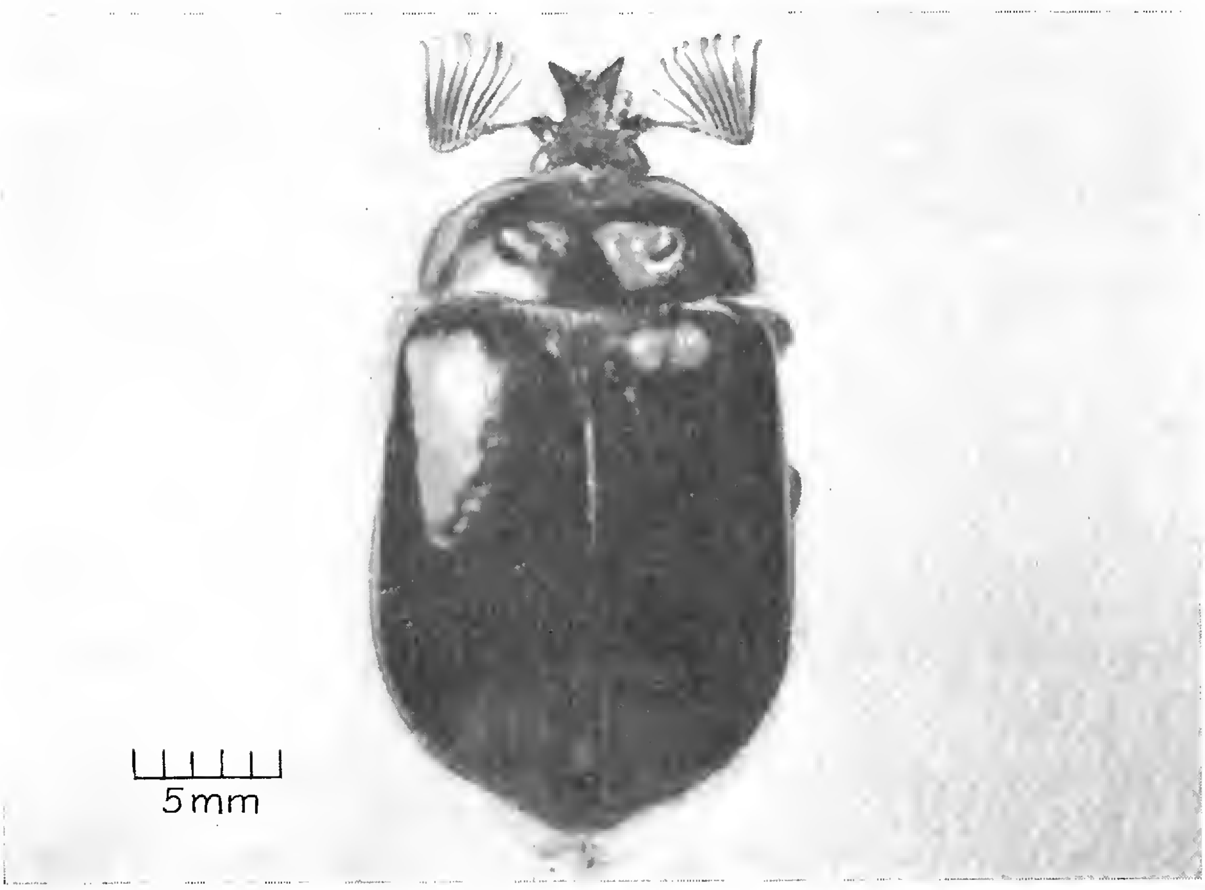
The habit of the male beetle of flying to lights and to the surfaces of ponds (Davis, 1934), facilitates their collection. Material taken recently by myself and Noel McFarland in this manner, represents a new species. It has the unique characteristic of possessing eight lamellae in the antennal club. This feature excludes it from either of the "four to five" or "six to seven" lamellate antennal club groups which are presently utilized in classifying *Pleocoma* species (Linsley, 1946, Ellertson & Ritcher, 1959).

Pleocoma octopagina Robertson, new species
(Fig. 1–4)

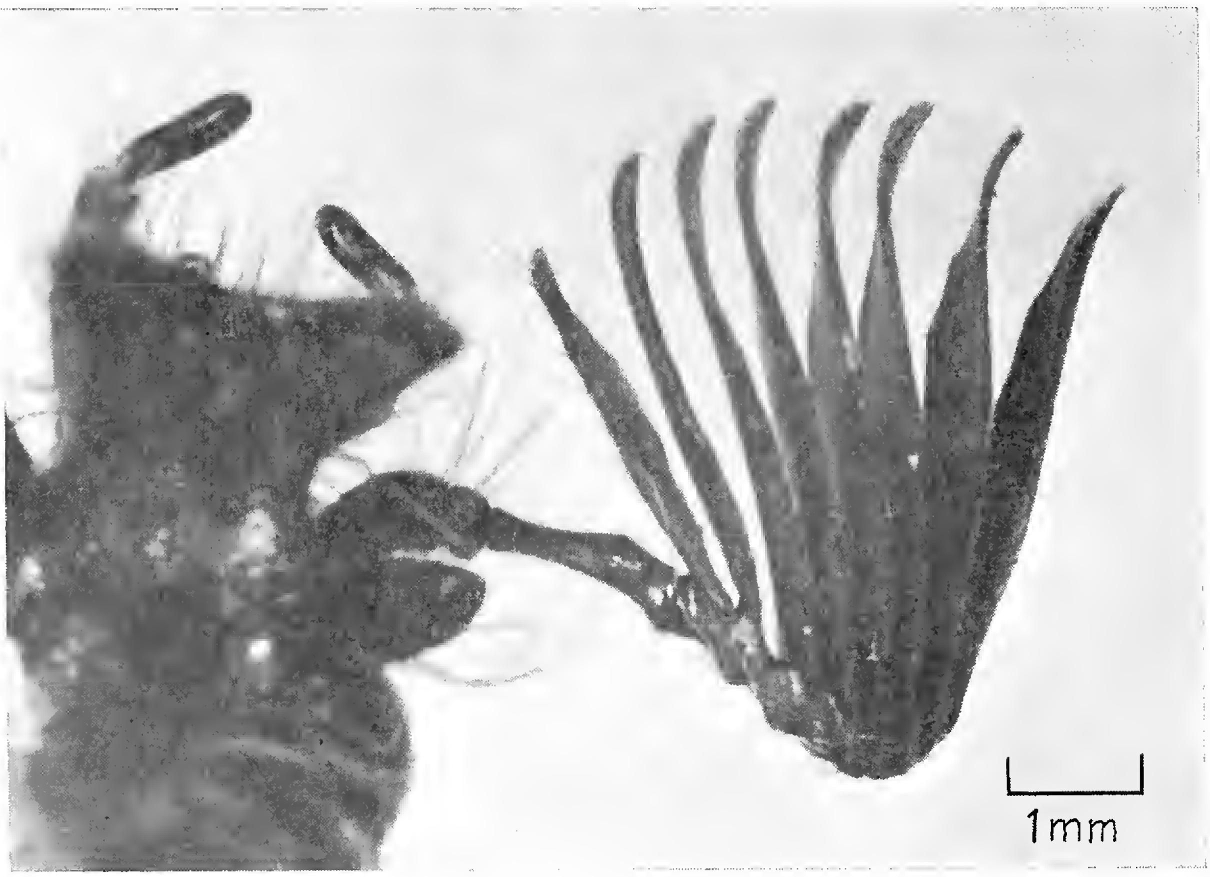
MALE (holotype).—Form large, robust, broadly oval, (Fig. 1), piceous-brown, golden pubescent beneath. *Head* castaneous, edged with black; clypeal horn very pronounced, deeply notched, moderately punctured, slightly fimbriate; horn of vertex long, slightly notched, moderately clothed with long hairs, clypeal and vertex horns subparallel, (Fig. 2); ocular canthi radiused on apex; eyes prominent; antennae with scape moderately stout, subconical, second segment moniliform, oblate; third segment four times as long as broad, longer than first and second segments combined, slightly reflexed with flattened extended process anteroventrad on outer end; fourth segment lamellate, longer than second and third combined, fourth-fifths as long as fifth segment, markedly laciniate on ventral edge, fifth segment lamellate, nine-tenths as long as sixth, less laciniate than fourth, segments six to eleven lamellate, extremely long, longer than length from antennal socket to eleventh segment, with pronounced curve outward at tip, less and less laciniate on ventral edges, all segments containing setae to varying degrees, especially on periphery, all lamellate segments covered with minute recumbent hairs, (Figs. 3 & 4). *Pronotum* tending to blotchey brown and piceous, approximately two and one-half times as broad as long; sides subparallel, anterior corners broadly rounded, posterior corner narrowly rounded; moderate anterior median depression only slightly crinite, rest of surface finely, rather sparsely punctate, shiny, cirrose on periphery. *Scutellum* finely, sparsely punctate, hardly fimbriate. *Elytra* piceous, somewhat shining; finely, very sparsely, irregularly punctate, opaque; striae only faintly visible, cirrose around outer margins. *Body* beneath castaneous, densely clothed in reddish golden pubescence. *Legs* castaneous, stout, fossorial, pubescent. *Length* 27mm, *width* 15mm (ranges from total type series, 25–31mm by 14–17mm).

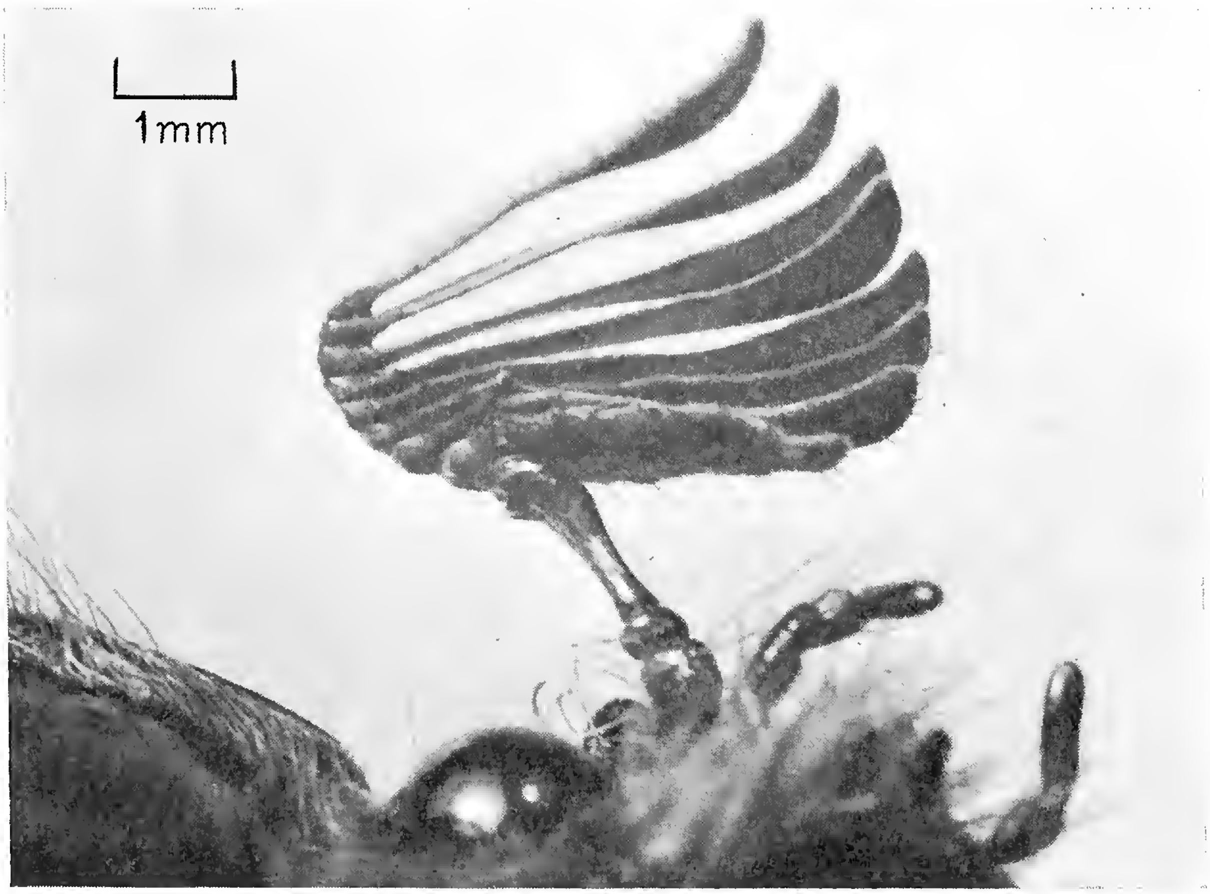
FEMALE AND IMMATURES.—Unknown.

This species is immediately distinguishable from all others of the genus *Pleocoma* by having a long lamellate fourth antennal segment, thereby having eight lamellate plates in the club. All other species fall into one of two groups with either four to five or six to seven plates. The configuration of the third antennal segment also differs from that of previously known *Pleocoma*. In the others it is cylindrical and



FIGS. 1 and 2. *Pleocoma octopagina* Robertson. FIG. 1 (Upper.) Dorsal aspect, adult male, holotype. FIG. 2 (Lower). Lateral view of head.





FIGS. 3 and 4. *Pleocoma octopagina* Robertson. FIG. 3 (Upper). Dorsal view, right antenna. FIG. 4 (Lower). Ventrolateral view (beneath head) of antenna.

simple, while in *octopagina* the segment bears a flattened, extended process.

Holotype male, 7 MILES SOUTH OF PEARBLOSSOM (2½ MILES SSW OF VALYERMO), LOS ANGELES COUNTY, CALIFORNIA (34°25′ N., 117°52′ W.) elevation 4800 ft., 30 November 1965 (Jim Robertson) (Deposited in the collection of the Los Angeles County Museum of Natural History). Paratypes: 36 males, same locality as holotype, dates and collectors as follows: mid-December 1960 (Noel McFarland-flying at night); 6, 19, 21, 26, 30 December 1963, January, 2 March 1964 (McFarland, in reservoir); 30 November, 9 December 1965, 8 November, 8 December 1969, 10 January 1970 (Jim Robertson, blacklight and in reservoir) (author's collection; California Insect Survey Collection, Berkeley; California Academy of Sciences; Los Angeles County Museum; U. S. National Museum).

DISTRIBUTION.—Thus far, this species has been found only at the type locality, on the alluvial slopes of the north side of the San Gabriel Mountains at elevations of 4800 to 4900 feet. Collecting attempts at nearby points have proven negative, even though dates have been the same.

BIOLOGY.—The type locality is situated in a mixed Chaparral-Pinyon Woodland ecotone. Common perennial plants in the immediate vicinity are *Arctostaphylos glauca* Lindl., *Artemisia tridentata* Nutt., *Ceanothus greggii* var. *vestitus* (Greene) McMinn., *Cercocarpus betuloides* Nutt., *Eriastrum* sp., *Eriodictyon trichocalyx* Heller., *Eriogonum fasciculatum* ssp. *polifolium* (Benth.) S. Stokes., *Fremontia californica* Torr., *Lupinus* sp., *Malacothamnus* sp., *Penstemon centranthifolius* Benth., *Quercus chrysolepis* Liebm., *Rhamnus crocea* ssp. *ilicifolia* Greene, *Rhus trilobata* var. *anisophylla* (Greene) Jeps. Nearby, but at somewhat lower elevations, Pinyon (*Pinus monophylla* Torr. & Frem.), Juniper (*Juniperus californica* Carr), Scrub Oak (*Quercus dumosa* Nutt.), and Yucca (*Yucca whipplei* ssp. *caespitosa* (Jones) Haines.) become dominant, along with *Salvia dorrii* (Kell.) Abrams, and *Purshia glandulosa* Curran. Nearby, at somewhat higher elevations, *Quercus chrysolepis* Liebm., becomes more abundant, along with *Ceanothus cuneatus* (Hook.) Nutt., and *Pinus coulteri* D. Don. The thick duff which covers the ground makes seeking of burrows difficult. Being on the south edge of the Mojave Desert, summer temperatures (93–95° F.) can be quite high, in spite of the elevation. In winter, temperatures drop low enough for occasional snows. At the time of the author's collecting, the temperature was in the neighborhood of 40–50° F. Winter rainfall averages 10.4 to 10.8 inches as recorded at two points, 2½ miles on either side of the collecting site. Occasional summer rains (cloudbursts) occur in July, August, and September, but it is essentially an area of summer drought. Two nearby creeks (really dry arroyos) flow after rains and in the early spring. Primary soil composition is decomposed granite with occasional outcroppings of clay. The soil make-up is loosely consolidated and well drained, and contains a black powdery loam to some degree.

ACKNOWLEDGMENTS

The author is indeed grateful to Dr. Charles Hogue of the Los Angeles County Museum of Natural History, Noel McFarland of The South Australian Museum, and Dr. John Chemsak of the University of California, Berkeley, for their advice and suggestions in the preparation of this paper.

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The Nearctic Species of the Genus *Leistus* Frölich

(Coleoptera : Carabidae)

TERRY L. ERWIN
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INTRODUCTION

The nebriine genus *Leistus* Frölich contains many species in the Palearctic region, but heretofore only two North American species have been recognized, and one of these from only the female type in the collection of Thomas Lincoln Casey (USNM). Lindroth mentions these species in his "Ground-Beetles of Canada and Alaska" (1961). In 1965, while visiting the California Academy of Sciences, I came across 88 specimens of *Leistus longipennis* Casey that Van Dyke had collected, but never reported. During a visit previous to my own, Lindroth had missed these specimens because they were not with the carabids, and I discovered them by accident only. While studying this

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series, I noticed two types of male genitalia occurred. Further investigation satisfied me that this series consisted of specimens of two species, one of which was undescribed. In this paper the recognized species are redescribed, one new species is described, the male genitalia of all three species are figured, and a key is given to separate the species.

The male genitalia of Nearctic and Palearctic forms are grossly different in form. On the basis of this fact a new subgenus of *Leistus* is proposed to contain the North American forms. In the past, other authors (Reitter 1885, 1905, Daniel 1903, and Bänninger 1925) have erected various subgenera on the basis of characters such as presence or absence of wings, and presence or absence of a posterolateral seta on the pronotum. In a forthcoming paper I will discuss the classification of *Leistus* on a world basis.

METHODS AND MATERIALS

The methods and species criteria used here are those which I have described in considerable detail elsewhere (Erwin 1965, and Erwin 1970).

The materials used here are specimens borrowed from, or seen in, the California Academy of Sciences, San Francisco (CAS), the Museum of Comparative Zoology, Cambridge (MCZ), and the United States National Collection (USNM). One specimen, the holotype of *L. madmeridianus* Erwin, was loaned to me by my colleague at San Jose State College in 1965, Richard D. Spadoni.

LEISTUS Frölich

The type species is the European *Carabus ferrugineus* Linné, 1758: 415. The following combination of characteristics is diagnostic of the genus: mandibles moderately to broadly explanate; scrobes unisetose; ligula trifid at apex; cardines, stipites, base of mentum at sides, and submentum strongly spinose, spines arranged as circular cage; palpi extremely slender and elongate; head constricted behind eyes; lateral thoracic setae present; venter at sides punctate from head to first or second abdominal sternum.

Neoleistus Erwin, new subgenus

TYPE SPECIES.—Here designated, *Leistus ferruginosus* Mannerheim, 1843: 187. The following combination of characteristics is diagnostic of this subgenus: posterior lateral setae of pronotum absent; sides of pronotum straight before square hind angles; third antennal article shorter than fifth; mandibles broadly explanate; ligula with ventral bisetose cone posterior to apex; second abdominal sternum not punctate; male genitalia with median lobe bipartite, apex extended considerably beyond apical orifice.

KEY TO THE SPECIES OF NEOLEISTUS

1. Humeri prominent (Fig. 2); hind wings fully developed; pronotum narrower than humeri just behind scutellum .... *ferruginosus* Mannerheim
   Humeri strongly sloped (Figs. 1, 3); hind wings reduced outside stigma; pronotum as wide as or wider than humeri 2
2. Pronotum as wide as humeri just behind scutellum; male median lobe as in Fig. 4 .... *longipennis* Casey
   Pronotum wider than humeri just behind scutellum; male median lobe as in Fig. 6 .... *madmeridianus* Erwin, n. sp.

LEISTUS FERRUGINOSUS Mannerheim

(Figs. 2, 5, 7)

Leistus ferruginosus Mannerheim, 1843: 187. Lectotype, designated by Lindroth, 1961: 56, in University Museum, Helsinki. Type locality.—Sitka, Alaska, as originally given by Mannerheim.

Leistus ferrugineus Dejean, 1831: 569. Junior homonym of *Carabus ferrugineus* Linné 1758: 415. Lindroth 1961: 56.

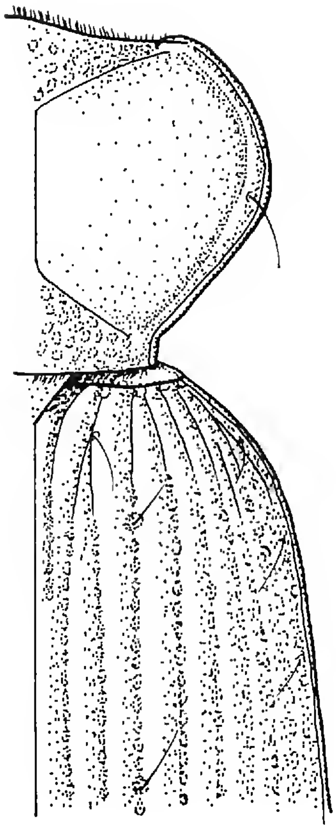
Leistus nigropiceus Casey, 1913: 45. Holotype, a female, in USNM, number 46,843. Type locality.—Metlakatla, British Columbia, as originally given by Casey. Lindroth 1961: 56.

DIAGNOSTIC COMBINATION.—The almost square humeri, narrow pronotum, and short elytra separate these beetles from those of the following two species.

DESCRIPTION.—Medium-sized beetles, 8.0 to 9.0 mm. *Color*: Rufopiceous to testaceous, elytra often slightly iridescent; legs, antennae and venter usually paler. *Microsculpture*: Nearly isodiametric on head, more transversely stretched on disc of pronotum and elytra. *Macrosculpture*: Anterior and posterior transverse impressions of pronotum and elytral striae punctate. The following punctate: head at sides, prosternum at sides, proepimera, mesepisterna, mesepimera, metepisterna; metasternum at sides, and abdominal sternum 1 (and in some specimens abdominal sternum 2) at sides. *Head*: Frontal furrows suggested, continuous on clypeus. Antennal scape elongate, cylindrical. Mandibles broadly explanate, seta present in scrobe. Ligula tripartite at apex with median, ventral, setiferous keel. Mentum and submentum strongly setiferous, setae arranged as ring around periphery of venter of head "collembola cage," see *Life History*). *Prothorax*: Pronotum (Fig. 2) narrower than elytra across humeri; side margins narrowly reflexed, straight just before hind angles. *Pterothorax*: Hind wings fully developed. Elytral humeri prominent, arcuate. *Genitalia*: Male (Fig. 5): Median lobe with apex extended far beyond apical orifice. Apex broad, tapered to acutely rounded point. Venter of shaft with median keel, nearly straight in lateral aspect. Basal bend strongly arcuate, basal keel small. Internal sac without sclerites, but apically with small membranous papillae. Female stylus as in Fig. 8. Twenty specimens of each sex investigated.

VARIATION.—The number of setiferous punctures in the third stria of the elytra varies from two to five. The Alaskan and British Columbian specimens I have seen are at the lower end of the size range, while the Washington and Oregon ones are at the higher end.

FLIGHT.—The flight of these beetles has not been recorded.



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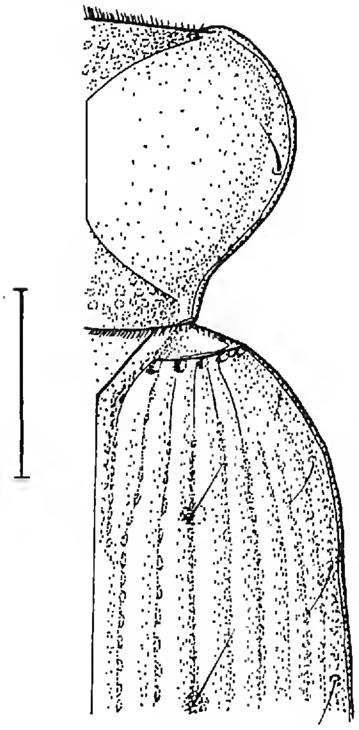

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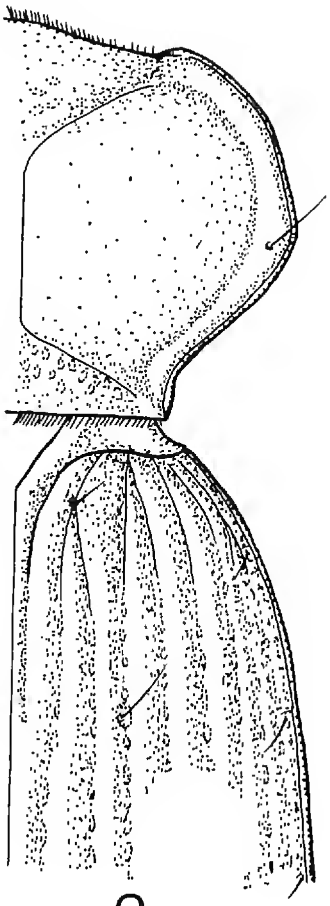

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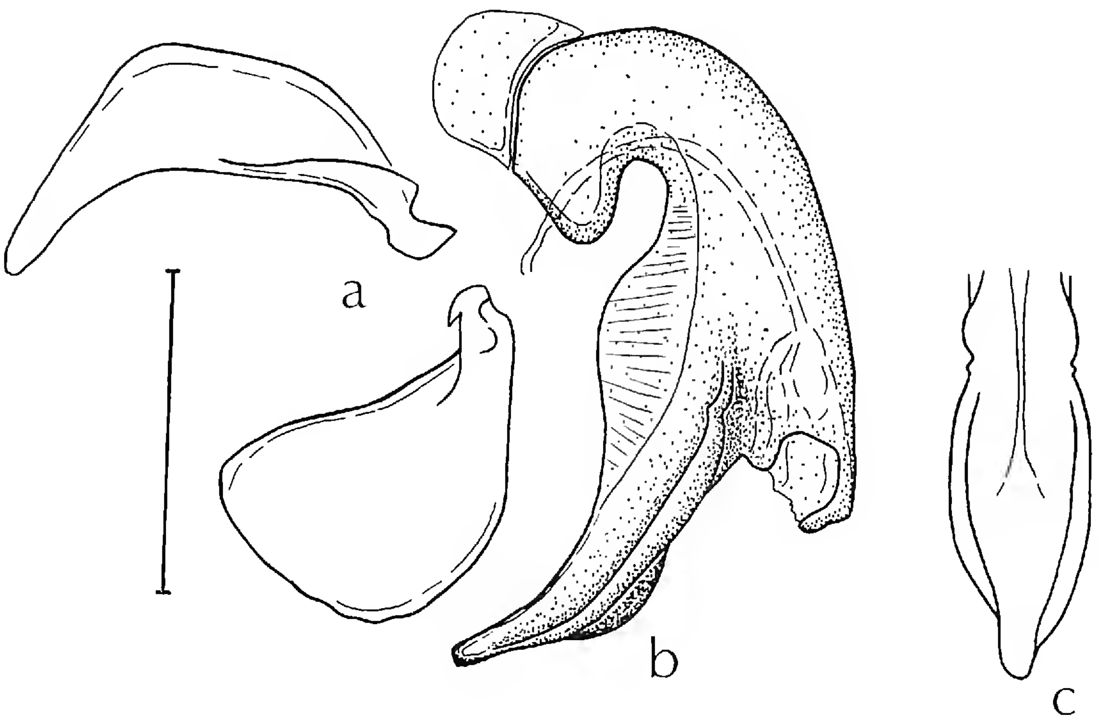

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ETYMOLOGY.—Latin, *ferrugineous* = iron red, referring probably to the overall color of these beetles, although they are more piceous than ferrugineous.

LIFE HISTORY.—I have seen specimens collected from May to August and one teneral adult from 11 June 1936. The adults collected in May were not teneral and were fully colored. It is possible that adults overwinter, but see also Lindroth, 1961: 57. According to Howard Frank (per. comm.) Palearctic species have members which feed on Collembola using their peculiar mouth parts as a cage (previously unreported in print).

DISTRIBUTION.—(Fig. 7). The range of this species extends from Alaska south to northern California, but apparently does not overlap the range of the following species. Eastward it extends to Jasper, Alberta and Revelstoke, British Columbia. I have seen 143 from the following localities: British Columbia: (Garibaldi) MCZ, (Metlakatla) MCZ, (Mountains between Hope and Okanogan) MCZ, (Nanaimo) CAS, (Sidney) MCZ, (Stanley) CAS, (Steelhead) CAS, (Vancouver Island) CAS, (Victoria) MCZ, (Yale) MCZ. Alaska: (Elmendorf, Anchorage) MCZ, (Seward) CAS, (Wrangle) CAS, (Yakatoga Beach) CAS. California: MCZ. Oregon: (Canon Beach) CAS, (Dilley) CAS, (Florence) CAS, (Marshfield) CAS, (Olney) CAS, (Waldport) CAS. Washington: (Crescent Lake) CAS, (Fairmont) MCZ, (Humptulipa) CAS, (Longmire) CAS, (Monroe) CAS, (Mt. Bonaparte) MCZ, (Northbend) CAS, MCZ, (Olympia) MCZ, (Port Angeles) CAS, (Seattle) CAS, (Tacoma) MCZ, (The Forks), CAS. See Lindroth (1961) for additional records.

LEISTUS LONGIPENNIS Casey

(Figs. 1, 4, 7)

Leistus longipennis Casey, 1920: 148. Holotype, a female, in USNM, number 46,842. Type locality.—Humboldt County, California as originally given by Casey.

DIAGNOSTIC COMBINATION.—The sloped humeri, wide pronotum, spatulate elytra, and truncate wings separate these beetles readily from those of the preceding species, but only male genitalic differences are reliable for positive separation

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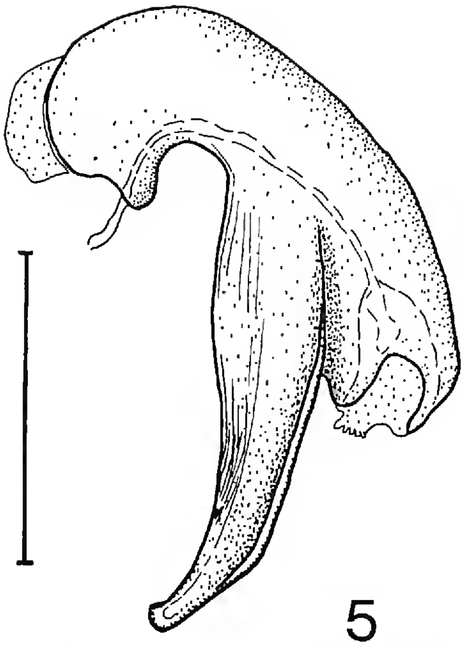
FIGS. 1–3. Pronotum and basal part of elytron, right side, dorsal aspect. FIG. 1. *Leistus longipennis* Casey, male, Orick, California. FIG. 2. *L. ferruginosus* Mannerheim, male, Crescent Lake, Washington. FIG. 3. *L. madmeridianus* Erwin, male, Jacoby Creek, California. FIG. 4. Male genitalia of *L. longipennis* Casey, a. parameres, b. left lateral aspect of median lobe, c. ventral aspect of apex, Prairie Creek, California.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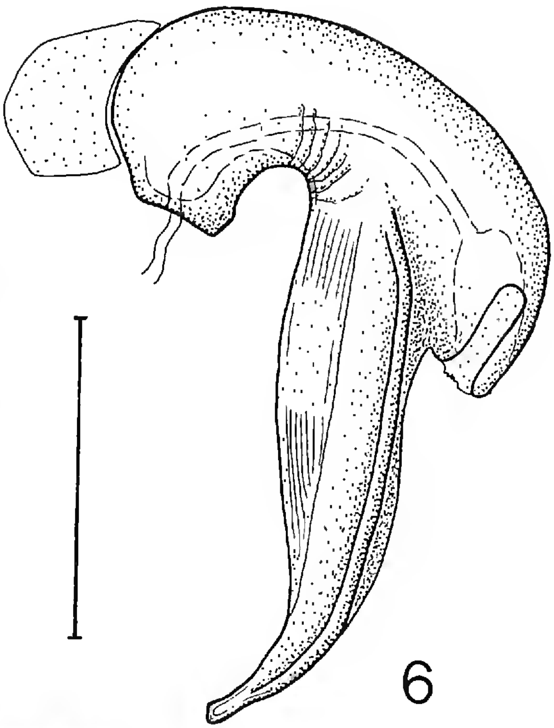
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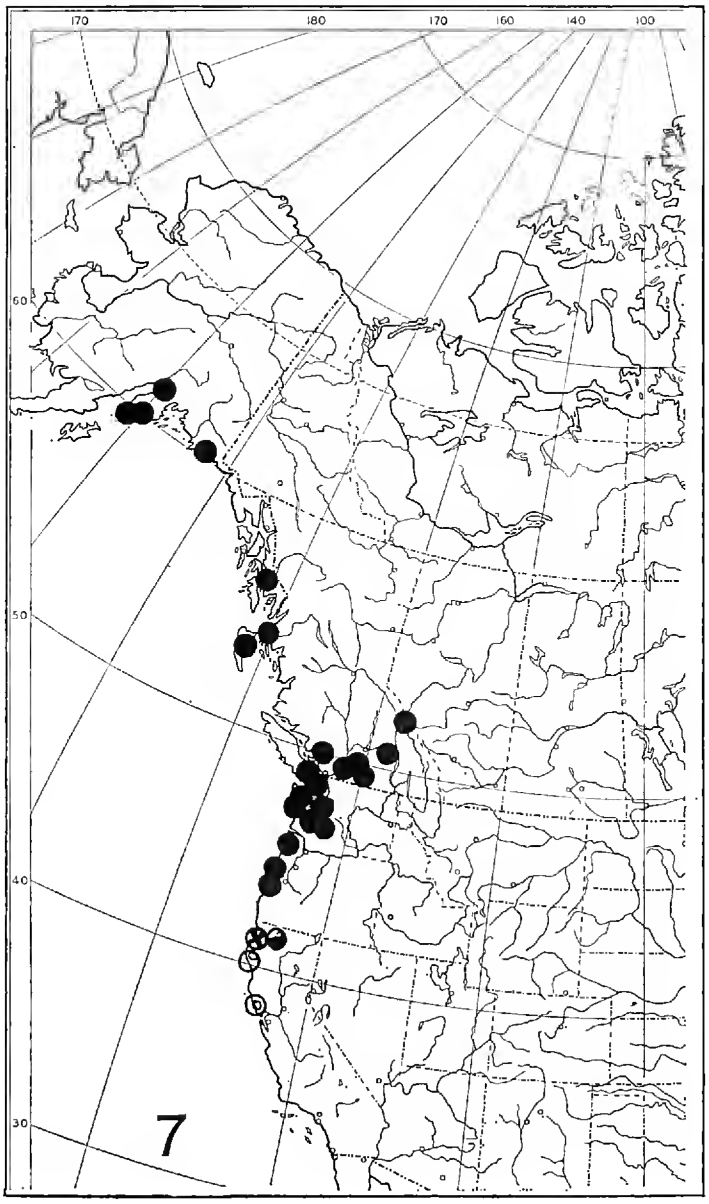

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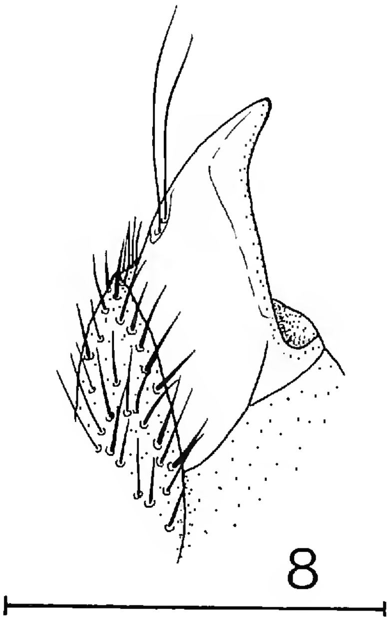
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from male members of the following species. After comparing numerous specimens one recognizes that the pronota of *L. longipennis* specimens are narrower than the pronota of specimens of the following species.

DESCRIPTION.—Medium-sized beetles, 8.5 to 10.2 mm. *Color*, *Microsculpture*, *Macrosculptpure*, and *Head*: As in *L. ferruginosus*. *Prothorax*: Pronotum (Fig. 1) wider than *L. ferruginosus*, slightly wider or subequal to width across humeri just behind scutellum; side margins more broadly explanate, straightened for longer distance just before hind angles than in *L. ferruginosus*. *Pterothorax*: Hind wings truncate posterior to stigma. Elytral humeri sloped; elytra long and spatulate, widened about apical third. *Genitalia*: Male (Fig. 4): Median lobe more strongly arcuate than *L. ferruginosus*, with ventral keel more prominent, and basal keel higher. Female (as in Fig. 8). Ten males and twenty females investigated.

VARIATION.—Elytral punctation varies as described for *L. ferruginosus*. There does not appear to be any geographic size difference in the sample before me as in the preceding species.

FLIGHT.—It is doubtful that these beetles can fly.

ETYMOLOGY.—Latin, *longus* = long or lengthy, *pennis* = wing; referring to the long spatulate elytra of these beetles.

LIFE HISTORY.—I have seen specimens collected in June and July. The June specimens average paler than those collected in July, but no markedly teneral adults have been seen.

DISTRIBUTION.—(Fig. 7). The known range of this species is limited to the extreme northwestern tip of Humboldt County, California. I have seen 88 specimens from the following localities: California: Humboldt County CAS, MCZ, USNM, (Deer Lodge, near Trinidad) CAS, (Orick) CAS, (Prairie Creek) CAS, MCZ.

Leistus madmeridianus Erwin, new species

(Figs. 3, 6, 7, 8)

TYPE LOCALITY.—JACOBY CREEK, 5.0 MILES SOUTHEAST OF ARCATA, HUMBOLDT COUNTY, CALIFORNIA.

TYPE SPECIMENS.—The *holotype male* and allotype are in CAS. The holotype was collected at the type locality by R. D. Spadoni on 23 June

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FIGS. 5–6. Male genitalia, left lateral aspect. FIG. 6. *L. madmeridianus* Erwin, Eureka, California. FIG. 5. *L. ferruginosus* Mannerheim, Vancouver Island, British Columbia, Canada. FIG. 7. Distribution map of Nearctic *Leistus* spp. Solid circles represent L. *ferruginosus* Mannerheim. Half-filled circle represents state locality only of *L. ferruginosus* Mannerheim. Open circles represent *L. madmeridianus* Erwin. Circle with a cross in middle represents *L. longipennis* Casey. FIG. 8. left female stylus of *L. madmeridianus* Erwin, ventral aspect, Eureka, California.

1965. The allotype was collected 7 July 1937 by E. C. Van Dyke. Three paratypes, all males, collected on various dates in various localities are herewith designated. One is in CAS, MCZ, and my personal collection.

DIAGNOSTIC COMBINATION.—The wide pronotum, wider than the elytral humeri just behind the scutellum, separates these beetles from members of the two preceding species.

DESCRIPTION.—Medium-sized beetles, 8.7 mm to 10.0 mm. *Color*, *Microsculpture*, *Macrosculpture*, and *Head*: As in *L. ferruginosus*. *Prothroax*: Pronotum (Fig. 3) broad, wider than elytra across humeri just behind scutellum; side margins more widely reflexed than *L. longipennis*; straight just before hind angles as in *L. longipennis*. *Pterothorax*: Hind wings truncate posterior to stigma. Elytral humeri sloped; elytra long and spatulate, widened about apical third. *Genitalia*: Male (Fig. 6): Median lobe similar to *L. ferruginosus*, except apex beyond apical orifice longer. Shaft straighter than in two preceding species. Female (Fig. 8): Stylus trigonal; with two ventral setae. Membranes at base densely setiferous. Three males and two females investigated.

VARIATION.—Too few specimens are known to evaluate variation.

FLIGHT.—It is doubtful that these beetles can fly.

ETYMOLOGY.—Latin, *meridianus* = southward; Mad, from the Mad River; referring to the present known distribution of these beetles south of the Mad River.

LIFE HISTORY.—Teneral specimens were collected in June and July. The other specimens seen were not labelled with date of collection.

DISTRIBUTION.—(Fig. 7). The known range of this species extends from the Point Reyes Peninsula of California to the type locality in Humboldt County, California, just south of the Mad River. I have seen five specimens from the following localities: California: Humboldt County CAS, (Jacoby Creek, 5.0 miles southwest of Arcata) CAS; Marin County (Point Reyes) CAS.

DISCUSSION

Because a more detailed discussion on the phylogeny and zoogeography will be forthcoming in a paper on *Leistus* classification, a few words here will suffice. The Nearctic *Leistus* are no doubt a monophyletic group that has entered the New World via "Beringia." They probably entered with the widespread arctotertiary forests in the early Tertiary and have been restricted to the remnants of these forests until now. Two of these species are confined to the "redwood belt" of northern California, while the third species is more widespread, but still confined to the more moist coastal forests of the northwestern United States, British Columbia, and Alaska. The small local populations of *L. longipennis* and *L. madmeridianus* could either be all that is left of more widespread populations (restricted along with the restricted redwoods) or small peripheral populations of *L. ferruginosus* which have become isolated, brachypterous, and have undergone speciation.

ACKNOWLEDGMENTS

I would like to thank George E. Ball and Donald R. Whitehead for reading the manuscript of this paper. Also I would like to thank my wife La Verne for her assistance in preparation of this paper.

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A New Genus and New Species of Callipterinae from India[1]

(Homoptera : Aphididae)

RABINDER KUMAR AND ROBERT LAVIGNE

University of Wyoming, Laramie

Among the aphids collected by the senior author while working on the migration of aphids from potato fields to alternate hosts at the Central Potato Research Institute, Simla, India, were two new species one of which was found to represent a previously undescribed genus.

Tuberdefectus Kumar and Lavigne, new genus

This new genus closely resembles the genus *Tinocallis* Matsumura (1919), in the presence of setae on the outer side of the cornicles and in the presence of two centrodorsal rows of spinal setae. The pairs of spinal setae in the new genus are equidistant from each other and do not have the characteristic pattern found in the genus *Tinocallis*. Unlike *Tinocallis* the abdominal tubercles are completely absent in the new genus. This character is shared with genus *Therioaphis* Walker (1870).

The type species is *T. eastopi* Kumar and Lavigne, new species.

Tuberdefectus eastopi Kumar and Lavigne, new species

(Figs. 1–5)

ALATOID NYMPH.—Color in life: pale to light yellow. Sclerites on dorsum of abdomen visible with naked eye. Color when macerated: yellow disappears, antennae and apical portions of legs brownish.

Morphology.—Head blunt without swelling; frontal tubercles absent; ocelli absent; triommatidion visible. Length of antennal segments: III 0.31–0.40 mm, IV 0.14–0.21 mm, V 0.17–0.21 mm, and VI 0.12–0.15 + 0.11–0.14 mm; longest hair on antennal segment III nearly ⅓ the basal diameter of that segment. Rostrum reaches beyond the front coxae. Abdomen with two rows of sclerites on dorsum of segments I–VII; abdominal setae prominent and strongly capitate as in Fig. 2; lateral abdominal sclerite not developed; each sclerite with 3–7 setae; seta of abdominal sclerite VI present on the outer side of the cornicle on either side; dorsal and lateral abdominal tubercles lacking; longest spinal seta present dorsally on abdominal segment VIII.

ALATE MALE.—Color in life: pale yellow. Sclerites on dorsum of abdomen distinctly visible with naked eye. Color when macerated: yellow disappears, antennae, legs, head, thorax brownish; abdomen with brown patches dorsally.

Morphology.—Head moderately blunt without swelling; frontal tubercles ab-

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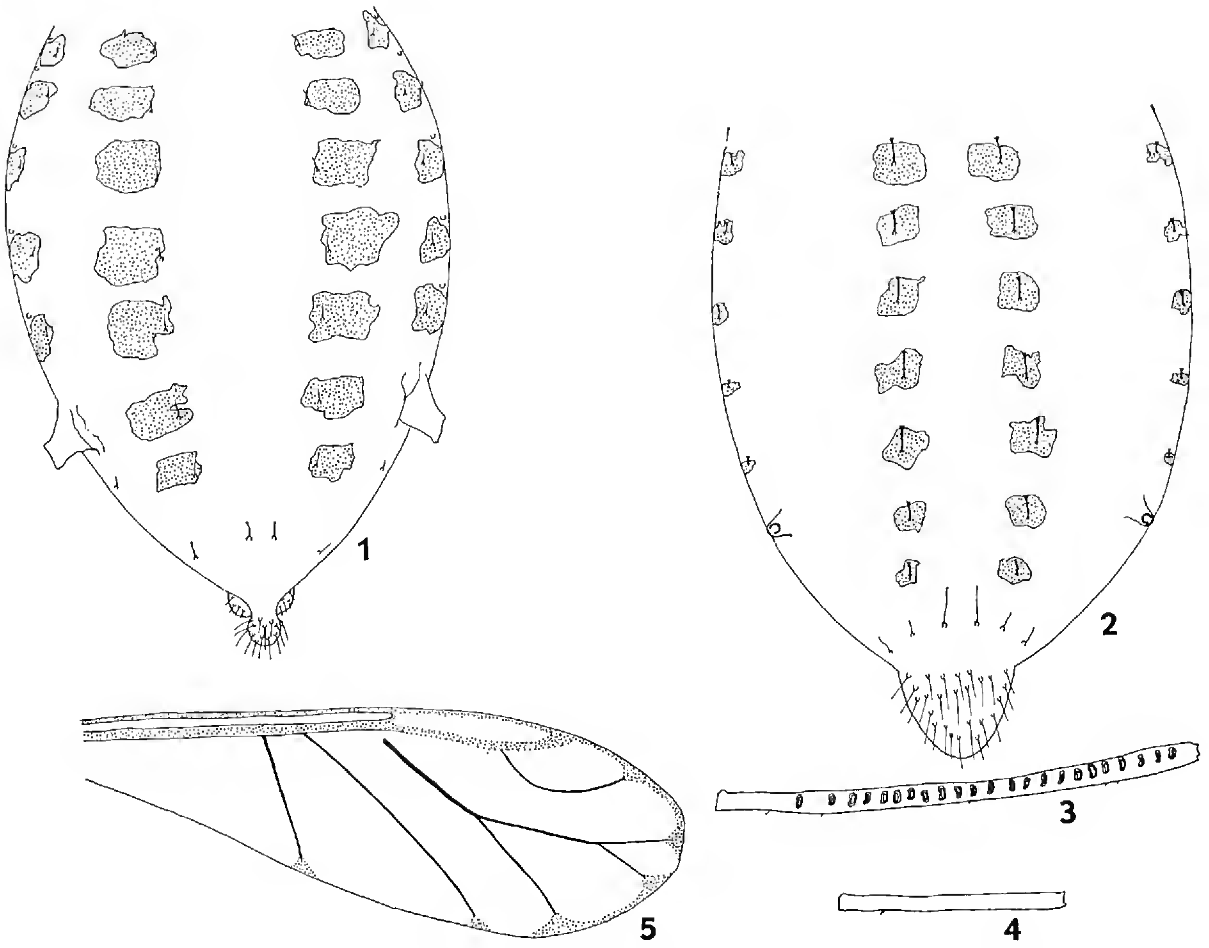
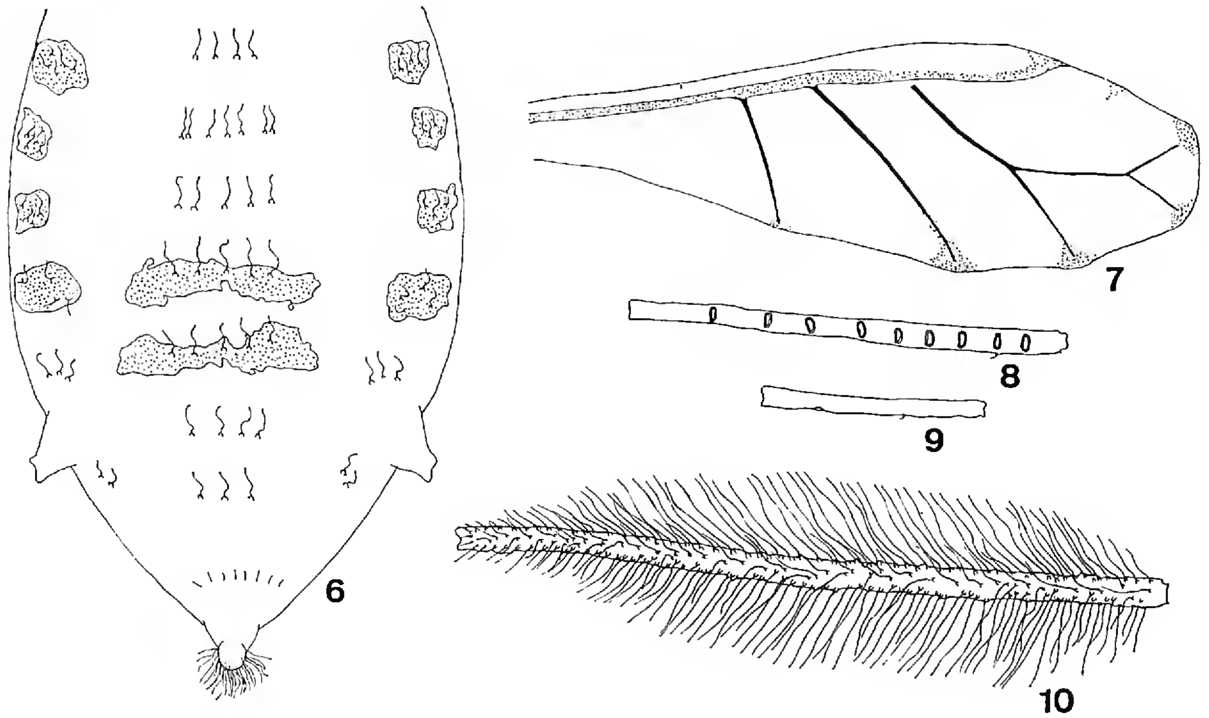


FIGS. 1–5. *Tuberdefectus eastopi* Kumar and Lavigne. FIG. 1. Dorsum of abdomen of alate viviparous female. FIG. 2. Dorsum of abdomen of alatoid nymph. FIG. 3. Right antennal segment III of alate viviparous female. FIG. 4. Right antennal segment IV of alate viviparous female. FIG. 5. Right fore wing of alate viviparous female.

sent; ocelli very prominent; triommatidion visible. Length of antennal segments: III 0.52–0.58 mm, IV 0.24–0.31 mm, V 0.23–0.28 mm, and VI 0.14–0.16 + 0.12–0.16 mm; secondary rhinaria on antennal segments: III 21–23, IV 1–4, V 4–5 and VI 2–3; these vary in size, position and number in the same specimen on both antennae and in different specimens; longest hair on antennal segment III nearly half the basal diameter of antennal segment III; hair present on antennal segments I–VI. Rostrum reaches beyond the front coxae. Distal setae single. Prothoracic setae normal and single. Setae on body parts pointed. Two rows of sclerites dorsally on abdominal segments I–VII; sometimes sclerites of tergite VI coalesce; each sclerite with a spinal seta; lateral abdominal sclerites are well developed in abdominal segments I–V; sclerite VI coalesces with base of cornicle on either side; sclerites VII and VIII very faintly developed; each sclerite with a seta except on the outside of the cornicle on either side on abdominal segment VI; dorsum of abdomen without any tubercles; lateral abdominal tubercles present on abdominal segments II–V. Cauda knobbed and densely hairy. Anal plate deeply indented. Wings (Fig. 5) and legs normal.

ALATE VIVIPAROUS FEMALE.—Color in life: pale yellow. Sclerites on dorsum of abdomen distinctly visible with naked eye. Color when macerated: yellow



FIGS. 6–10. *Chromaphis hirsutustibis* Kumar and Lavigne (alate viviparous female). FIG. 6. Dorsum of abdomen. FIG. 7. Right fore wing. FIG. 8. Right antennal segment III. FIG. 9. Right antennal segment IV. FIG. 10. Right femur.

disappears, antennae, legs, head, thorax brownish; abdomen with brown patches dorsally.

Morphology.—Head moderately blunt without swelling; frontal tubercles absent; ocelli very prominent; triommatidion visible. Length of antennal segments: III 0.62–0.71 mm, IV 0.30–0.36 mm, V 0.26–0.32 mm, and VI 0.15–0.17 + 0.15–0.18 mm; secondary rhinaria on antennal segment: III, 20–23 in number, upper $\frac{1}{7}$ of segment III rarely with rhinaria as in Fig. 3, these vary in size, position and number on both antennae in the same individual and in different specimens; longest hair on antennal segment III nearly half the basal diameter of segment III; hair present on antennal segments I–VI (Fig. 4). Rostrum reaches beyond front coxae. Distal setae single. Prothoracic setae normal and single. Setae on body parts pointed. Abdomen with two rows of sclerites on dorsum of abdominal segments I–VII; sclerites of middle tergites sometime coalesce with those on anterior and posterior abdominal segments; lateral abdominal sclerites well developed on segments II–V; sclerite VI coalesces with base of cornicle on either side; sclerite VII only faintly developed; each sclerite with a seta, that on abdominal sclerite VI present on outer side of cornicle; setae on abdominal segment VIII large; dorsum of abdomen without tubercles as in Fig. 1; lateral abdominal tubercles present on segments II–V. Cauda knobbed and densely hairy. Anal plate deeply indented.

TYPES.—*Holotype alate male*, SIMLA, INDIA, 7000 ft., 23 August 1966 (R. Kumar) on *Prunus* sp. (wild peach). Allotype: alate viviparous female, same data. Paratypes: one alatoid nymph, one alate male and one alate viviparous female. Deposited in British Museum (Nat. Hist.), London, England. Four paratypes in collection of senior author.

COMMENTS.—The aphids were first observed on wild peach on 23 August 1966. Alate males were present only in the latter part of January. Viviparous reproduction was at its peak during February. All stages feed near the midribs of the leaves forming dense colonies. Leaves become very sticky due to aphid excretion and are often visited by ants.

The authors take great pleasure in naming this species for the distinguished aphidologist, Dr. V. F. Eastop, British Museum (Nat. Hist.) who kindly examined the specimens and compared them with existing genera.

Chromaphis hirsutustibis Kumar and Lavigne, new species

(Figs. 6–10)

ALATOID NYMPH.—Color in life: pale yellow with paired patches black dorsally on abdominal terga. Color when macerated: becomes colorless except for abdominal patches blackish.

Morphology.—Frontal tubercles poorly developed. Antennae six segmented; length of antennal segments; III 0.23–0.24 mm, IV 0.11–0.12 mm, V 0.11 mm, and VI 0.08–0.09 + 0.04 mm; secondary rhinaria absent; longest seta on segment VI, setae of antennae, head, thorax and abdomen capitate; apex of antennal segments V and VI dark brown; most of antennal setae present on the inner side. Head and pronotum with one pair of setae. Two pairs of spinals on mesonotum, metanotum and abdominal tergites I–VII. Abdominal tergite VIII usually with six spinals; with median pair spinals often longest; mostly setae arise from dark sclerotized rows placed segmentally; abdominal segments I–VII with 3–4 lateral capitate setae, those on segment VI situated on the ventral surface of cornicle on either side.

ALATE VIVIPAROUS FEMALE.—Color in life: yellowish with prominent black patches on dorsum of abdomen. Costal margins of wing dark brown. Abdominal patches and wing markings absent in early stages but become prominent with maturity. Color when macerated: yellow disappears, whereas brownish areas remain.

Morphology.—Frontal tubercles poorly developed; frontal ocellus visible when head viewed from above. Longest hair on head much longer than basal diameter of antennal segment III, but shorter than setae on dorsum of abdomen. Antennae six segmented; length of antennal segments: III 0.57–0.58 mm, IV 0.25–0.33 mm, V 0.18–0.20 mm, and VI 0.08–0.16 + 0.04 mm; secondary rhinaria on segment III: 8–10 (Fig. 8) IV: 1 (Fig. 9); longest hair on antennae ¾ of basal diameter of segment III and pointed; seta on segments I and II much longer than on other segments. Proximal part of antennal segments IV, V and processes terminalis dark brown. Rostrum reaching beyond front coxae. All body setae pointed. Spinal setae on dorsum of abdomen segmentally arranged, very prominent median dark brown bars on dorsum of abdominal segments IV and V which sometime coalesce at points, marginal sclerites present on abdominal segments I–IV, usually with 4–5 setae in Fig. 6. Cornicles small and without flange. Cauda knobbed. Anal plate weakly indented. Wings normal as in Fig. 7. Hind tibiae densely hairy as in Fig. 10, and blackish on the margins in the middle region, upper half comparatively darker, dark blackish brown patch present below the apical region on femur.

TYPES.—*Holotype alate viviparous female*, SIMLA, INDIA, 21 September 1966 (R. Kumar) on *Juglans regia* L. Paratypes: one alate viviparous female and one alatoid nymph, same data. Deposited in the British Museum (Nat. Hist.), London, England. Four paratypes in collection of senior author.

COMMENTS.—This new species is easily distinguished from other species of the genus *Chromaphis* Walker (1870) by the presence of dense hair on the hind tibiae.

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The Life Cycle of *Rhithrogena morrisoni* (Banks) in Western Oregon

(Ephemeroptera : Heptageniidae)

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Detailed biological data are lacking for the North American species of *Rhithrogena.* Some species in the genus are distinguished only by minute details of the male genitalia, and the females and nymphs are frequently undescribed. The species treated here will be referred to as *R. morrisoni.* Specimens of all stages are deposited in the Oregon State University Insect Collection, Corvallis.

Rhithrogena morrisoni was described by Banks from Nevada in 1924. It also occurs in western Canada (Berner, 1959), California (Day, 1963), Idaho (Jensen, 1966), Oregon (Allen and Edmunds, 1956), and Utah (Edmunds, 1952). Jensen (op. cit.) described the nymphs and included both adult males and nymphs in his keys to the Rhithrogena of Idaho.

METHODS AND COLLECTIONS

Nymphs of *R. morrisoni* were collected from a variety of streams in the Benton County area. The description of nymphal development is

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based on intensive sampling in Oak Creek, near Corvallis, from July 1967 to June 1968. Adults were reared or collected in 1966, 1967, and 1968.

In the sample area, Oak Creek was 5–10 feet wide, 6–18 inches deep, and had a dense canopy of deciduous trees. The sample area consisted of a series of riffles and pools, the former having a rubble and gravel substrate. Other information on the stream can be found in Anderson and Lehmkuhl (1968) and Lehmkuhl (1968).

Benthos samples were taken by embedding the end of a one foot length of stovepipe 6 inches in diameter into the substrate. Contents of the sampler were removed by hand and with a fine aquarium net. Surface velocity, water depth, distance from shore, and general bottom type were recorded for each sample. Three samples were taken each month from each of the major habitats in the stream: slow deep glide, still backwater, middle of riffle, edge of riffle (12 samples per month).

Mayfly nymphs of equal maturity may vary much in size, i.e., ultimate instar nymphs (having black wing pads) may differ in length by several mm. In addition to length measurements, a system of groupings based on biologically significant characters was used, as described below:

Group		Biological Significance
I	Gills poorly developed, threadlike or absent; nymphs scarcely resemble mayflies.	Newly hatched.
II	Definite mayfly appearance, gills developed beyond I, no wing buds.	Young nymphs.
III	Wing buds present on posterior margin of meso- and metathorax; mesothoracic wing pads do not completely cover metathoracic wing pads.	Half grow nymphs.
IV	Mesothorarcic wing pads cover metathoracic wing pads.	Mature nymphs.
V	Wing pads black.	Ready to emerge to subimago.

To obtain adults, nymphs collected in the field were placed in small screen cages which were partly submerged in a trough in which water was circulated by a paddle wheel. Nymphs could rise to the water surface or crawl up the side of the screen to emerge.

LIFE CYCLE

Of over 100 samples taken in Oak Creek, about 15% contained large stones (4–5″ dia.) and were in water over 2 ft./sec. surface velocity.

TABLE 1. Sizes and natural groups of *Rhithrogena morrisoni* (Banks) nymphs from Oak Creek bottom samples, 1967–1968.

	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.
Length (mm)	1–2	3–5	6–8	8–9	none	8–9
Natural Groups[1]	II	II–III	III	IV	—	V

[1] See text.

Nymphs of *R. morrisoni* were found only in these samples indicating that the nymphs have strict environmental requirements.

Table 1 illustrates the seasonal development of the nymphs in the 1967–1968 sample period. None was found from March to August but small nymphs may have been overlooked in August because of the presence of *Cinygmula reticulata* McDunnough nymphs which might be confused with *Rhithrogena*. Nymphs of *R. morrisoni* were 1–2 mm long in September and had increased to 9 mm in December. Severe spates in the fall and winter caused much disturbance in the stream (Anderson and Lehmkuhl 1968), and this may explain the absence of nymphs in the January sample. Nymphs increased greatly in maturity but only slightly in length from November to February (compare lengths and natural groups, Table 1). Nymphs had black wing pads (natural group V) in February, and the first adults appeared at this time.

Adults were collected between the following dates: 1966—25 March to 26 April; 1967—11 March to 21 April; 1968—29 February to 24 April. In 1968, the main emergence from Oak Creek was early and of short duration (first week of March), probably because of several days of unseasonably warm weather at this time (air temp., over 20° C; water temp., about 7° C). This explains the absence of nymphs in March and April samples (Table 1). Adults from other areas were collected as late as 24 April 1968.

Cast skins from laboratory-emerged specimens were found floating free on the surface of the water, indicating that the nymphs do not climb out of the water to transform to the winged stage. The subimago stage lasted from 4–6 days for laboratory reared specimens kept at outside temperatures of 5–15° C. Subimagos collected on buildings in Corvallis and kept indoors (21–23° C) usually required 2 days to transform to the adult stage.

A mating swarm was observed over a roadside ditch (March 2, 1968) near a stream at 3 P.M. on a misty day. The swarm consisted of a dozen males widely spaced 8–15 ft. above the ground. Jensen (1966), reported that the adults swarm over streams and adjacent ground in mid-morning, but that the main flight occurs in the evening.

No nymphs were collected in the summer indicating that the eggs have a resting period of several months. This is similar to *R. semicolorata* in England (Macan, 1960).

DISCUSSION

Jensen (1966) reported that *R. morrisoni* had an early emergence in Idaho and Utah (May and June). This species also has an early emergence in the Corvallis area (March and April). Macan (1960) suggested that the end of the period of emergence occurs when rising water temperatures reach a point which kills the nymphs. I have shown that emergence may be correlated with temperature in some species of *Epeorus* (Lehmkuhl, 1968), but that temperature alone will not explain the emergence period in all cases for a given species. In the present case it is unlikely that high water temperatures limit the period of adult emergence. Jensen (1966) found *R. morrisoni* nymphs in water up to 18° C, which is well above the temperature in Oak Creek when the last adults emerged.

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New Genera and Species in the Lepturine Complex Related to *Euryptera* and *Choriolaus*

(Coleoptera: Cerambycidae)

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The Lepturinae of Mexico and Central America, last reviewed by Bates (1879–1885), are still very poorly known. The present paper is designed to make available names for certain genera and species which have special evolutionary importance in relation to the lepturine fauna of the United States. It is a companion to that of Chemsak (1969) in which he characterizes for the first time Mexican and Central American species of *Strangalia* Audinet-Serville. Large numbers of undescribed genera and species from Mexico and Central America are now at hand. It is our intention to make many of these known as time permits. However, priority will be given to the naming of presumably mimetic forms and others of special ecological or evolutionary significance.

Megachoriolaus Linsley, new genus

Form moderately robust; elytra parallel-sided or slightly expanded posteriorly, not attenuated. Head elongate; antennae usually relatively short in both sexes, basal segments shining, clothed with coarse suberect hairs, fourth segment short, outer segments dull, with or without poriferous areas. Pronotum with punctation not finer than that of base of elytra, usually very much coarser. Prosternum with intercoxal process very narrow, often laminiform, coxae prominent, exerted, approximate; mesosternum with intercoxal process prominent but not elevated above the coxae, steeply but arcuately declivous in front. Legs with posterior tarsi not longer than tibiae, first segment not or only slightly longer than remaining segments combined. Elytra with fine, non-elevated costal lines. Abdomen with last segment not excavated.

TYPE OF GENUS: *Megachoriolaus chemsaki* Linsley

This genus is proposed for a species from Mazatlan with lycid-like coloration. It also includes a number of others from southwestern United States, Mexico, and Central America which have been previously assigned to *Euryptera* by Linsley (1961) including: *M. breviceps* (Linsley) n. comb., *M. flammatus* (Linsley) n. comb., *M. ignitus*

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(Schaeffer) n. comb., *M. sabinoensis* (Knull) n. comb., *M. spiniferus* (Linsley) n. comb., and *M. texanus* Knull n. comb.

Megachoriolaus chemsaki Linsley, new species

(Fig. 1)

MALE.—Form somewhat oblong; elytra gradually but narrowly expanded posteriorly before rounding to apices; integument yellowish-brown, antennae, apical two-fifths of elytra, abdomen, except first sternite, most of tibiae and tarsi black, head, with vertex at middle, genae, neck except medially above pronotum and sterna at sides wholly or partially black or piceous. Head elongate, ratio of distances between apices of antennal tubercles and line midway between them and apex of labrum, 2.3:6.0; vertex finely, densely punctate, impressed on each side of midline; antennal tubercles prominent, lateral areas below antennal insertions finely, densely punctate; clypeus and labrum shining, sparsely punctate, surface minutely tessellate; antennae extending beyond middle of elytra, first four segments shining, clothed with coarse, suberect black setae, fifth with few at apex, segments five to eleven dull, minutely, densely punctate and pubescent, poriferous areas of outer segments small and inconspicuous, third segment subcylindrical, but slightly thickened apically, about as long as scape, fourth segment distinctly shorter than third, widened apically, fifth about as long as third, also expanded apically, segments six to ten thickened but subparallel, eleventh distinctly longer than tenth, at most very feebly appendiculate. Pronotum densely, moderately coarsely punctate, punctures larger than those of vertex and elytra, with vague or evanescent median impunctate line; pubescence short, appressed; sides moderately rounded in front of middle, posterior angles extending out over humeri, acute; prosternum finely, sparsely punctate and shining; mesosternum finely, sparsely punctate medially and shining, densely punctate on lateral sclerites. Legs with posterior tarsi about as long as tibia, first segment scarcely shorter than remainder of tarsus. Elytra more or less oblong, ratio of humeral width to subapical width, 6:7; surface more finely, discretely punctate than pronotum, discal punctures mostly separated by one or two diameters, pubescence moderately short, depressed; apices broadly transversely rounded to external angle which is dentiform. Abdomen shining, finely, sparsely punctate medially, finely, densely punctate laterally, last sternite sinuate-truncate at apex, lateral angles dentiform. Length, 11.5 mm.

FEMALE.—Form very similar to that of male, pronotum and basal abdominal sternites yellow. Length, 11 mm.

Holotype male and allotype female from 5 MILES NORTH OF MAZATLAN, SINALOA, MEXICO, 27 July 1964, taken *in copulo* on flowers of *Buddleia wrightii* Robins, by J. A. Chemsak, seven paratypes, same locality, 27–28 July 1964 on *B. wrightii* (J. A. Chemsak), fourteen, 24–29 July 1964 (H. F. Howden), six bearing flower labels for *Jatropha curcas* L., and one for *Buddleia wrightii*, and nine dated 5–11 August 1964 (H. F. Howden) without flower data. One additional specimen, also designated paratype, is from Venedio, Sinaloa, Mexico, 3 July 1918 (E. C. Van Dyke collection). The holotype and allotype are deposited in the California

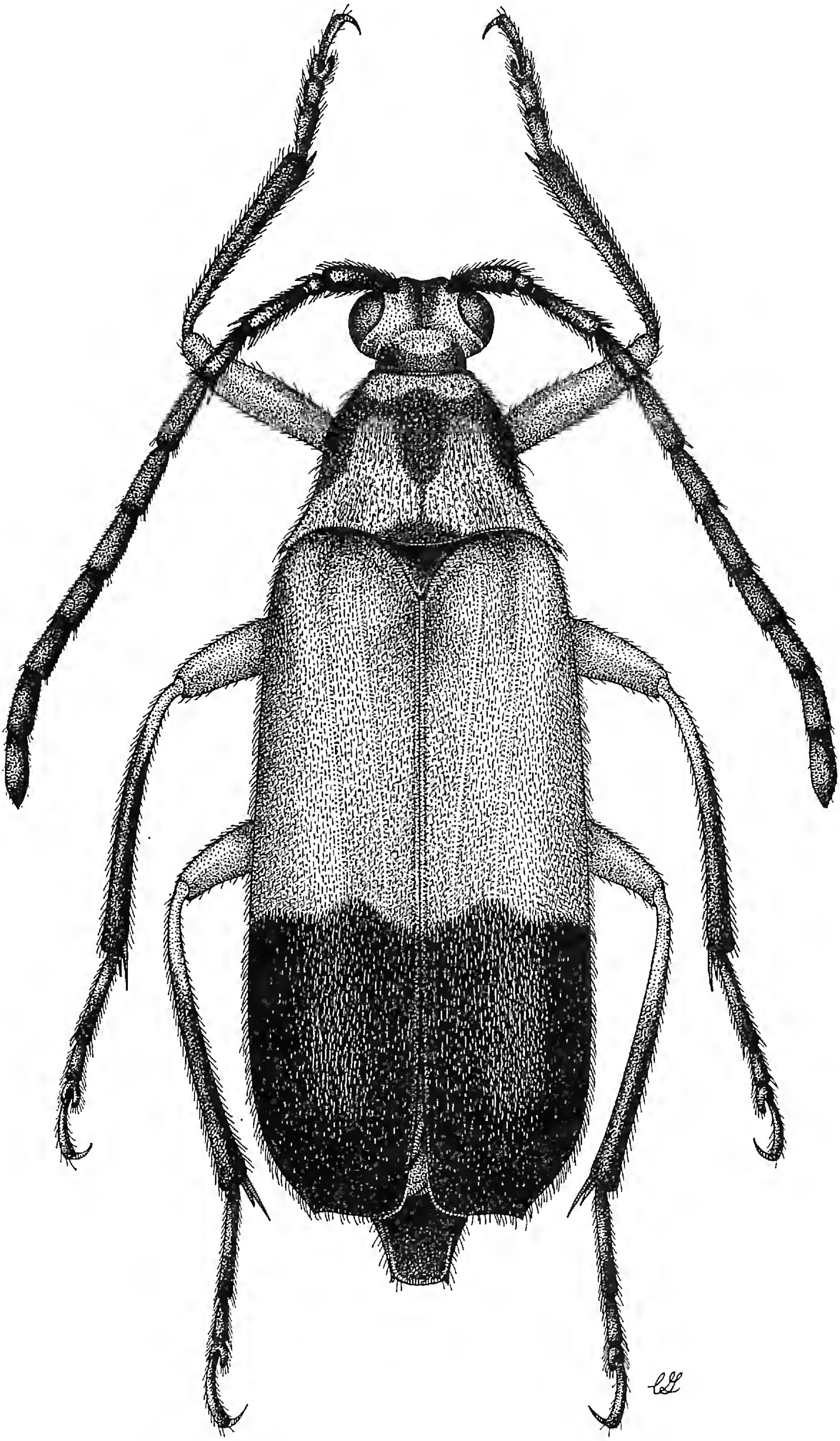

FIG. 1. *Megachoriolaus chemsaki* Linsley ♀

Academy of Sciences, San Francisco; paratypes in the Canadian National Collection, Ottawa, and the collections of the British Museum (Natural History) London, the California Insect Survey, University of California, Berkeley, and the California Academy of Sciences.

This species is smaller than most *Megachoriolaus*, ranging in size from 9–12 mm, and is distinctive in form and coloration. The two sexes lack obvious secondary sexual characters and are very difficult to distinguish without dissection. The last abdominal segment usually extends a little more conspicuously beyond the elytral apices in the female but the last sternite is similar in both sexes. Among specimens believed to be males, most, but not all, have the pronotum and sterna predominantly black or piceous; conversely most females have the pronotum predominantly yellow.

This species is named in honor of my colleague, John A. Chemsak, with whom I have collected at the type locality but not during the season when adults of this species were active.

Megachoriolaus imitatrix Linsley, new species

FEMALE.—Form robust; elytra gradually but narrowly expanded from humeri to middle then gradually narrowed posteriorly before rounding to apices, ratio of width at middle to humeral width, 4.5:4.0; integument black, head, pronotum and elytra red, prosternum, pro- and mesocoxae and intercoxal process of mesosternum brown. Head elongate, ratio of distance between apices of antennal tubercles and line midway between them and anterior margin of labrum, 2.8:6.0; vertex finely punctate above, more coarsely below, pubescence very sparse, more evident between upper lobes of eyes; area above antennal supports triangularly impressed and impunctate and glabrous, impression deeper at sides, antennal supports finely punctate, subglabrous, triangular area at base of clypeus shining, impunctate, glabrous; clypeus with length at sides subequal to width, surface coarsely punctate basally, impunctate apically; general length below eye greater than basal width of mandibles; antennae extending to about middle of elytra, basal segments subcylindrical, clothed with short, appressed, coarse black setae, longer at apices, outer segments dullish, minutely densely punctate and pubescent, expanded but not serrate, third segment subequal in length to scape, fourth segment distinctly shorter than third and fifth, slightly thickened apically, fifth segment not quite as long as third, expanded apically, six to ten thickened and successively slightly shorter, poriferous areas not evident, eleventh segment a little longer than tenth, apex attenuated but scarcely appendiculate. Pronotum with sides obtusely rounded in front of middle, basal angles extending over humeri; disk coarsely subcontiguously punctate except for an ill-defined median longitudinal impunctate line, pubescence short, coarse, recurved, not obscuring surface. Legs with posterior tarsi distinctly shorter than tibiae, first segment slightly longer than remainder of tarsus. Elytra about twice as long as broad; surface finely discretely punctate, punctures mostly separated by one or two diameters, pubescence short, appressed, not obscuring surface; apices transversely sinuate-truncate, outer angle dentiform.

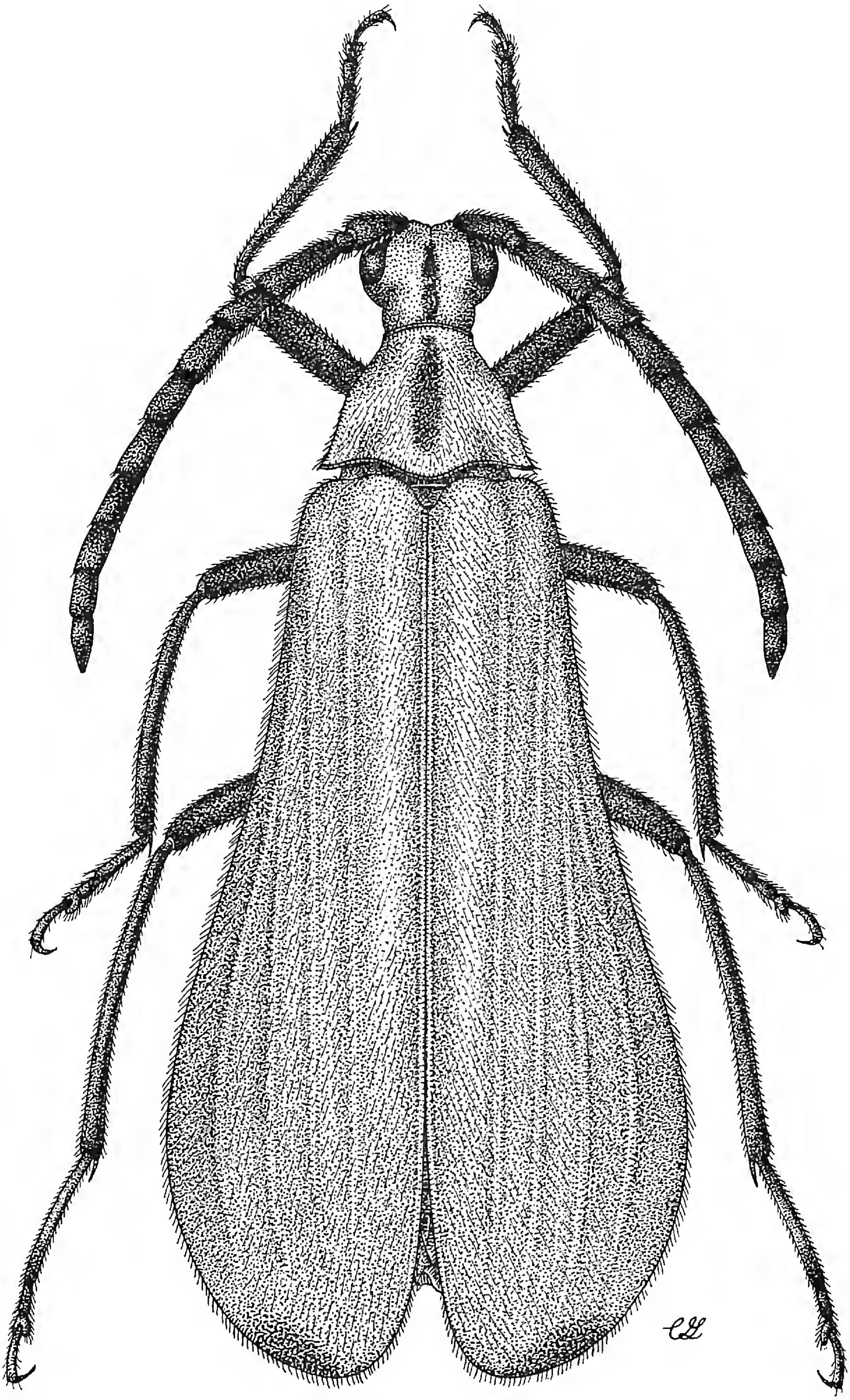

FIG. 2. *Lycomorphoides simulans* Linsley ♀

Abdomen shining, sparsely punctate medially, densely punctate laterally, last sternite truncate at apex, lateral angles prominently dentiform. Length, 11 mm.

Holotype female (University of Kansas), from EL SALTO, SAN LUIS POTOSI, MEXICO, 8 June 1961, 1900 ft. elevation (University of Kansas Mexican Expedition).

This species superficially resembles *M. flammatus* (Linsley) from Cuernavaca, but differs markedly in the form of the head which is more elongate, differently shaped and subglabrous, rather than densely clothed with long, golden, recumbent pubescence. In addition, the third antennal segment is as long as the scape and longer than the fifth (it is shorter than either in *M. flammatus*); the pronotum is more coarsely, and the elytra more distinctly, punctate. In general outline it is distinct from any of the other known species, being more robust, with the elytra widest at the middle.

Lycomorphoides Linsley, new genus

Form elongate, flat, lyciform, elytra broadly expanded posteriorly, apices separately rounded. Head elongate, neck prominent, temples short, genal length below eyes much greater than basal width of mandibles; antennae short, stout, inserted adjacent to upper anterior margin of lower lobe of eye outside of emargination, basal segments densely clothed with coarse erect setae, outer segments dull, minutely punctate and pubescent, poriferous areas not evident. Pronotum campanuliform, posterior angles extending over humeri; prosternum with intercoxal process narrow, laminiform, anterior coxae exerted; mesosternum with intercoxal process not prominent, much narrower than coxae, sunken between them, gradually and more or less flatly declivous in front. Legs slender, tibiae arcuate, posterior tarsi short, first segment elongate. Elytra elongate, costate.
TYPE OF GENUS: *Lycomorphoides simulans* Linsley

This genus is proposed for an anomalous *Lycus*-like lepturine of the *Choriolaus-Strangalia* group, with which it agrees in sternal characters but differs markedly in the form of the elytra which are broadly expanded and separately rounded without any trace of an external angle.

Lycomorphoides simulans Linsley, new species

(Fig. 2)

FEMALE.—Integument dark brown, head, except for mouthparts and median longitudinal stripe on vertex, pronotum except for broader median stripe which does not reach base or apex, and elytra except for extreme apices, anterior and intermediate coxae and intercoxal processes and basal portion of tibiae and tarsi yellow brown; pubescence black on dark areas, golden on pale areas. Head with neck shining, punctures much larger and less dense than those of vertex; vertex prominent, opaque, finely densely punctate, densely clothed with appressed golden pubescence, area above antennal insertions slightly impressed, ratio of distance between apices of antennal tubercles and line midway between them and anterior margin of labrum approximately 2:3; clypeus coarsely punctate basally; antennae with only apical half extending beyond elytral humeri, scape about one and one-half times as long as apical width, third segment a little longer and stouter than scape, fourth segment less than half as long as third, equally stout, fifth segment a little shorter than third, six to ten successively a little shorter and less stout, eleventh segment scarcely longer than tenth, with pale conical projection at apex. Pronotum opaque, finely densely punctate, densely clothed with fine appressed golden pubescence; prosternum shining, sparsely punctate; metasternum densely punctate at sides, metepisterna punctate throughout. Elytra about three and one-third times as long as basal width, subapical width more than twice basal width; surface subopaque, with two costae extending from base nearly to apex and two additional evident externally over most of expanded apical half; punctures dense, larger than those of pronotum, interspaces minutely tessellate; pubescence long, fine, golden, appressed not obscuring surface; apices narrowly rounded at suture, broadly rounded externally. Abdomen shining; surface sparsely punctate, thinly clothed with suberect pubescence; last sternite medially and subapically impressed, apex rotundate-truncate. Length: 13 mm, greatest width, 6 mm.

Holotype female (United States National Museum), from TURRIALBA, COSTA RICA, 800 m (Schild, in collection of F. Nevermann).

Macrochoriolaus Linsley, new genus

Form large, robust, subparallel; elytra gradually and very slightly narrowed posteriorly before rounding to apices which are transversely truncate and feebly emarginate. Head large, occiput excavated behind, vertex and postocular area very prominent, wider than upper lobe of eye and continuous with genae, genae also prominent giving the head proper a squarish outline; antennal tubercles very prominent; eyes very large, emargination shallower than lateral width of eye, antennae inserted adjacent to upper anterior margin of lower lobe of eye outside of emargination, antennal sockets large, conspicuous; area at base of antennal tubercles deeply transversely impressed; muzzle short, prognathous; clypeus transverse, twice as wide as long; labrum short, transverse; antennae short, basal segments shining, discretely punctate and setose, outer segments minutely, densely punctate and pubescent, poriferous areas not evident. Pronotum transverse but less than twice as wide as long, sides obtusely rounded in front of middle, arcuately narrowed in front of posterior angles, posterior angles produced but do not extend over humeri, basal width twice apical width but only seven-tenths as wide as elytra across humeri; prosternum with intercoxal process narrow, laminiform, coxae prominent, mesosternum with intercoxal process narrow, arcuately declivous in front. Legs relatively stout, tibiae not arcuate, tarsi short, first segment of posterior pair much shorter than remainder of tarsus.

TYPE OF GENUS: *Macrochoriolaus elegans* Linsley

The remarkable structure of the head immediately sets this genus apart. Although somewhat suggestive of *Megachoriolaus* in the form of the body, the narrow pronotum and heavy appendages will further distinguish it from that genus.

Macrochoriolaus elegans Linsley, new species

(Fig. 3)

FEMALE.—Body black, shining, pronotum and elytra brownish-yellow. Head with vertex and postocular area finely punctate with scattered larger punctures superimposed, sparsely clothed with erect black hairs, median line on vertex impressed, impression above antennal supports somewhat V-shaped, punctures larger and denser than those on lobes of vertex, antennal supports distinctly punctate, punctures moderately large, mostly well separated, about the size of those on antennal scape; clypeus with narrow band of coarse punctures at base, apical two-thirds glabrous, impunctate; labrum glabrous, shining; genae shining and almost impunctate at sides, irregularly punctate below eyes; antennae with segments subcylindrical, segments three and four gradually enlarged toward apices. Pronotum with disk coarsely, closely punctate basally, more finely and less discretely toward apex, transversely impressed about one-third distance between basal lobe and apex; pubescence short, erect, golden, not obscuring surface; scutellum black, apex rounded. Elytra more finely, shallowly punctate than pronotum, pubescence short, nearly erect, not obscuring surface. Legs densely punctate, clothed with short suberect hairs, posterior tarsus with last segment elongate, distinctly longer than first segment. Abdomen shining, sternites more densely punctate and pubescent at sides, last sternite rotundate-truncate, feebly emarginate, apex pubescent. Length, 15.5 mm, breadth 5 mm.

Holotype female (Cornell University) from THE VICINITY OF OLMICTEME, GUERRERO, MEXICO, 29–30 July 1965, in a humid pine-oak formation at an elevation of 2300 to 2500 meters (Cornell University Mexico Field Party).

Platerosida Linsley, new genus

Form elongate, slender, flattened. Head relatively short, deeply impressed above antennal tubercles which are fused and shallowly longitudinally impressed at apex, triangular area above clypeus deeply impressed, transverse impression at base of clypeus also deep so that muzzle prognathous; antennae inserted near upper anterior margin of lower lobe of eye outside of emargination, those of male extending beyond middle of elytra, basal segments shining, setose outer segments dull, poriferous areas not evident, scape robust, second segment bead-like, about as long as broad, third segment short, about three times as long as second, claviform, fourth segment very short, bead-like, only about twice as long as second, fifth segment about as long as three preceding segments taken together, gradually widened externally to apex, sixth segment distinctly longer than fifth, similarly shaped but more slender, seventh segment subequal in length to sixth, segments eight to ten successively slightly shorter and more slender, eleventh segment a little longer than tenth, feebly constricted before apex; antennae of female reaching to about basal one-fifth or one-sixth of elytra, first four segments proportioned much as in the male but with segments five to eight broadly triangular, their apices nearly as wide as their length, segments nine and ten also broad but a little more parallel-sided, eleventh segment not longer than tenth, apex obtusely pointed. Pronotum broadly constricted at apex, sides obtusely subangulate at middle, base with lateral angles produced but not extending over elytral humeri;

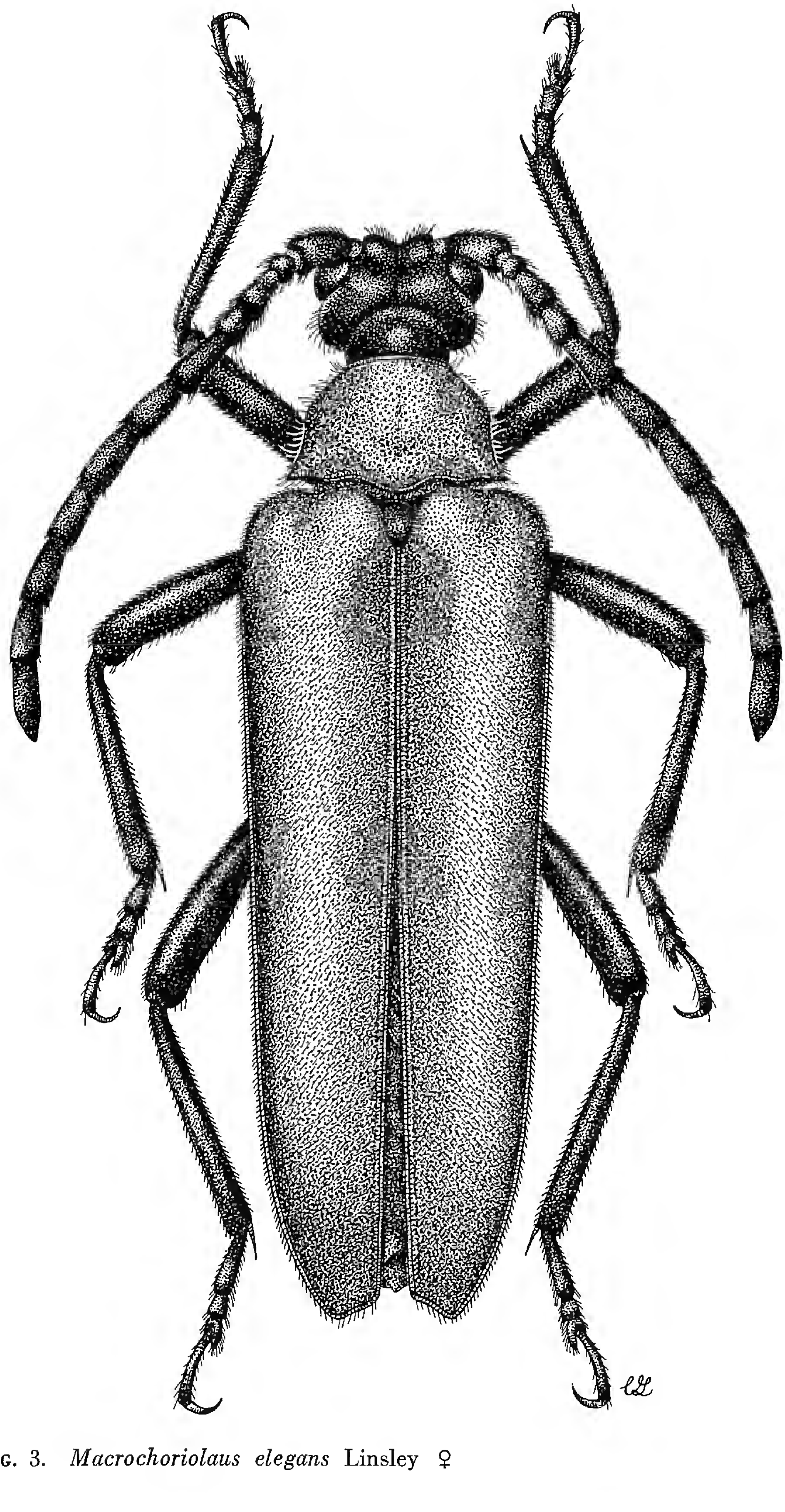

FIG. 3. *Macrochoriolaus elegans* Linsley ♀

prosternum with intercoxal process narrow, laminiform, coxae exerted, approximate; mesosternum with intercoxal process much narrower than coxae, submerged between them, arcuately declivous in front. Legs long and slender in male with posterior tarsi longer than tibiae, shorter in female with the posterior tarsi not as long as tibiae. Elytra subparallel, costate, apices separately rounded. Abdomen with last sternite broadly excavated in male, narrowly so in female.

TYPE OF GENUS: *Platerosida howdeni* Linsley

The species upon which this genus is based bears a remarkable superficial resemblance to "*Euryptera*" *huachucae* Schaeffer from southern Arizona and "*E.*" *chihuahuae* Bates from the western Chihuahua (probably all three have the same or similar small dark lycid models). However, the highly modified antennae, particularly in the female, readily distinguish it from these and other members of the *Choriolaus-Strangalia* complex.

Platerosida howdeni Linsley, new species

(Fig. 4)

MALE.—Body black, opaque. Head with neck finely, densely punctate, punctures larger at sides, pubescence sparse, suberect, golden; vertex minutely, densely punctate and pubescent, with few scattered long erect hairs; eyes fringed with long, suberect golden pubescence; genae below eyes finely densely punctate and pubescent; antennal supports densely punctate, triangular area above clypeus shining, glabrous; labrum finely punctate; antennae with first four segments finely, discretely punctate and clothed with coarse suberect black setae, segments five to eleven minutely densely punctate, densely clothed with minute, erect pubescence. Pronotum with anterior constriction more or less rugosely punctate, disk finely and very densely punctate, punctures larger on median basal lobe; entire surface densely clothed with moderately long erect black pubescence with few scattered very long hairs at sides; pro- and mesosternum finely densely punctate, metepisterna punctate throughout. Elytra about three times as long as basal width; surface very densely punctate, punctures slightly larger than those of pronotum, interspaces minutely tessellate; pubescence depressed but not recumbent; apices obliquely rounded. Abdomen with sternites densely punctate, thinly clothed with rather long, suberect hairs; last sternite coarsely punctured at base and sides of excavation which is elevated at the sides, deeply concave, shining and involving most of apex of segment, lateral angles prominent, produced. Length, 11.5 mm, breadth 3 mm.

FEMALE: Form slightly broader; abdomen with last sternite shallowly, triangularly impressed, apex subtruncate, lateral angles not prominent. Length 12 mm, breadth 3.5 mm.

Holotype male from 10 MILES WEST OF EL SALTO, DURANGO, MEXICO, 11 July 1964 (H. F. Howden), allotype female from P. Buenos Aires, 37 miles west of El Salto, Durango, Mexico, 1 July 1964 (H. F. Howden) and one male paratype from 10 miles west of El Salto, Durango, Mexico, 9000 ft. (W. R. Mason) and a female paratype from 3 miles west of El Salto, Durango, Mexico, 9000 ft. (J. A. Powell). The holotype and

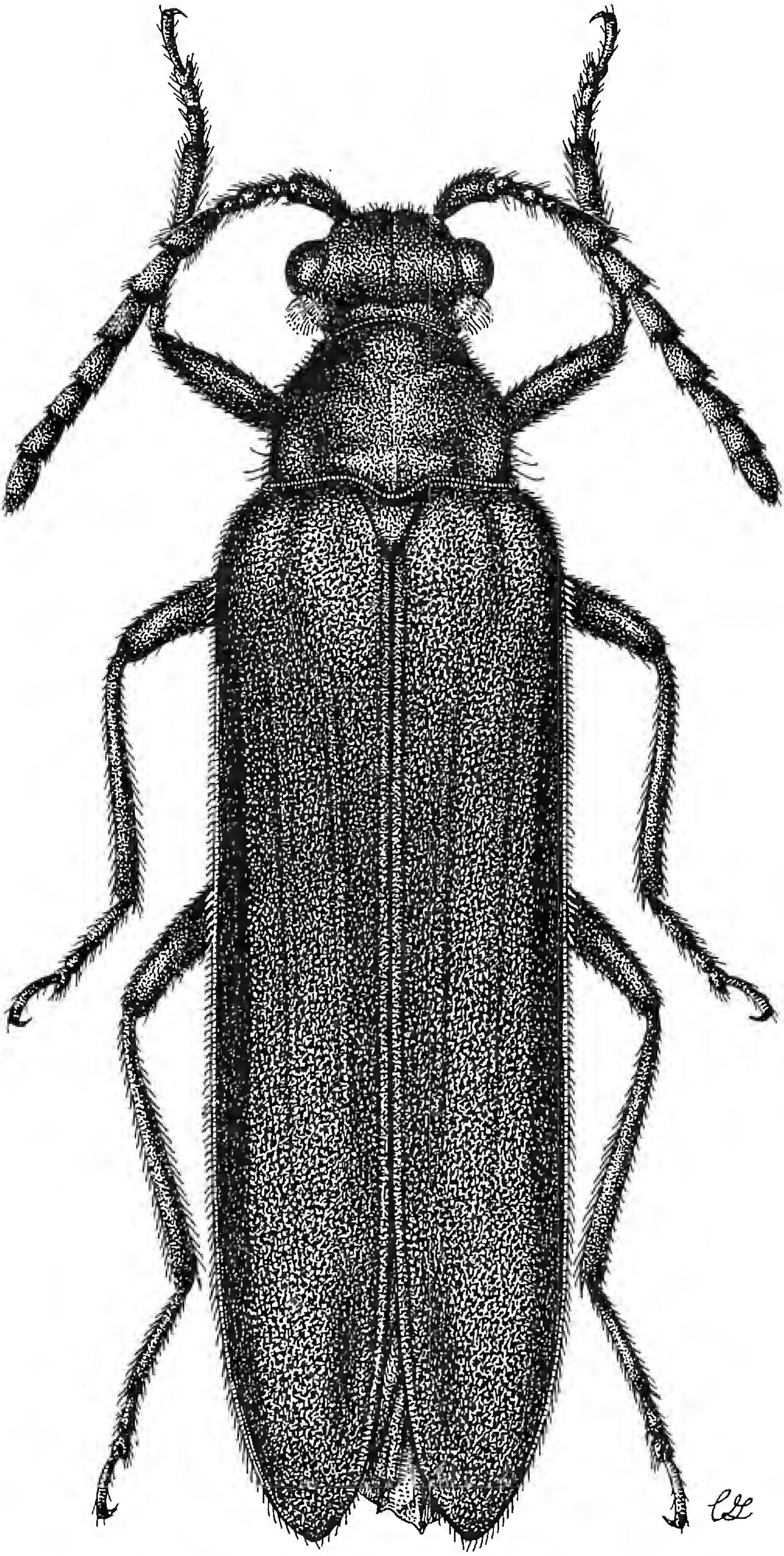

FIG. 4. *Platerosida howdeni* Linsley ♀

allotype are deposited in the Canadian National Collection, the two paratypes in the collection of the California Insect Survey, University of California, Berkeley.

Choriolaus sulcipennis Linsley, new species

MALE.—Form elongate; elytra gradually expanded posteriorly before rounding to apices; integument black, head in part, pronotum at sides, and basal one-half of elytra reddish-orange, vertex brownish; pubescence golden on reddish-orange areas, otherwise black. Head with vertex convex, with median longitudinal line extending toward base of clypeus, surface brownish, very finely densely punctate, clothed above with fine, short, erect golden pubescence; face densely punctate, antennal tubercles not prominent, antennal insertions not, or scarcely separated from upper anterior margin of inner lobe of eye; antennae reaching to middle of elytra, first four segments clothed with coarse suberect setae, fifth less so, outer segments minutely densely punctate and pubescent, with large, conspicuous apical poriferous area, scape subcylindrical, third segment subcylindrical but slightly thickened toward apex, a little shorter than scape, fourth segment shorter than third, fifth subequal to third, segments six to ten expanded externally, subserrate, successively shorter, eleventh segment distinctly longer than tenth, appendiculate, appendix conical, pale. Pronotum scarcely rounded at middle; surface opaque, finely, densely punctate but punctures much larger than those of vertex; pubescence fine, appressed; median dark area basally at least twice as wide as scutellum, equally wide at apex. Legs with posterior tarsi about as long as tibiae. Elytra about three and one-third times as long as humeral width; each longitudinally shallowly bisulcate, the sulcae separated by an obtuse, costa-like ridge; surface finely, densely rugoso-punctate, punctures much larger than those of pronotum, more or less transversely confluent; pubescence fine, suberect, not obscuring surface; apices rounded to external angle which is distinct but not acute. Abdomen shining, very sparsely punctate and pubescent, apex truncate. Length, 10 mm.

FEMALE.—Form a little shorter and broader than male; antennae surpassing basal one-third of elytra but not attaining middle, outer segments thickened but not apically expanded, poriferous areas not evident. Length, 8 mm.

Holotype male, allotype female and five paratypes (California Academy of Sciences) from CORDOBA, VERA CRUZ, MEXICO (A. Fenyes). An additional paratype from the same series is deposited in the collection of the California Insect Survey, University of California, Berkeley.

This species bears a very strong superficial resemblance to "*Euryptera*" *mimula* Bates which also occurs at Cordoba. However, it differs at once in the elongate, apically expanded, longitudinally sulcate elytra as well as in the apically expanded outer antennal segments of the male which bear large, conspicuous poriferous areas.

Choriolaus aurifer Linsley, new species

FEMALE.—Form moderately stout; elytra subparrallel, not expanded posteriorly before rounding to apices; integument golden yellow, vertex, eyes, antennae, longitudinal stripe on pronotum, scutellum, apices of femora, tibiae except at base, and tarsi in part, black or brownish. Head with vertex convex, with median longitudinal line extending to base of clypeus, surface brownish, very finely densely punctate, thinly clothed with fine appressed hairs, short and suberect above; face shining, antennal tubercles finely punctate, sparsely pubescent, frons with transverse impression at base of clypeus moderate, clypeus and labrum shining, moderately coarsely punctate; antennal insertion distinctly but narrowly separated from upper anterior margin of lower lobe of eye; antennae rather stout, extending a little beyond middle of elytra, first four segments with coarse suberect black setae, fifth with fewer, outer segments minutely densely punctate and pubescent, without poriferous areas; scape subcylindrical, third segment slightly enlarged toward apex, not shorter than scape, fourth segment shorter and thicker than third, fifth longer and thicker than fourth but shorter than third, segments six to ten stout but not expanded at apices, successively gradually decreasing in length and diameter, eleventh segment a little longer than tenth, appendiculate, appendage conical, pale. Pronotum moderately rounded at middle; surface finely, very densely punctate but not opaque, punctures larger than those of vertex, more or less transversely confluent, pubescence appressed, not dense but partially obscuring punctation, median stripe narrow, at base about one-half as wide as scutellum, at apex extending only to anterior constriction. Legs with posterior tarsi about as long as tibiae. Elytra less than two and one-half times as long as humeral width; surface densely, granulate-punctate, punctures very much larger than those of pronotum; pubescence fine, moderately short, depressed but not recumbent; apices rotundate-truncate, external angle acute. Abdomen shining, finely punctate and pubescent; last segment rotundate truncate, disk coarsely punctate, impressed before apical margin. Length 8.5 mm.

Holotype female (Department of Entomology, Cornell University), from EL LIMON, TAMAULIPAS, MEXICO, 9 June 1951 (H. E. Evans).

This species was taken at the same time and place as examples of "*Euryptera*" *mimula* Bates, and, in spite of the different facies and coloration, was at first assumed to represent a color phase of that species. However, in addition to the golden coloration, it differs in the shorter, stouter form and structure of the antennae, as well as details of punctation and pubescence. The posterior tarsi are unusually long for a female of this genus.

Choriolaus similis Linsley, new species

FEMALE.—Form moderately narrow; elytra subparallel, not expanded posteriorly before rounding to apices; integument golden brown, eyes, antennae, a longitudinal stripe on pronotum, apices of femora and apices of tibiae black. Head with vertex convex, with median longitudinal line extending to base of clypeus, surface very finely, densely punctate, clothed with fine, short, appressed pubescence; face shining, antennal tubercles finely punctate, sparsely pubescent; frons with transverse impression at base of clypeus moderate; clypeus and labrum shining, moderately coarsely punctate; antennal insertions distinctly but narrowly separated from upper anterior margin of lower lobe of eye; antennae moderately slender, surpassing basal one-third of elytra but not attaining middle, first four segments shining, with numerous coarse, suberect black setae, fifth with fewer, segments six to ten opaque, minutely densely punctate and pubescent, with distinct apical poriferous areas, scape feebly claviform, third segment barely shorter than scape, slightly enlarged apically and emarginate externally, so as to expose attachment of fourth segment, fourth segment shorter than third, apex wider than that of third, similarly emarginate externally, fifth a little longer than fourth, shorter than third, sixth with apex wider than that of fifth, seventh to tenth successively shorter and slightly narrower, parallel-sided, eleventh segment appendiculate, appendage conical, pale. Pronotum obtusely rounded at middle; surface finely densely, somewhat granulate-punctate, punctures larger than those of vertex, pubescence appressed, not dense but partially obscuring punctation; median stripe narrow, not wider than scutellum. Legs with posterior tarsi slightly shorter than tibiae. Elytra twice as long as humeral width; surface densely punctate, punctures very much larger than those of pronotum, more or less transversely confluent, pubescence fine, suberect basally, otherwise depressed; apices rounded to external angle which is distinct but not acute. Abdomen shining, finely, sparsely punctate and pubescent; last segment truncate, moderately coarsely but not densely punctate, shallowly impressed medially at apex. Length, 10.5 mm.

Holotype female (California Academy of Sciences) and one paratype female from TEMESCAL, OAXACA, MEXICO, 6 July 1965 (G. H. Nelson and family).

This species bears a strong superficial resemblance to *C. aurifer* Linsley in aspect and coloration. However, it is less stout, the ground color is golden brown rather than golden yellow, the outer antennal segments have distinct apical poriferous areas, and the external angle of the elytra is not acute. The female paratype differs from the holotype by having the median pronotal band wider and extending from base to apex (in the type it does not attain either), the scutellum black, thoracic sterna, abdominal sternites brownish black, except anterior femora, intermediate and posterior tarsi, metasternum at middle and the two subapical abdominal sternites, which are yellowish. None of these differences materially affect the superficial aspect of this individual as a presumed lycid mimic.

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Biology and Structure of the Dobsonfly, *Neohermes californicus* (Walker)

(Megaloptera: Corydalidae)

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During a study on the evolution of external insect genitalia and other appendages (Smith, 1969), 2 species of Corydalidae were reared or collected as adults for dissections. They were *Neohermes californicus* (Walker) and *Protochauliodes infuscatus* Caudell (= *N. nigrinus* Van Dyke, *teste* Chandler 1956). This paper reports observations on the behavior, rearing and external structure of these peculiar insects. Their genitalic anatomy will be covered in a separate article.

Relatively little has appeared on California Megaloptera. One of the most recent papers is on the biology of 2 species of western Sialidae by Azam and Anderson (1969). Among the most comprehensive works on corydalids are 2 master's theses discovered after completing my initial investigation: Maddux (1952) and Penland (1953). I have drawn upon them freely to flesh out the life histories.

REARING TECHNIQUES AND GENERAL BIOLOGY

Larvae of *Neohermes californicus* (Fig. 1), mostly in the final 3 instars, were collected by hand in shallow, stony creeks in the Chico (Butte County) area of California in April 1969. The small streams were drying up rapidly, and hellgrammites were most abundant at the ends of the creeks where the water sank into the riverbed and disappeared underground. The larvae were usually in shallow excavations under stones, but some were away hunting prey on the bottom and others were out of the water and burrowing into the damp volcanic sand of the banks to pupate. Collections of larvae were reared easily and continuously en masse in a plastic breadbox 32 cm L × 26 cm W × 11 cm D. The container was filled to a depth of 6 cm, the bottom littered with mud and stones, and open areas filled with aquatic plants. Aeration was provided by an aquarium air pump. Another breadbox of identical size was inverted over the water-filled one to maintain humidity and to prevent the restless insects from crawling out.

Azam and Anderson (1969) noted frequent cannibalism among larvae of *Sialis rotunda* Banks and *S. californica* Banks. Maddux (1952) and Penland (1953) reported similar behavior by the corydalids *Neohermes californicus* and *Protochauliodes* spp. yet I found no fighting

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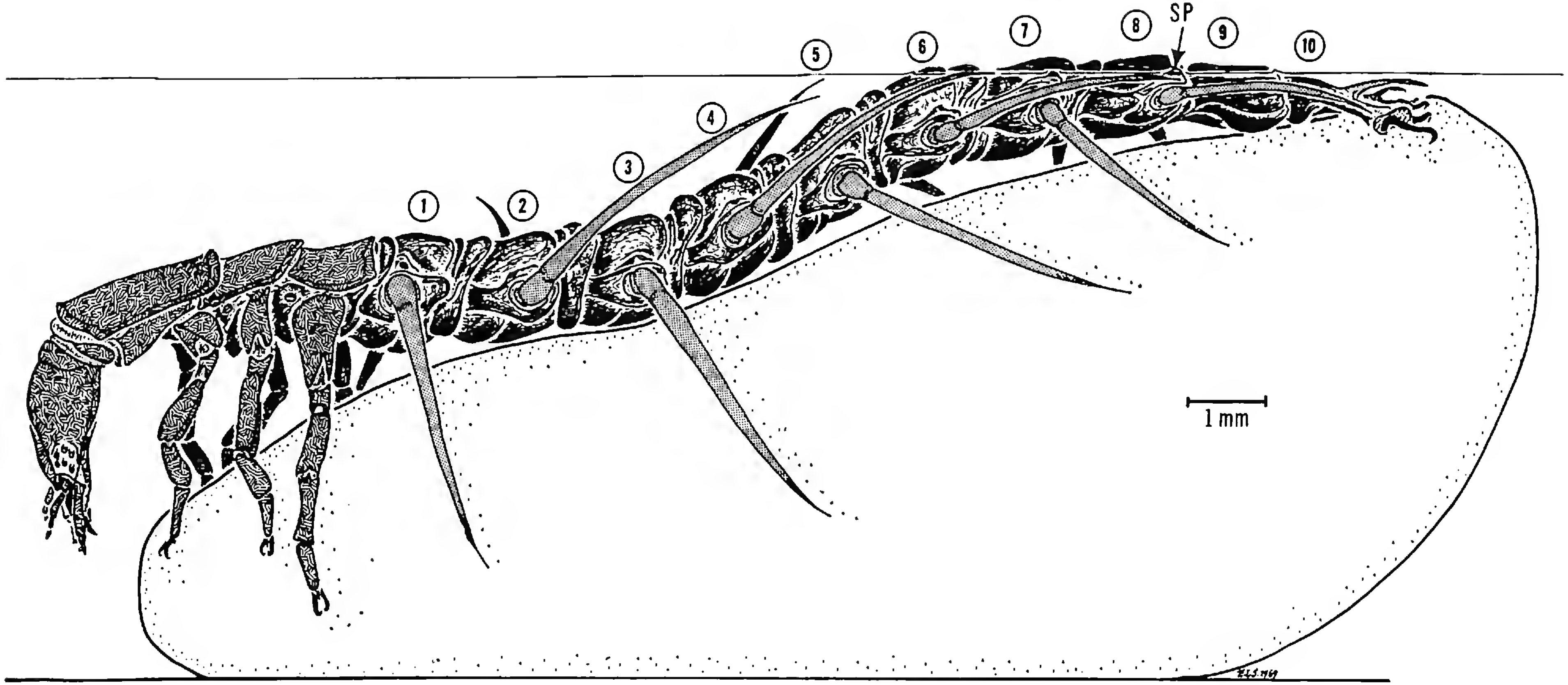


FIG. 1. Female last instar larva of *Neohermes californica* (Walker) (Megaloptera: Corydalidae) exposing spiracles (SP) of segments 7, 8 above the water (somites numbered in circles). Note alternating position of styli, and the gripping action of the claws on the cercal vesicles.

and but a single instance of cannibalism out of nearly 100 *N. californicus*, and this one took place in the crowded collection jar at the time of capture. There was no fighting or cannibalism among specimens in the laboratory, although more than 30 larvae of different sizes were kept together in less than a liter of water. A very pronounced avoidance reaction was always displayed between larvae, regardless of disparate size. This behavior, coupled with an excess of both refuges and food, was probably responsible for keeping the peace presumably normal in the natural environment.

Food consisted of mayfly and caddisfly larvae, small tadpoles, a few small sialids accidentally collected with the pollywogs, and chunks of raw beef about 1 cm in diameter. The hellgrammites not only readily accepted insects (alive or freshly killed) and meat offered them in forceps, but would actively hunt down such material when it was dropped into the tank. Food was seized with both jaws and front legs, then macerated sufficiently to be swallowed whole. This engulfing was observed in sialids by Azam and Anderson. It was very rapid in *N. californicus*, and meat of the size described was devoured in less than 5 min. by mature larvae.

In the middle of the plastic tank, a stainless steel pan 13 cm in diameter and 7 cm deep was filled to the top with a mixture of damp gravel, sand, clay and small stones. Mature larvae readily climbed up over rocks heaped around the pan, and excavated rapidly into the soil to build pupal chambers at varying depths. Maddux (1952) found most of his pupae under stones along the creek banks, but no larva reared in this study made a chamber beneath a rock. All hollowed out a small cavity, usually at the bottom of the pan. The container was emptied daily and larvae removed to 5-cm petri dishes containing some of the pupation medium. The petri dishes were labeled and kept in a darkened (but not light-tight) box. The soil was kept barely moist.

Out of 29 larvae allowed to pupate, an average of 13 days (range 7–20) elapsed from the time they entered the soil until pupal ecdysis. About 5 days before shedding, a larva would assume the characteristic comma-shaped prepupal resting position on its side, and take on an inflated, dropsical appearance. The styli shriveled. Towards the end of this period, the pupa could be seen beneath the prepupal integument. While usually quiescent, prepupae suddenly exposed to bright light would engage in violent activity, and often would vomit an extremely foul-smelling, dark greenish liquid. This defense is employed also by larvae when disturbed. The actual molting of the prepupa is very rapid (about 5 min.). The pupa emerged through the median dorsal slit in the thorax and head, assisted by thrusts of the anal legs (cerci) and wrenching telescopic motions of the abdomen. In 2 instances, the head capsule was incompletely cast, and the insects subsequently died when the adults attempted to emerge. Several females developed an intersegmental ventral abdominal hernia as they emerged from the prepupal integument. These abnormalities may have been rearing artifacts.

Freshly molted pupae were a light cream color, and quite active when disturbed. Not only were they capable of biting, but could struggle about using the cerci to push and steady themselves. About 9 days after emergence from the prepupa, pupae began to darken. The first rearings died in the closed petri dishes at this point, apparently from excessive humidity. Subsequent pupae were allowed to complete development in open petri dishes once the eyes had begun to darken. The soil upon which they rested was moistened slightly every few days. Regardless of treatment, the majority of males in all rearings died from an undetermined malady. The affliction was always heralded about 4 days before death by all wingpads becoming grotesquely distended with hemolymph, and taking on a roughly tubular appearance. No females were so affected.

Of 11 surviving specimens not dissected prior to adult emergence, the pupal period lasted for an average of 11 days (range 9–12) at about 25° C. There was no significant difference between the sexes. Maddux (1952) also found the average pupal period for 15 specimens of *N. californicus* and *Protochauliodes aridus* Maddux to be 11 days. Penland (1953) obtained the same data with rearings of *P. aridus.* Maddux managed to prolong pupation up to 40 days by placing specimens collected as pupae in a refrigerator at 4° C. Azam and Anderson reported pupal stages of but 4–6 days for their sialids.

Just prior to adult emergence, the pupa would crawl out of the open petri dish and wander about. The method of ecdysis was the same as that exhibited by the prepupa, and equally as rapid. One of the first acts of the still teneral adult was to void white, ill-smelling meconium.

Adult corydalids of indeterminate age caught in nature voided meconium when handled, and so did reared specimens up to 3 days after emergence. No adults were kept alive for longer than that, but Maddux (1952) maintained unfed adults 7–10 days in the laboratory. He obtained oviposition in 5 instances, all but 1 depositing their eggs on the exposed surfaces of flat rocks. He found a similar egg mass in the field, and described one from the laboratory as "roughly rectangular in outline, approximately 500 mm at its greatest length and 250 mm at its greatest width; it consisted of more than 3,000 white eggs arranged in a series of parallel rows, with the micropylar ends all facing the same direction. The mass was without any protective coating. Individual eggs were approximately 1 mm in length and 3× longer than wide. . . . the micropylar projection was similar to that seen in the eggs of various sialids." This description was for *P. aridus*, and closely approximates the pattern of *Sialis californica* shown by Azam and Anderson in their figure 2B. The naked condition of the eggs is interesting. The adults of at least *N. californicus* and *P. aridus* emerge only after the small creeks they inhabited as larvae have dried up. Maddux (1954) noted that the adult females of at least the latter species deposited their eggs on stones in the dry creek bed.

Last instar larvae removed from the water before they had voluntarily come out to pupate would go into an inactive state. If returned to the tank within 2 weeks, they developed normally. After that time, however, they shriveled and eventually died. Given the intermittent nature of many of the creeks various California corydalids inhabit, I suspect larvae may bore into the mud when the stream temporarily dries up.

Estivation of newly hatched hellgrammites is the rule with *P. aridus*, and probably with *N. californicus*. Maddux (1954) reported that the larvae after eclosion immediately burrowed down into the gravel of the dry stream bed to await the winter rainy season. It was his fellow worker Penland (1953) who apparently worked out the details. Penland found abundant egg masses of corydalids deposited during late May and early June upon the downstream faces of relatively large, flat stones in well-sheltered areas of dry creek channels in the foothills around Chico. The eggs hatched in 7–10 days, and the larvae dropped down onto the soil and excavated 4–12 inches into it. They made small cells beneath stones, and remained there until the streams flowed once more (usually by November in the Chico area). When he removed larvae to a completely dry environment, they died in 3–4 days, so the estivation site must retain a minimal humidity even during the most scorching summer days (ground temperatures in the vicinity of Chico often surpass 55° C). The larvae emerged from their cells about a week after water reappeared. The only species mentioned in this context was *P. aridus*. Estivation is apparently not obligatory, since hatchlings will accept food. Penland reared *P. aridus* in a novel way: he kept them individually in damp soil (rather than in water), and fed them termites.

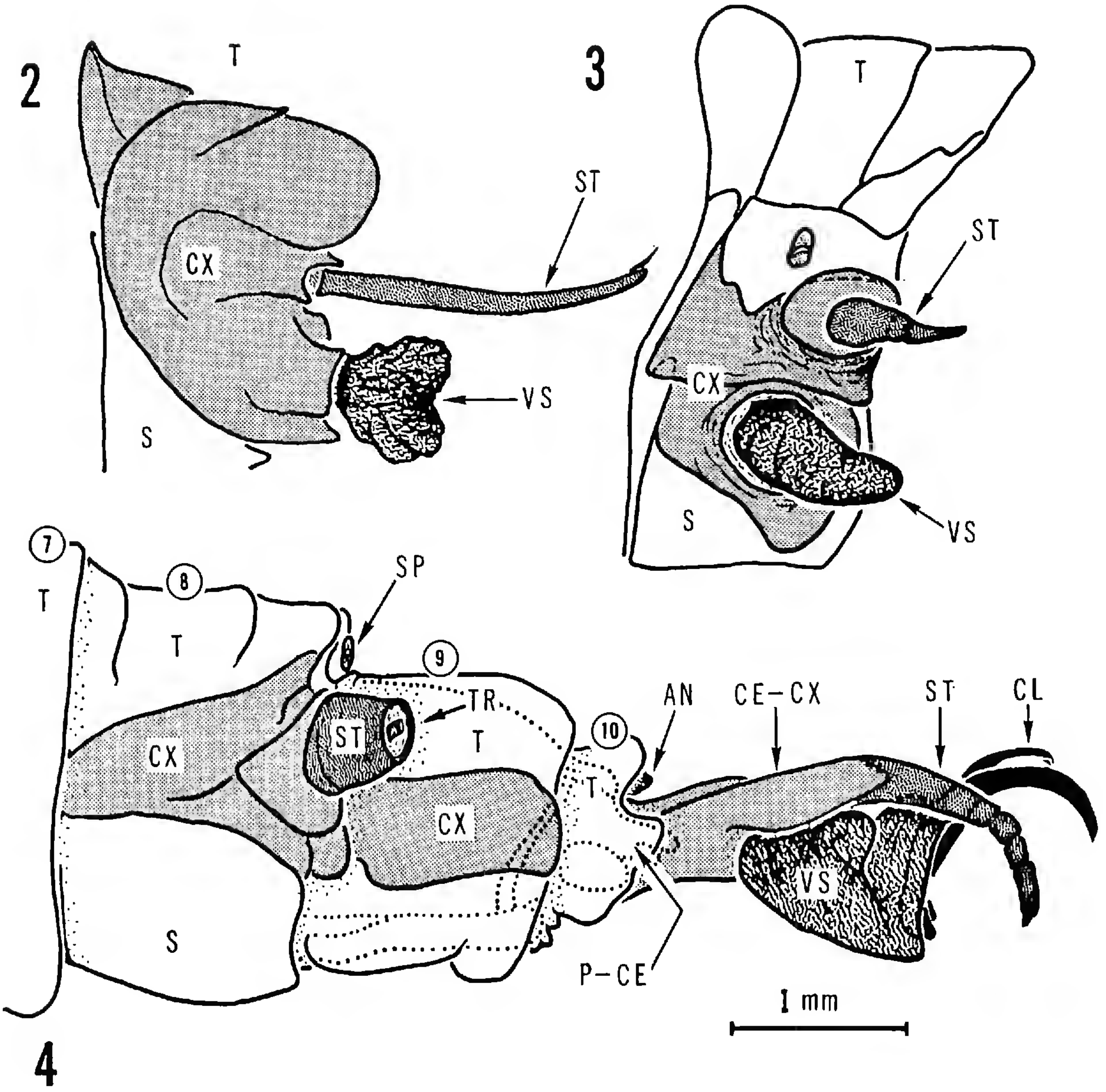
I suspect *N. californicus* has a similar life cycle: adults emerged only after the streams had dried, and there were only mid- to late-instar larvae present in early spring of the following year, which larvae reached adulthood by June. Indeed, this life history pattern seems likely for most or all California Corydalidae. Whether hellgrammites in late instars can rest for extended periods in an emergency (e.g., premature drying out of their creeks in spring, requiring estivation) as do hatchlings (and thus take 2 years to develop) is not known, but does seem unlikely.

Adults of *N. californicus* and *Protochauliodes infuscatus* were netted a few miles from where larvae were collected. The appearance of adults in nature corresponded with the emergence of reared material. What may have been a mating swarm of *P. infuscatus* was watched from about 1330–1430 (PST), 23 May 1969. Over 15 males were flitting about some distance apart 0.5–3 m above the grass. The area was a hillside clearing about 100 m square, immediately downwind to a rivulet, and there was an almost continuous overstory of valley oak (*Quercus lobata* Née). Only 1 female was discovered in the vicinity. The insects vanished as abruptly as they had appeared. Similar flights, but composed of but 2 or 3 individuals (all male), were noted in adjacent areas of similar ecology. This diurnal activity of adult *P. infuscatus* also has been noted by Chandler (1956).

USE AND STRUCTURE OF ABDOMINAL STYLI AND TERMINAL APPENDAGES

Unlike *Corydalis cornutus* (L.), larvae of the much smaller far-western corydalids normally lack the vesicles borne ventrally on abdominal coxites I–VI. These permanently everted sacs, the apparent coxal endites (the lateral styli on abdominal segments I–VIII are the telopodites, or legs themselves), have cuticular tufts in *C. cornutus*, and serve a respiratory function. On the flank of one female *N. californicus* pupa, however, I found a permanently everted vesicle (VS, Fig. 3) having not only the appearance, but the primitive laterodistal orientation of both the gonapophyses (endites of the genital segments: VIII, IX) and eversible vesicles of Apterygota (Fig. 2). The slightly recurved appendage was filled with fat body.

The lateral abdominal styli of Megaloptera have very thin cuticle, and contain a large median tracheal trunk (Fig. 4, TR), which gives rise to numerous smaller branches in no obvious sequence among Corydalidae. The styli are more or less rigid, their shape being maintained by blood pressure. While gas exchange in larvae undoubtedly takes place across the entire integument, the principal sites of transfer are the styli. The retention of vesicles and the still further increase in exchange surface by hollow cuticular extensions from them in *Corydalis cornutus* but not in other corydalids is probably related to the much



FIGS. 2–4. FIGS. 2, 3. Comparison of the abdominal coxite, stylus and vesicle of an adult machilid (2) with the apparent homologs of a female *Neohermes californica* pupa (3). The permanently everted vesicle (endite?) found on segment IV of this particular Megaloptera specimen is atavistic in this genus, and not normally retained. The 1 or 2 vesicles of the microcoryphian coxite are everted by blood pressure and retracted by coxal muscles, and employed to sponge up water from damp surfaces. FIG. 4. Terminal segments (numbered) of moulting male *Neohermes californica* prepupa; the pupa within is outlined. The left cercal coxite bears a ventral vesicle armed with paired claws, and a dorsal, segmented (?) stylus. At this stage, the pupal appendages have pulled away from the prepupal integument, and the cercal claws have retracted. ABBREVIATIONS.—AN, anus; CE-CX, cercal coxite; Cl, claw; CX, subcoxal-coxal plate (s. lat: = pleuron); P-CE, pupal cercus; S, sternite; SP, spiracle; ST, stylus (= telopodite); T, tergite; TR, trachea; VS, vesicle (= endite?). The scale in Figs. 3 and 4 is the same.

larger size of the former, and resultant smaller ratio of surface area to body volume. Larval styli also have a sensory function. As the hellgrammite creeps about, the pairs of one segment are held at an angle over the body, while those of the next set are angled below it, and so on alternately (Fig. 1). The styli also help to orient the insect in crevices.

While there are no styli on segment IX (here replaced by the gonostyli, which appear externally only in the imago), the invaginated composite segment X–XI bears a pair of 2-part appendages. Ventrally, each terminates in a vesicle armed with paired retractile claws (Fig. 4, CL). A pseudosegmented stylus (ST) homologous with styli on preceding abdominal segments recurves about each vesicle from the cercal coxa (CX-CE). The mobile, clawed vesicles thrust the larva forward much as do the homologous pair ("pygopods") of Mecoptera, Hymenoptera and Lepidoptera caterpillars. The appendages also serve to anchor and maneuver the larva in the current as do the corresponding anal hooks of Trichoptera immatures. These terminal larval appendages in the instances cited above give rise to the pupal and adult cerci (Fig. 4, P-CE). Both pupal and adult corydalids use the cerci to assist in moving as do the larvae, and employ the same vigorous telescopic contractions of the abdomen. Cercal mobility in the pupa and adult, however, is restricted largely to adduction.

The abdominal styli which precede the cercal styli in the larva are retained by the pupa as small, conical, musculated coxal rudiments (Fig. 3, ST). They are capable of slight movements. The homologous coxal plate of the ephemerid subimago (which marks the site of the nymphal abdominal styli—also respiratory in function) is capable of similar twitching. The precercal styli of the adult corydalid are mere dorsolateral nubbins, although recognizable as limb bases.

While the abdominal styli serve as the primary respiratory devices in young Megaloptera larvae, the most posterior abdominal spiracles become functional in later instars of corydalids. The spiracles are dorsolateral, just above and mesal to either stylus, and present on abdominal segments I–VIII (and also on the meso- and metathorax). Under the stimulus of low oxygen tension in laboratory rearings, mature larvae back up to the surface and expose at least the most caudal set of abdominal spiracles (Fig. 1). According to Chandler, the still—stagnant water-inhabiting corydalid, *Nigronia*, bears the last pair of spiracles on short, individual extensions. The similar tubes of *Chauliodes* actually extend caudally beyond the body. These behavioral and structural modifications probably represent the respiratory patterns antecedent to the evolution of the complex terminal breathing tube (derived from the caudal segments and a posterior migration of the 8th set of abdominal spiracles) so characteristic of aquatic larvae in the phylogenetically more advanced Coleoptera and Diptera.

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NEW BIOLOGICAL CONTROL ORGANIZATION

This is a brief report on a meeting convened by IUBS at Amsterdam, November 17–19, 1969 to finalize plans for the proposed new 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 above (IOBC), were consummated at Amsterdam in November, as far as could be done at the time. 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.

The following slate of candidates for the Executive Committee of the proposed new Council of IOBC was recommended by unanimous vote of the delegates in Amsterdam:

Paul DeBach, President
E. Biliotti, Vice President
Frank Wilson, Vice President
Vittorio Delucchi, Secretary General
Fred J. Simmonds, Treasurer

A fuller statement of the meeting in Amsterdam and of the aims and functions of this new organization, and the progress of developments in other respects is being published in The Bulletin of Entomological Society of America, to which interested parties are referred. Such interested parties should contact any of the above slate of candidates, or for the United States, Dr. Reece Sailer.—C. B. HUFFAKER, *University of California, Albany.*

SCIENTIFIC NOTE

Examples of convergence between blister beetles of California and others from Chile (Coleoptera: Meloidae).—Collections of meloid beetles from desert areas of western Chile have been made available by their collectors (E. I. Schlinger, M. E. Irwin, and L. A. Stange). Their close morphological similarity to Californian genera and even individual species is remarkable, and it is hoped that further knowledge of the adult and larval morphology and foods will permit a more satisfactory determination of their phylogenetic affinities.

As suggested in Selander's (1960, Ill. Biol. Monogr., No. 28) monograph of the genus *Lytta*, the South American species (currently assigned to that genus) may be new genera and may only be named, as at present, due to convergence rather than close relationship. Certainly, all of them fall within the current definition of the genus *Lytta*. One (new and undescribed wingless species) might be comparable to the wingless genus *Poreospasta* in North America which was placed in the genus *Lytta* by MacSwain (1956, Univ. Calif. Publ. Entomol., 12). In the same paper, *Poreospasta polita* Horn [= *Lytta* (*Poreospasta*) *sublaevis* (Horn)] was placed near *L. auriculata* Horn on the basis of comparative larval morphology. Edwards (1951, Pan-Pac. Entomol., 27:44) in a short note recorded one pair of these two species in copulation.

Other genera and species (undescribed, probably) are even more remarkable in that they superficially resemble members of the North American Tribe Eupomphini [= Calospastini according to MacSwain (1956)] but when viewed under the highest magnification are clearly members of the Lyttini. One looks amazingly like our *Cysteodemus armatus* LeConte (or like *Gynaecomeloe* females); while another looks like many of our species of *Eupompha* [= *Calospasta* according to MacSwain (1956)]. Yet the first mentioned has the short tarsal spine free at the base and the other a long tarsal spine. These species represent additional examples of extreme convergence in this family as previously shown for *Hornia* in North America and *Allendesalazaria* from North Africa by Linsley (1942, Univ. Calif. Publ. Entomol., 7: 169–188) and confirmed by further data revealed by MacSwain (1956).

In all of the examples referred to above, the structures may eventually be correlated with very similar habits and environments.—J. W. MACSWAIN, *University of California, Berkeley.*

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BOOK REVIEW

CURCULIONIDAE SUBFAMILY APIONINAE OF NORTH AND CENTRAL AMERICA WITH REVIEWS OF THE WORLD GENERA OF APIONINAE AND WORLD SUBGENERA OF APION HERBST (COLEOPTERA). By David G. Kissinger. Taxonomic Publications, South Lancaster, Massachusetts. 559 pages, illus. 1968. $20.00.

In this revision of Apioninae, Kissinger has once again accomplished a monumental task. The large number of species and small size of most of the individuals make this a taxonomically difficult group. Included are keys to all 28 genera and the males of the 13 subgenera and 317 species. There are 221 pages of figures and maps of species distribution. The many diagnostic photographs of generic, subgeneric, and specific features, frequently including the male genitalia, aid greatly in the identification of specimens. Some of the keys are difficult to use and even weevil specialists will find many *Apion* are not easy to identify.

The subgeneric key and many of the specific keys are to males only, and it is rather difficult to sex *Apion.* The list of male secondary sex characters is complex and the small size of *Apion* complicates matters. A separate plate illustrating these secondary sex characters would have aided the reader. Except for the difficulties concerning the secondary sex characters, the sections on technique and the discussion of taxonomically valuable structures of the adults are well written.

There are lists of the genera and subgenera not available for study, the 12 species known only from females, and the 6 species not recognized. There are indices to all taxonomic categories covered in the paper; to the new taxa, new combinations, and new synonymies; and to host and associated plants. One minor omission noted is the lack of symbols for three species in the "Key to Symbols" for figure 188, and two species in figure 190, maps of species distributions.

This publication, though difficult to use, has drawn together in one place much widely scattered data and has added a great deal of new information. It is essential to anyone who wishes to identify Apioninae from North and Central America.—CHARLES W. O'BRIEN, *Purdue University, Lafayette, Indiana.*[1]

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[1] Present address: Texas Tech University, Lubbock.

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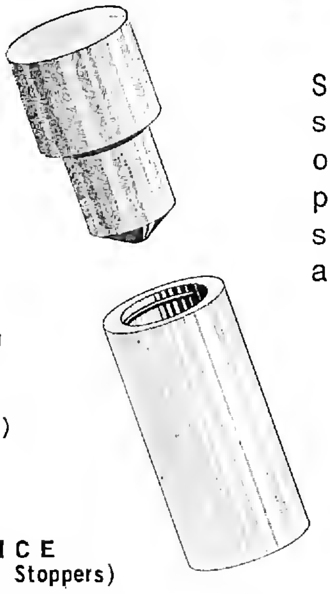

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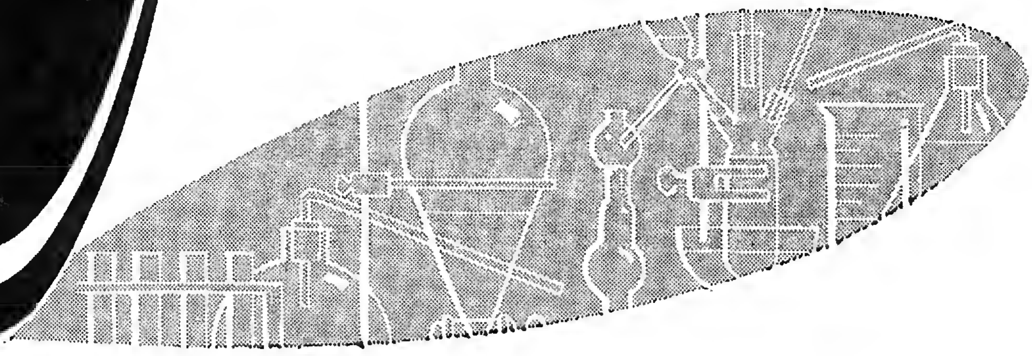

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Vol. 46 JULY 1970 No. 3

THE PAN-PACIFIC ENTOMOLOGIST

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The Pan-Pacific Entomologist

Vol. 46 July 1970 No. 3

A Revision of the Genus *Leptoschema* of California with a Key to Related Genera

(Coleoptera: Elateridae)

Jeffrey N. L. Stibick[1]
Arlington, Virginia

The comparatively rare elaterid genus *Leptoschema* possesses a striking appearance which brought it to my attention several years ago. In the course of this study it eventually became clear that this group is properly placed in the Pomachiliini and not in the Denticollini where it is currently listed. In addition, examination of available specimens shows that a closely related complex of two species and four subspecies exists throughout California. The results of the investigation are presented in this paper.

I wish to express my appreciation to Miss C. M. F. von Hayek, British Museum of Natural History (BM), who has assisted me through her determinations of Chilean material in several genera of Pomachiliini and discussed some diagnostic characters separating *Leptoschema* and *Deromecus*. Mr. Hugh B. Leech, California Academy of Sciences (CAS), kindly presented critical material, including the type of *L. protractum* variety *elegans* Van Dyke, and provided indispensable information on certain obscure localities. Thanks must also be expressed to Mr. T. J. Spilman, U. S. Department of Agriculture (USNM), for the loan of specimens; Prof. R. L. Fischer, Michigan State University (MSU), for much of the Chilean material examined in this study; Dr. John Lawrence, Museum of Comparative Zoology, Cambridge, Mass. (MCZ), for specimens; and Dr. N. D. Jago, Philadelphia Academy of Sciences (PAS), for permission to see the lectotype of *L. protractum* (Horn). Finally, I appreciate the efforts of Drs. C. W. and L. B. O'Brien, Purdue University, for collecting several species of *Deromecus* and *Medonia* during a recent visit to Chile.

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The Pan-Pacific Entomologist 46: 153–166. July 1970

POMACHILIINI Candèze

Pomachiliites Candèze, 1859, p. 4; 1860; 1891.

Pomachiliini, Champion, 1895, p. 402; Schwarz, 1906; Heyne and Taschenberg, 1908.

Pomachiliinae, Schenkling, 1925, p. 189.

Pomachilinae, Laurent, 1965, p. 249. (Misspelling)

Head.—Mouthparts inferior; frons more or less vertical with distinct and moderate to feebly arcuate carina between eyes, carina well separated from labrum; antennae filiform to serrate; posterior part of eyes more or less covered by pronotum.

Thorax.—Prothorax anteriorly somewhat broader than before base; prosternum moderately lobed anteriorly, prosternal sutures double, often excavate anteriorly; scutellum truncate anteriorly, noncordiform. Mesosternum separated from metasternum by distinct suture; mesepisternum very narrowly open to mesocoxae, touching mesotrochantin; mesocoxal cavities well separated from each other. Metepimeron narrow. Legs with normally thickened femur and tibia (neither compressed nor broadened towards the tip) ; tarsi simple or fourth broadened and cordate or fourth very small and third broadened or lobed; first hind tarsal segment from nearly as long as segments two and three to sometimes longer than two, three and four; claws of all legs simple.

Abdomen.—Five visible segments.

Leptoschema, when first described by Horn (1884) was placed in Candèze's tribe Athoites. *Agriotes protractus* Horn was removed from the Agriotini and designated as type species of *Leptoschema*. Horn, however, made special note of the resemblance of *A. protractus* to a figure of *Psiloniscus borborurus* Candèze, which occurs in Mexico (Cordoba, Veracruz). Apparently there were no further efforts to investigate any relationship to the Pomachiliini. Candèze removed it to his Ludiites in 1891, associating it with *Oxygonus* and *Agriotes*, both now in the Agriotini. Schwarz (1906) moved it back to his Athouini (later the Athouinae), and Arnett (1962) put *Athous* and *Denticollis* in the same tribe (the Denticollini) with *Leptoschema* and other genera. However, Van Dyke (1932), among other things, said that *Leptoschema* was somewhere near *Sericus* (now in the Elaterini) and not far from *Agriotes*. He pointed out that the short, free, elevated clypeal margin and gradually dilated metacoxal plates separate it from the Athoini (now Denticollini). The chief reason for confusion as noted by him was Horn's provisional inclusion of *Athous bicolor* LeConte and *Athous discalceatum* (Say). These species do belong in the Athouini, differing from *Athous* chiefly in the double prosternal sutures, and he reestablished Reitter's *Elathous* (placed in synonymy under *Leptoschema*) which was based on congeneric European species. Most European references to *Leptoschema*, then, actually refer to members of this genus.

It is unfortunate that neither Drs. Horn or Van Dyke carried their inquiries further. But during my investigation of *Leptoschema* I ran across numerous examples of various genera of Pomachiliini from Chile, all in the collection of Michigan State University. Struck by the extremely close affinities between *Leptoschema* and especially *Deromecus* species in the first section of that genus, I sent a number to Miss von Hayek, who confirmed their generic placement and established some specific identifications, based on material in the British Museum. Later, fresh Chilean material was received from the O'Briens. The general facies and other characters mentioned by Dr. Van Dyke, as well as features given in the tribal description, leave no doubt on systematic placement of *Leptoschema* in the Pomachiliini.

Since first proposed by Candèze, the Pomachiliini have been lately elevated to subfamilial status. It seems to me that this is undesirable, for there are strong relationships between this group and the Agriotini. Consequently, I am retaining the Pomachiliini as a tribe of the Elaterinae very near those Agriotini known as *Dalopius*, and the criddlei group of *Agriotes*.

The name Pomachiliini is not new to North America (north of Mexico). For a long time it was believed that one genus, *Betarmon*, was represented in this area by *Betarmon californicus* Schaeffer and *B. bigeminata* (Randell). Brown (1933) put these species in a new genus, *Agriotella*, which he placed near *Agriotes* and *Dalopius* (Agriotini). Later Arnett (1968) put *Agriotella* in the Ampedini. While there are strong reasons for keeping *Agriotella* in the Agriotini, I do not wish to do more here than note that this genus need not be considered where the Pomachiliini are concerned. Reestablishment of this tribe in the United States is hence based on *Leptoschema*, which may be likened to a northerly extension of the Pomachiliini into our area from Mexico.

LEPTOSCHEMA Horn

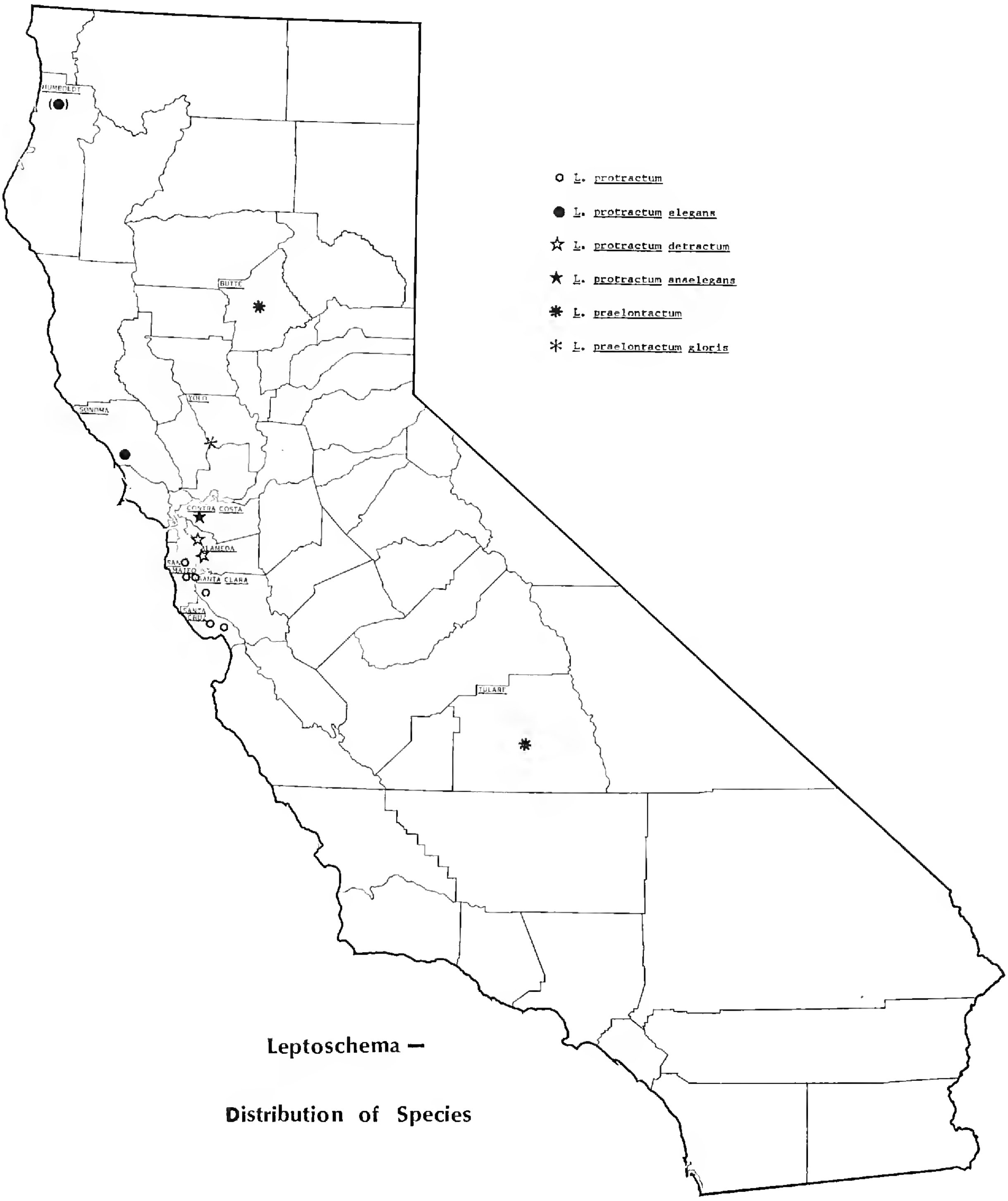
Leptoschema Horn, 1884, p. 50; Candèze, 1891, p. 200; Schwarz, 1906, p. 196; Schenkling, 1925, p. 303; Van Dyke, 1932, p. 356; Arnett, 1962, p. 506.

Head.—Mouthparts inferior; head convex, deeply inserted; frontal ridge moderately arcuate; eyes relatively small; antennal segments IV to X distinctly longer than wide, II and III segments subequal in length, together about equal to IV.

Thorax.—Prothorax anteriorly broader than before base; pronotum medially convex, more or less broadly and shallowly concave laterally; hind angles prolonged and acute; prosternal sutures double, distinctly curved inwards, feebly excavated in front, inner carina narrow and thin; prosternal mucro slender and straight. Mesosternum moderately declivous, margins of fossa feebly raised in front. Elytra obtuse at tip. Metacoxae rather narrow, gradually dilated inwards, inner angle very obtusely toothed at best. Tarsi simple, segments I to IV decreasing in length, hind tarsal segment I subequal in length to segments II and III.

This genus is very closely related to *Deromecus*, especially to those species forming the first group of the latter. *Deromecus impressus* (Solier), in fact, is a close copy of *Leptoschema protractum elegans* Stibick. A specimen of this species from Trovolhue, Chile (MSU) was at first thought by me to be in or near *Leptoschema.* Miss von Hayek, who identified it, pointed out that both this specimen and the type species of *Deromecus, D. angustatus* (Solier), differ from *Leptoschema protractum* as follows: *Deromecus*—prosternal suture strongly grooved anteriorly and accompanied for ⅓ of its length by smooth area on prosternum, prosternal mucro turned inward behind mesocoxae, mesosternal groove with raised border, and metathorax with lateral groove; *Leptoschema*—prosternal suture feebly grooved anteriorly without smooth area on prosternum, prosternal mucro straight, mesosternal groove with only feebly raised border at best, and metathorax without lateral groove. In addition, the female and male genitalia of *Deromecus* (Figs. 2–3) show some differences when compared with those of *Leptoschema* (Figs. 6–12). All these seem sufficient for separate genetic identity, the most important of which is the prosternal mucro. *Leptoschema,* due to its curved and grooved prosternal sutures, elongate antennae, and close affinity to *Deromecus,* may be placed near the latter genus and *Parapomachilius.* It is not particularly close to the aforementioned *Psiloniscus* which has (among other things) straight and closed prosternal sutures. In geographical terms it is of interest to note that its close relative *Deromecus trivittatus* Champion (group one of Candèze) occurs in Oaxaca, Mexico, and that *Paranius mexicanus* Champion is known from Ciudad, Durango, Mexico.

Leptoschema is presently known only from California (Map 1). The specimens included in this study were collected between May and October, with no indications that any of the species or subspecies appear at any particular times. This paper greatly extends the known range, including a previously unsuspected southward extension to Tulare County. It is apparent that the various species and subspecies have more or less well separated ranges arrayed east-west and north-south with an important division of the subspecies of *L. protractum* in the San Francisco Bay area. The reasons behind this pattern are not clear, but it is remarkable that only one of the 35 specimens I have seen is a female. This disparate sex ratio may be significant as a clue to speciation and the present geographical arrangement of species and subspecies.



MAP 1. Distributions of *Leptoschema* species.

The role of San Francisco Bay, San Pablo Bay, and other physical obstructions as barriers, assumes more importance in this light, but it should be added that both male and female are fully alate.

KEY TO THE SPECIES OF LEPTOSCHEMA

1. Body solid brown; pronotal punctures shallow and close but not nearly confluent (Fig. 4); middle California .... *praelontactum* Stibick, n. sp. 2

   Body bicolored, pronotum darker than elytra or with median dark vitta; pronotal punctures deep, nearly to sometimes confluent (Fig. 5); Coastal and San Francisco Bay area .... *protractum* (Horn) 3

2. Antennae reaching two segments behind hind angles of pronotum .... *p. praelontactum* Stibick, n. subsp.
Antennae scarcely attaining apex of hind angles of pronotum .... *p. gloris* Stibick, n. subsp.
3. Pronotum uniformly dark or with very faint median vitta; east and west of San Francisco Bay, south of Golden Gate 4
Pronotum with prominent median vitta, sides and elytra reddish-brown; north of Golden Gate and south of San Pablo Bay 5
4. Along coast west and south of San Francisco Bay; aedeagus of moderate length, without clear area at apex of paramere (Fig. 8); shorter (12–13 mm) .... *protractum* (Horn)
Alameda County east of San Francisco Bay; aedeagus long and slender, basal piece with notch in internal edge (Fig. 9); longer (14 mm) .... *p. detractum* Stibick, n. subsp.
5. North of San Francisco Bay along coast; aedeagus of moderate length, with clear spot at apex of paramere (Fig. 10) .... *p. elegans* Stibick, n. subsp.
Contra Costa County, south of San Pablo Bay; aedeagus long and slender, basal piece V-shaped along internal edge (Fig. 11) .... *p. analelegans* Stibick, n. subsp.

LEPTOSCHEMA PROTRACTUM (Horn)

(Figs. 1, 5, 8)

Agriotes protractus Horn, 1871, p. 317; 1884, p. 50.

Leptoschema protractus (Horn); Schwarz, 1906, p. 197; Heyne and Taschenberg, 1908, p. 159; Schenkling, 1927, p. 303. (Error)

Leptoschema protractum (Horn); Horn, 1884, p. 51; Candèze, 1891, p. 200; Van Dyke, 1932, p. 356.

Readily recognized by the deep and close, coarse punctation, bicolored appearance, and male aedeagus.

MALE.—Length 12 mm, width 2.9 mm, shape elongate, scarcely convex; color black to brownish-orange, generally bicolored with the pronotum pitchy black and the elytra and sometimes the abdomen and legs brownish-orange; punctation unisetigenous, coarse and very dense, finer on venter; surface generally rough on pronotum, smoother and more lucidus elsewhere; vestiture moderate, lightly flavous, wiry and decumbent.

Head.—About ⅝ as long as wide, nearly ¾ median width of pronotum; front arcuate at vertex, otherwise vertical; punctures large, vaguely hexagonal and nearly confluent. Antennae reaching one segment beyond pronotal hind angles, scape cylindrical, as long as pedicel and III segment combined; the latter short, feebly cylindrical and compressed; IV to XI segments each nearly twice length of preceding two, moderately serrate, save oblongly slender eleventh.

Thorax.—Median width/length as 6.25/9.25; sides straight, scarcely arcuate at apex, feebly arcuate along hind angles; hind angles very prominent, prolonged and acute, sides continued laterally by caudal extension of propleuron, bisecting dorsal carina present, this prominent, thin, and sharp, continuing beyond base of angle; disk moderately convex, sides abruptly declivous to low notopleural suture running nearly ventral to eyes, caudal side very abruptly declivous in front of hind angles, especially in median line where a short median canal is formed, this side abruptly ending well before enlarged lateral plates of propleuron (consequently exposing them to dorsal view); surface piceous, with vague longitudinal impressions near sides, median area convex; punctures large, coarse, very closely spaced to confluent, vaguely hexagonal; setae directed caudad. Pleural region piceous with band of siennous shading along pleurosternal suture, punctures moderately large, moderately dense, rather circular in outline, surface lucidus; setae directed anteriorly. Prosternal lobe rather abruptly turned ventrally and only moderately arcuate; prosternum with moderately large punctures, these dense and rather circular in outline, surface lucidus and convex, scarcely concave on sides, setae directed anteriorly, prosternal suture feebly grooved anteriorly, prosternal mucro slightly concave near base, straight. Sides of mesosternal fossa feebly raised in front. Metasternum somewhat finely and closely punctate. Scutellum elongate, width/length as 2.5/4, moderately inclined (30°), surface finely punctate, slightly opaque and rather rugulose. Elytra striate, these more or less formed by moderate, sometimes confluent punctures or grooves between punctures; interspaces with three rows of very fine punctures; color lightly siennous.

Abdomen.—Moderately finely punctate, lighter in color towards middle.

Male genitalia.—Aedeagus (Fig. 8) slender, moderately elongate (1.9 mm). Dorsal side flat, heavily sclerotized; ventral side nearly covered by lateroventral sides of parameres, membranous under center piece except near apex. Apex of center piece exceeding parameres; median strut slender, divided at apex and fused to base of each paramere; lateral struts slender, elongate, nearly straight. Parameres with strong lateral lobe; 12 to 13 loosely clustered setae on ventral side of lobe, all confined to well-defined lightly sclerotized area at apex; lobe acute, outer side straight (Fig. 8a). Pars basalis narrow and extremely convex, V-shaped.

FEMALE.—Unknown for the nominate subspecies. See under *L. protractum elegans.*

DISTIBUTION.—California, found south of San Francisco Bay near the coast. Thirty specimens were examined, all males.

No locality: 5, including types (CAS, MCZ, PAS). *San Mateo Co.*: 1, Crystal Lake, 7 May 1916 (CAS); 2, Jasper Ridge (E. of Searsville Lake), 21 May 1950 (CAS, JNLS). *Santa Clara Co.*: 1, Stanford Univ., 21 May 1951 (CAS); 1, Stevens Creek (NW of Saratoga), 5 May 1940 (CAS). *Santa Cruz Co.*: 1, 9 June 1917, 600 ft. (CAS); 15, Ben Lomond, 1931, 16 and 17 May 1931, April 1932, May, 25 May and 17 September 1932, 17 July 1933, 19 May and 3 July 1946 (BM, CAS, JNLS, MCZ, MSU, USNM); 4, Soquel Creek, 30 May 1909 (CAS, JNLS).

The California Academy of Sciences, through Mr. Leech, kindly presented me with seven specimens. I have in turn donated one to the British Museum and one to Michigan State University. Five are retained in my collection (JNLS).

This is the form first described by Horn. I have seen both male cotypes in the Philadelphia Academy of Sciences. One has the following labels: "Cal.," "Lectotype, 3373," "Leptoschema protractum Horn." The other is labeled "Cal.," "Paratype 3373." The first specimen may be regarded as the lectotype of the species.

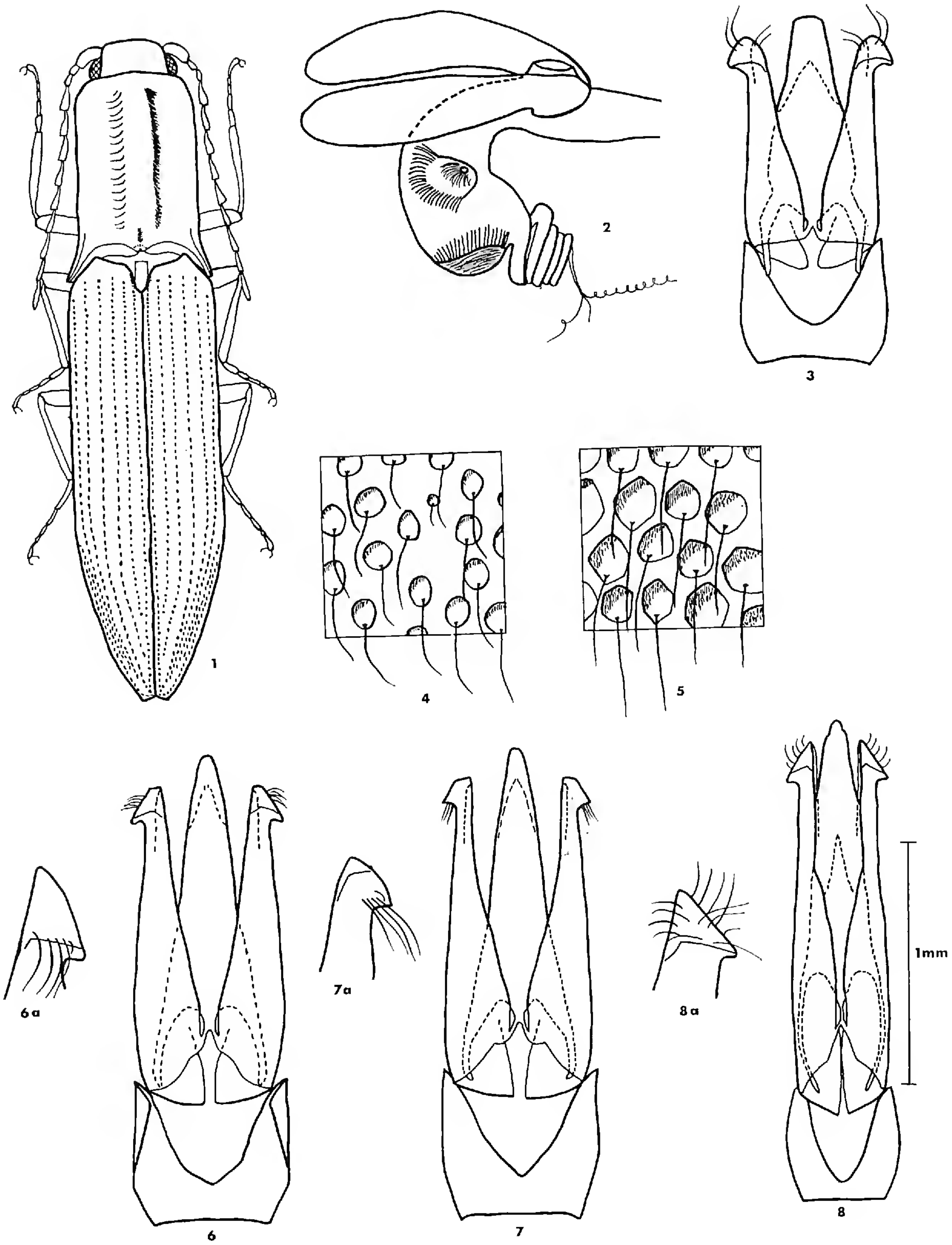


FIG. 1. *Leptoschema protractum* (Horn), length 12 mm. FIG. 2. *Deromecus impressus* Solier, female genitalia. FIG. 3. *Deromecus* sp., group 1, male genitalia, dorsal view. FIG. 4. *Leptoschema praelontactum* Stibick, section of pronotum, showing punctation. FIG. 5. *L. protractum*, section of pronotum showing punctation. FIG. 6. *L. praelontactum*, male genitalia, dorsal view; 6a. Apex of left paramere, ventral view. FIG. 7. *L. praelontactum gloris* Stibick, male genitalia, dorsal view; 7a. Apex of left paramere, ventral view. FIG. 8. *L. protractum*, male genitalia, dorsal view; 8a. Apex of left paramere, ventral view.

When Dr. Horn described the genus *Leptoschema* in 1884, *protractus* was corrected to *protractum*, since *Leptoschema* is a singular Greek adjective, neuter gender. Other authors apparently mistook the generic name for Latin, hence their use of the *-us* ending.

The relationship of a number of morphological features with locality has indicated the necessity of recognizing a number of subspecies. Two of these subspecies may yet prove to form a separate species.

Leptoschema protractum elegans Stibick, new subspecies

(Figs. 10, 12)

Leptoschema protractum var. *elegans* Van Dyke, 1932, p. 357.

MALE.—Length 12–13 mm, width 2.8–3 mm. Color yellow (flavous) to orange (aurantiacus), generally golden yellow (auratus) with median pitchy black (piceous) to shining brown (fulvescent) vitta on pronotum, more fulvescent on venter. Antennae extending one segment beyond pronotal hind angles, antennal setae erect. Aedeagus (Fig. 10) slender, moderately elongate (1.9 mm); apex of paramere with suboval clear spot, 14 to 15 setae, and feebly curved outer edge (Fig. 10a).

FEMALE.—Length 16.5 mm, width 3.6 mm. Pronotum (7/9) median width to median length, sides straight, moderately arcuate near apex, scarcely arcuate along hind angles. Antennal setae decumbent. Pleural region vaguely micro-reticulate. Female genitalia (Fig. 12) with elongate, apically narrowing bursa copulatrix adorned with numerous furca-like or simple spines in three major areas along back and one area in U-turn. Colleterial glands elongate and narrow.

DISTRIBUTION.—Found near the coast of California north of San Francisco Bay.

Holotype male, HUMBOLDT COUNTY, CALIFORNIA, collected on 15 May 1911 by F. W. Nunenmacher (CAS, No. 3144, type specimen of Van Dyke, 1932). Allotype, from Sylvania, Sonoma County, collected on 8 May 1898 by R. Haywood. Paratypes, four males as follows: 2, California (PAS, MCZ); 1, Sonoma County (USNM); 1, Sylvania, Sonoma County, May, collected by R. Ecker (CAS).

Originally described as a variety by Dr. Van Dyke, this form is now raised to subspecies status on the basis of the male aedeagus and distribution. It is apparently indistinguishable from *L. protractum analelegans* Stibick; save for the aforementioned features. However, the aedeagus shows it to be most closely related to the nominate subspecies (Figs. 8, 10).

I have not been able to determine the type locality, Humboldt County, more precisely, since the late collector, Nunenmacher, did not leave any pertinent notes. However, the similarity of the aedeagus in the male examples from Sonoma and Marin counties to the type lead me to place all these specimens in the same subspecies, including the one

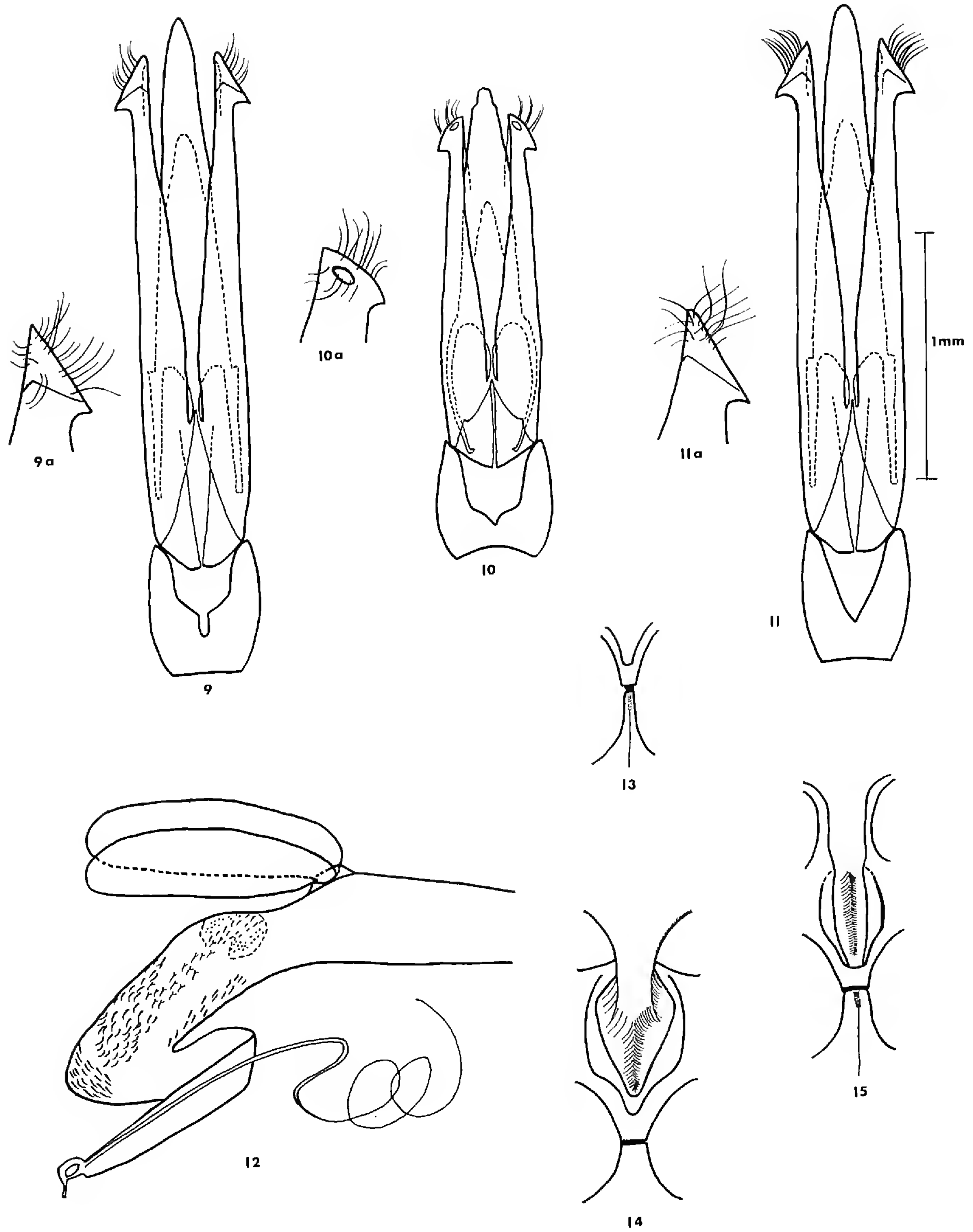


Fig. 9. *L. protractum detractum* Stibick, male genitalia, dorsal view; 9a. Apex of left paramere, ventral view. Fig. 10. *L. protractum elegans* Stibick, male genitalia, dorsal view; 10a. Apex of left paramere, ventral view. Fig. 11. *L. protractum analelegans* Stibick, male genitalia, dorsal view; 11a. Apex of left paramere, ventral view. Fig. 12. *L. protractum elegans*, female genitalia. Fig. 13. *Denticollis productus* (Randell), ventral view of metasternum, mesosternum, and mesocoxal cavities. Fig. 14. *Limonius ectypus* (Say), ventral view showing most of mesosternum, tip of metasternum, pro- and mesocoxal cavities, and prosternal mucro. Fig. 15. *Athous nigropilis* (Motschulsky), ventral view showing most of mesosternum, tip of metasternum, pro- and mesocoxal cavities, and prosternal mucro.

female allotype. Sylvania, not on today's maps, is near the present site of Camp Meeker, Sonoma County (H. B. Leech).

From the only female *Leptoschema* known, we may possibly expect other females of the genus to be somewhat larger and broader, and without the stiffly erect antennal pubescence characteristic of the male.

Leptoschema protractum detractum Stibick, new subspecies
(Fig. 9)

MALE.—Length 14 mm, width 3 mm. Pronotum piceous, elytra golden yellow, antennae extending one segment beyond pronotal hind angles. Aedeagus (Fig. 9) quite elongate (2.7 mm); apex of paramere with 17 to 19 setae, lobe acute, outer side straight (Fig. 9a); basal piece with notch in internal edge.

FEMALE.—Unknown.

Holotype male, SAN LEANDRO HILLS, OAKLAND, ALAMEDA COUNTY, CALIFORNIA, collected in June 1881 (CAS). "Hills back of Oakland, Cal., VI-1881"; "4808"; "Van Dyke Collection." One paratype male, from Alameda County, collected on 21 May 1930 by F. E. Blaisdell (CAS). "Hayward." Type locality defined as San Leandro Hills, Oakland, Alameda County, California.

Apparently indistinguishable from the nominate, save for a slightly larger size, slightly lighter elytra, and range. The aedeagus is elongate, so much so that this may form, with *L. protractum analelegans*, a distinct species. However, since the shape of the aedeagus is otherwise somewhat similar, and external features seem so feeble, for the present they should be regarded as subspecies of the nominate.

Leptoschema protractum analelegans Stibick, new subspecies
(Fig. 11)

MALE.—Length 13 mm, width 3 mm. Color generally golden yellow with median pitchy black vitta on pronotum. Antennae extending one segment beyond pronotal hind angles. Aedeagus (Fig. 11) quite elongate (2.7 mm); apex of parameres with 14 to 15 setae, lobe acute, outer side straight (Fig. 11a); basal piece without median notch.

FEMALE.—Unknown.

Holotype male, LAFAYETTE, CONTRA COSTA COUNTY, CALIFORNIA, collected on 24 May 1940 (CAS). The type locality defined as Lafayette, Contra Costa Co., California.

Similar to *L. protractum elegans*, and best distinguished by the aedeagus or by locality. But it is related to *L. protractum detractum*, and may be only a feeble variety of the latter, although the prominent median vitta, basal piece, and setae pattern of the parameres seem to separate it.

Leptoschema praelontactum Stibick, new species

(Figs. 4, 6)

MALE.—Length 15 mm, width 3 mm. Shape elongate, scarcely convex; color uniformly shining brown, generally lighter beneath, somewhat darker on scutellum and prosternum; punctation shallow, unisetigenous, moderately dense, finer on venter; surface generally lucidus; vestiture moderate, lightly flavous, wiry and decumbent.

Head—About ½ as long as wide, 5/7 median width of pronotum; front arcuate at vertex, otherwise vertical; punctures moderately large, circular in shape, close but not confluent. Antennae reaching two segments beyond pronotal hind angles, scape cylindrate, slightly longer than pedicel and III segment combined; the latter short, feebly cylindrate and compressed; IV to XI segments each 2½ times length of preceding two, moderately serrate, save oblongly slender XI.

Thorax.—Median width/length as 5.6/7.5; sides straight, scarcely arcuate at apex, very feebly arcuate along hind angles; hind angles very prominent, prolonged, acute, sides continued laterally by caudal extension of propleuron, bisecting dorsal carina present, this prominent, thin, and sharp, continuing beyond base of angles; disk moderately convex, sides abruptly declivous to low notopleural suture running nearly ventral to eyes, caudal side very abruptly declivous in front of hind angles, especially in median line where short median canal occurs, this side abruptly ending well before enlarged lateral plates of propleuron (consequently exposing them to dorsal view) ; surface with vague longitudinal impressions, median area convex, punctures moderately large, shallow, and numerous, generally well-spaced, circular in shape; setae directed caudad. Pleural region with moderate punctation, surface lucidus; setae directed anteriorly. Prosternal lobe abruptly turned ventrally and only moderately arcuate; prosternum with somewhat coarse but well-separated punctures, surface highly lucidus, convex, scarcely concave on sides, setae directed anteriorly; prosternal suture feebly grooved anteriorly; prosternal mucro slightly concave near base, straight. Sides of mesosternal fossa feebly raised in front. Metasternum somewhat finely and closely punctate. Scutellum elongate (1.3/2.4), moderately inclined (30°), surface tending to piceous shade, finely punctate, slightly opaque and rugulose. Elytra striate, these formed by moderate punctures or grooves between punctures; interspaces with three rows of very fine punctures.

Abdomen.—Moderately finely punctate, color darker away from sides.

Male genitalia.—Aedeagus (Fig. 6) somewhat stout (1.9 mm) ; dorsal side flat, heavily sclerotized; ventral side only partly covered by lateral-ventral sides of parameres, membranous under center piece except near apex. Apex of center piece exceeding parameres; median strut slender, divided at apex and fused to base of each paramere; lateral struts moderately stout, nearly straight. Parameres with strong lateral lobes; loose row of five setae on ventral side of lobe, these confined to well-defined lightly sclerotized area at apex, lobe rather obese in shape, outer side somewhat arcuate (Fig. 6a). Basal piece convex, U-shaped.

FEMALE.—Unknown.

Holotype male, SPRINGFIELD, TULARE COUNTY, CALIFORNIA, collected on 24 May 1935 by F. T. Scott (CAS). "Springville, Cal., 5–24–35";

"Ft. Scott Coll."; "R. Hopping Collection"; "*Leptoschema* sp. prob. new, G. R. Hopping"; "n. sp. H.B.L." One paratype male, creek near Chico, Butte County, collected on 23 April 1922 by E. C. Van Dyke (CAS). Type locality defined as Springville, Tulare Co., California.

A beautiful and unmistakable, but very rare species. Its distribution (Map 1) greatly extends the known limits of *Leptoschema* throughout California. There is one subspecies, described next.

Leptoschema praelontactum gloris Stibick, new subspecies

(Fig. 7)

MALE.—Length 16 mm, width 3 mm. Uniformly shining brown, lighter beneath save for darker prosternum and scutellum. Antennae scarcely attaining apex of hind angles, IV to XI segments each nearly twice length of II and III combined. Aedeagus (Fig. 7) somewhat stout (1.9 mm); apex of parameres with moderately strong lateral lobes, row of five setae on ventral side below lightly sclerotized apical area, lobe quite obese, outer side quite arcuate (Fig. 7a).

FEMALE.—Unknown.

Holotype male, PUTAH CANYON, YOLO COUNTY, CALIFORNIA, collected on 14 May 1933 by E. C. Zimmerman (CAS). Type locality defined as Putah Canyon, a section of Putah Creek in Yolo County, California adjacent to the Napa County line. Mr. Leech informs me that the Monticello Dam on the county line and the Putah Dam near Winters have radically changed ecological conditions there.

The general shape of the aedeagus, shallow pronotal punctation, and shiny brown appearance indicate its close relationship to the nominate. But the very short antennae and specific features of the aedeagus, especially the apex of the parameres, seem to warrant subspecific status. The range (Map 1) is interesting in that it is midway between the nominate and the various forms of *L. protractum* (Horn).

GENERIC KEYS

The systematic reassignment of *Leptoschema* requires some changes in Arnett's 1968 key to the genera, couplets 34 to 38. I have taken this opportunity to present some additional characters felt to be of value in separating the various genera involved, and the following key may be substituted for couplets 34 to 38 in Arnett (1968).

Tribe POMACHILIINI

1. Head convex, front vertical, mouth inferior .... *Leptoschema*
Head and front inclined, mouth nearly prognathous (Denticollini) 2

Tribe DENTICOLLINI

2(1). Metasternum pointed at apex (Fig. 13); mesocoxal cavities nearly contiguous; prosternal lobe not extending forward beyond hind margins of eyes .... *Denticollis*

Metasternum narrow, usually truncate (Figs. 14, 15); mesocoxal cavities usually well separated; if metasternum apparently pointed and cavities approximate, then prosternal lobe extending forward beyond hind margins of eyes 3

3(2). Prosternal mucro moderately to strongly broadened behind procoxae (Fig. 14), prosternal sutures double; antennal segments two and three usually subequal 4

Prosternal mucro not widened behind procoxae (Fig. 15); prosternal sutures single; antennal segment two usually smaller than three 5

4(3). Carina of frons thickened, frons deeply impressed behind margin .... *Elathous*

Carina of frons not thickened, often emarginate .... *Limonius*

5(3). Tarsal segments 1–4 with a membranous lobe beneath; carina of frons weak .... *Hemicrepidius*

Tarsal segment one without a membranous lobe, others various; carina of frons very well developed .... *Athous*

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A New Philippine *Sagocoris*
(Hemiptera: Naucoridae)

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During the course of monographic work with the naucorid fauna of New Guinea, isolated specimens have come to hand from peripheral areas. Since no unified treatment of these areas is contemplated in the immediate future, I am submitting the following single description as an interim contribution to what little we know of the naucorids of these regions.

Sagocoris usingeri La Rivers, new species

GENERAL.—A moderately convex, contrastingly mottled species with some sheen, micropunctation and roughness. Length 10.5 mm, width 6 mm. Head and pronotum a bit lighter overall than hemelytra (i.e., with greater preponderance of background light yellow). Venter a bit darker, with lighter plastron.

MALE.—*Head*—Rather square in interocular area, light yellow, darkening in posterior pattern; micropunctation cutting down noticeably on sheen; anteclypeal area moderately and smoothly protuberant between eyes, latter rising noticeably above general head surface when viewed obliquely from rear; inner eye margins subparallel; outer margin curving smoothly into posterior edge, small hyperoche (non-optical flap) evident at what would be the meeting point if that was angular. Head set broadly and shallowly into leading edge of pronotum. Viewed anteriorly, mouthparts (including labrum) set into distinct but shallow well formed by overhanging edge of anteclypeus above, and by shallow extension of juga and maxillary plates laterally. Labrum medium in size, yellowish, sharply rounded on end; ratio of length:width 5:11. Gula keeled, but not sharply so, not pointed at either end. Maxillary plates prominent, tips protruding free at edges of mouthparts-well. Antennae 3-segmented, slender, basal segment bilobed. Head ratios (1) total length:width (including eyes) 46:75, (excluding eyes) 23:21, (2) anterior distance between eyes:posterior distance between eyes 41:50, (3) total length:length of head posterior to line drawn between posterior eye edges 46:7.

Pronotum—Light yellowish, with usual double triangular pattern of dark brown dots and suffusions occupying disc, producing, particularly, a prominent and light posterior pronotal band. Side edges smoothly and slightly curved posteriorly to sharply rounded posterolateral areas, lacking pilosity. Venter lighter in vicinity of posterolateral areas, darkening inwardly. Prosternum prominently keeled in anterior three-fifths, leading edge extending as rather blunt but definite point over adjacent edge of gula. Propleural flaps just slightly free internally, but not extending over any part of posterior prosternum. Pronotal ratios (1) width between anterior angles:width between posterior angles 3:5, (2) median length:greatest width 6:25.

Scutellum—Brownish-black with light yellow center. Ratio of three sides, anterior and two laterals, 15:11:11.

Hemelytra—Brownish-black over most of area, with lightening in emboliar,

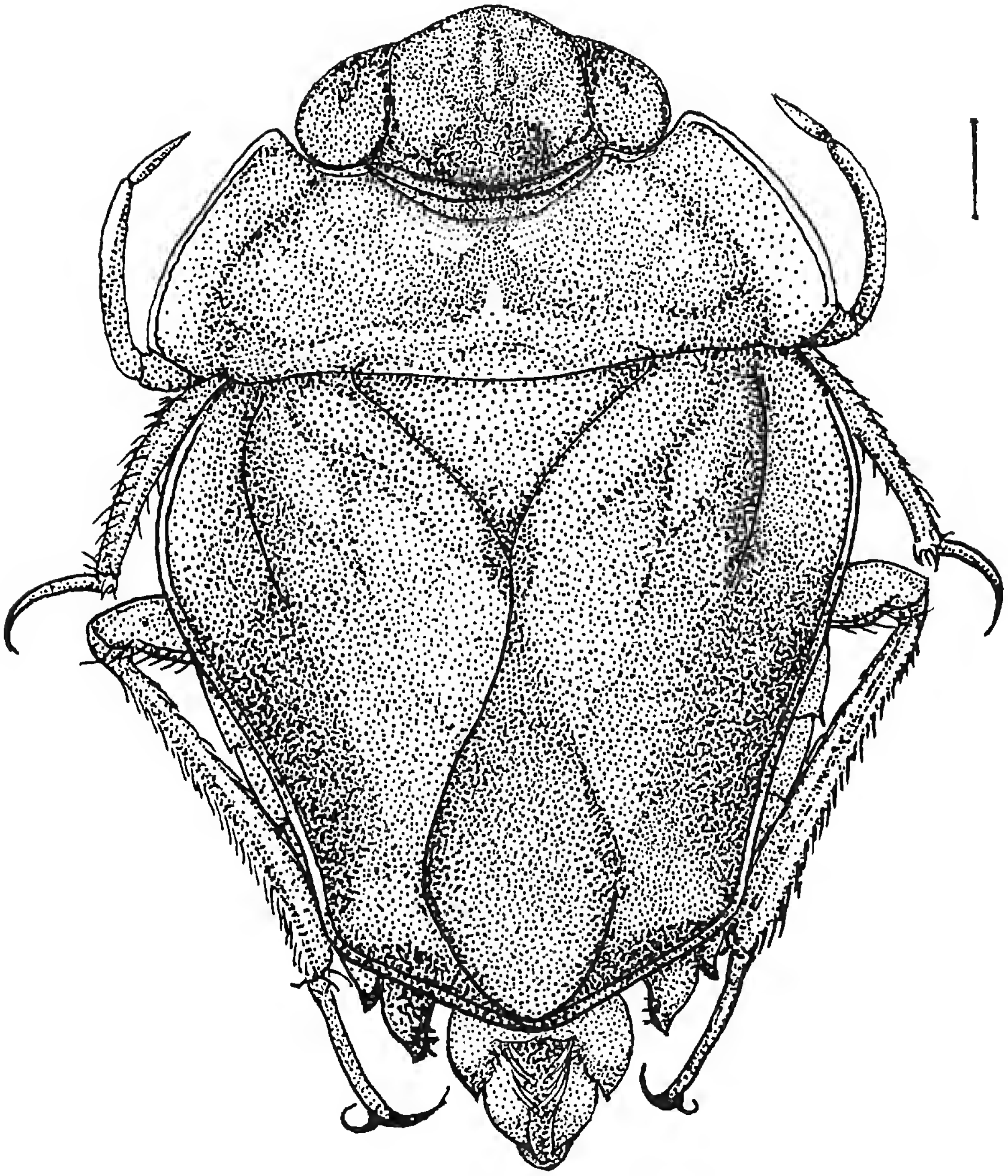

Fig. 1. *Sagocoris usingeri* La Rivers, holotype male.

claval and corium-membrane junction regions. Some glisten, but micropunctation very evident. Extend full length of abdomen, with well-developed membrane sections which overlap when wings closed. Claval, corial and emboliar areas well marked. Rather narrowly exposing connexiva. Embolium typically lighter anteriorly and laterally, crease anterointernally noticeable; ratio length:width 13:4, making it rather narrow. Hind wings vestigial, reduced to one-third abdominal length.

Venter—The prothoracic venter has been considered. Abdomen a bit lighter than sterna because of hydrofuge plastron. Mesosternal median tumidity bisinuous in lateral view, (highly reminiscent of some oedipodine grasshoppers) with anterior tumidity short and rounded, posterior one occupying remainder of mesosternum, the two separated by a sulcus. Connexival margins thin, posterolateral angles right-angulate but not spinose.

Proleg—Coxa and trochanter large, conspicuous, bearing very well-developed incrassate femur, globular and swollen when viewed ventrad, rather flat in horizontal view. Femoral ratio of length:width 31:23. Tibia-tarsus a single narrow unit closing against leading femoral edge, tarsus 1-segmented and grading into single sharp claw or point.

Mesoleg—Coxa elongate-globular, connecting to long, narrow, flattened femur by means of conspicuous trochanter. Legs of these sagocorines very reminiscent of *Ambrysus* in the Ambrysinae. Femur somewhat rectangular in cross-section with row of fine, short spines along each edge; ratio length:width 60:13, length 2.6 mm. Tibia narrower, rounded in cross-section, bearing more prominent reddish spines over its surface, these getting larger and more numerous distally; ratio length: width 50:7, length 2.3 mm. Tarsus 3-segmented, first segment very short, remaining two elongated and terminating in two large but weakly-curved claws.

Metaleg—Larger copy of mesoleg. Femur with ratio of length:width 82:15, length 4 mm. Tibia more heavily spined than mesotibia, spines arranged more systematically into longitudinal rows; ratio of length:width 95:8, length 4.1 mm; with fringe of long swimming hairs on inner margin. Tarsi as in mesoleg, but larger and darker.

FEMALE.—Unknown.

Holotype male and 1 paratype LUZON, MOUNTAIN PROVINCE, BENGUET, PHILIPPINES, 15 July 1946, D. G. Frey (Amer. Mus. Nat. Hist.); 2 paratypes, Mountain Province, Mt. Data, April 1946, H. Hoogstraal & D. Heyneman, 7,000 ft. (Chicago Nat. Hist. Mus.); 1 paratype, Mountain Province, Abatan, Buguias, 60 km S of Bontoc, 1 June 1964, H. M. Torrevillas, c. 2,000 ft., light trap[1] (Bishop Mus.).

This distinctive species is named for the late Robert Leslie Usinger—teacher, colleague and friend of 20 years, with whom I was working on southeastern Asiatic naucorids at the time of his premature death in San Francisco.

COMPARATIVE NOTES.—This is a well-defined species, in certain pronotal characteristics (such as the posterolateral angles) appearing more like *Sagocoris biroi* Montandon 1911 than any other member of the genus. However, it is rather sharply set off by the distinctive anterior angulation of the tip of the prosternal median keel of xiphus. Very likely the structure of the female subgenital plate will further distinguish it when this is known.

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[1] The designation "light trap" on the label of this specimen can only be an error, since this is a flightless species.

A Revision of the Neotropical Genus *Physemops* Cresson

(Diptera: Ephydridae)

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The genus *Physemops* Cresson has been known only from the type species, *P. nemorosus* (Cresson), a small black fly with bright whitish pubescent lower face, found around rocky streams in Neotropical rain forests. The systematic position of this fly was dubious because of several structural peculiarities which were thought to be of a generic nature. The following quotation from the discussion accompanying Cresson's (1914) original description shows the quandary this species has placed us in.

> "This genus may be distinguished by the peculiar shield-like development of the face which extends rather low, appearing somewhat subhemispherical, being evenly and distinctly convex in all directions, including the cheeks. There are no indications of the usual parafacial grooves or areas, and the face is destitute of characteristic bristles or hairs. In general the face appears vaulted or arched, as is typical with *Ephydra* and *Parydra*, but the mouth is not proportionately so large. At first glance its head suggests affinity to *Ilythea*, but on further examination it is seen to belong to an entirely different subfamily. The form of the head, thorax and abdomen, and its chaetotaxy determines its relation to *Hydrina* and *Axysta*. The abdomen suggests *Gastrops*, having apparently only four segments in the male and five in the female with the second and third much longer than the others. The apical margin of the third, in profile, is horizontal as in *Lytogaster* and *Axysta*."

Examination of much fresh material including five new species of this genus results in an expansion of our concept of the generic characters and indicates that some of the most striking characteristics of *P. nemorosus* are of a specific nature. The presence in some of these species of distinct series of dorsocentral and acrostichal bristles, and of a pair of enlarged bristles on the medifacies suggests that *Physemops* belongs in the subfamily Ephydrinae. Examination of the Oriental *Psilephydra cyanoprosopa* Hendel reveals that it is related to *Physemops* on one hand and to the Polynesian genus *Apulvillus* Malloch on the other. The latter in turn is closely related to *Scatella* Robineau-Desvoidy and *Neoscatella* Malloch.

Two terms coming into common use in Acalyptrate Diptera taxonomy

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should be mentioned here: The costal index is the length of the second section of the costa (between apices of first and second veins) divided by the length of the third section (between apices of second and third veins). The fourth vein index is the length of the apical section of the fourth vein (between posterior crossvein and wing margin) divided by the length of the preapical section (between anterior and posterior crossveins).

I am especially indebted to J. Maldonado Capriles of the University of Puerto Rico in Mayaguez, and to Marshall R. Wheeler of the University of Texas in Austin, for the opportunity to study material from their collections.

Genus PHYSEMOPS Cresson

Physemops Cresson, 1914, Trans. Amer. Entomol. Soc., 60: 211. Type species, *Psilephydra nemorosa* Cresson, by original designation.

DIAGNOSIS.—Small, broad and stocky, blackish flies with long convex face usually without bristles but with dense pubescence. Head broad, relatively high and short, the frons broader than long; one pair of fronto-orbital bristles curving laterad and caudad; inner verticals strong and also curving laterad and caudad; outer verticals strong, erect, bent slightly forward and mesad; ocellars strong, erect, bent slightly forward and laterad (absent in *P. wheeleri*). (In *P. nemorosus* and *P. azul* only the inner and outer verticals are strongly developed.) Face with a pair of moderately long, divergent submedian bristles at apex of facial hump on upper portion (these absent in *P. nemorosus* and *P. azul*) ; lower margin sharp at the moderately wide mouth opening; no trace of clypeus present. Antenna without spine on second segment; third segment usually broader than long, bearing long arista with variable development of pubescence above and below, or of short dorsal rays.

Thorax with one pair of strong dorsocentral bristles always present, some species sometimes also with considerable development of up to three anterior dorsocentrals and several pairs of acrostichals; two pairs of notopleurals and variable development of other lateral bristles (presuturals, supraalars, interalars, and postalars) ; two pairs of scutellars present; a strong mesopleural and a strong sternopleural. (In *P. nemorosus* and some other species all but posterior dorsocentral and marginal scutellars may be greatly or somewhat reduced.) Scutellum broader than long and somewhat convex (except in *P. panops*).

Abdomen short and moderately convex, relative lengths of terga variable with the species. Male abdomen usually with fifth tergum greatly convex and apex turned under.

Legs without special modifications or strong bristles; femora moderately stout; apical tarsomere may be expanded, especially in male; claws strong and curved, empodium and pulvilli well developed.

Wing unmarked, apex of first vein sometimes strong and darkened; second vein long, extending nearly to apex of wing; fifth vein straight in one group of species, in the other markedly bowed or sinuate, discal cell thus convex behind.

Key to the Species of Physemops

1. Antenna entirely black or dark brown 2
   Antenna with third segment entirely or mostly yellowish 3
2. Large species, wing 2.90 mm long; face entirely shining black, upper facials well developed; arista with longer raylike branches above and below; tarsi black .... *wheeleri* Wirth, n. sp.
   Small species, wing 2.00 mm long; face brown to black above, whitish to golden below, upper facials absent; arista with short pubescence on both sides; tarsi pale .... *nemorosus* (Cresson)
3. Integument of face yellowish; dorsum of thorax coarsely granulose, mesonotum greenish, scutellum bluish .... *panops* Wirth, n. sp.
   Integument of face blackish; dorsum of thorax blackish, not coarsely granulose 4
4. Small species, wing 1.75 mm long; lower face with bluish pubescence viewed from above, upper facials absent; legs with brown markings .... *azul* Wirth, n. sp.
   Large species, wing 2.10–2.34 mm long; lower face with whitish pubescence, upper facials present; femora blackish 5
5. Tibiae yellow; only one pair of long dorsocentrals present; arista with short dorsal rays .... *maldonadoi* Wirth, n. sp.
   Tibiae blackish; one pair of long dorsocentrals plus three shorter ones present; arista virtually bare .... *fairchildi* Wirth, n. sp.

Physemops azul Wirth, new species

FEMALE.—Length of wing 1.75 mm. Dark brown to black; mesonotum and scutellum subshining, with sparse fine punctures; third antennal segment yellow; legs yellowish, all of femora except apices, broad band on tibiae, and tarsomeres 3–5 brown; halter black, base of stem yellowish. Head bristles reduced except for strong inner and outer verticals. Face relatively short and broad, shaped about as in *P. nemorosus*, with scattered fine pale microscopic hairs, no enlarged submedian bristles on upper face; with dense greenish pubescence, that on lower portion bright aquamarine blue when viewed from above. Arista about as long as breadth of vertex, with coarse pubescence above and below. Mesonotum with long bristles, three pairs each in dorsocentral and acrostichal series. Scutellum broader than long, moderately flattened; two pairs of strong marginal bristles plus two pairs of finer marginal hairs. Relative lengths of abdominal terga 2–5 as 20:26:8:3. Wing deeply brownish infuscated, the veins dark brown; fifth vein deeply bowed; second vein long, costal index 5.0; fourth vein index 2.0.

MALE.—Unknown.

DISTRIBUTION.—Mexico.

TYPES.—*Holotype female,* 1 female paratype, VALLE NACIONAL, OAXACA, MEXICO, 15 May 1963, collector unknown (Type no. 70664, USNM).

DISCUSSION.—This small species is closely related to *P. nemorosus* resembling it in general body shape and small size, wing venation, its micropubescent arista, and lack of upper facials. It can readily be distinguished from that species by its yellow third antennal segment, shining dorsum with numerous large mesonotal bristles, and by its brilliant bluish face.

Physemops fairchildi Wirth, new species

MALE.—Length of wing 2.10 mm. Large shining black species; third antennal segment yellowish, becoming brownish on apex; tarsi brown distally, tarsomere one yellowish on foreleg, one to three yellowish on mid and hind pairs; wing yellowish brown hyaline with coarse microtrichia, veins yellowish brown; halter whitish. Arista short and nearly bare. Face longer than in *P. nemorosa*, with more pronounced facial hump, covered with blackish microscopic hairs, pair of long submedian facials at apex of hump, face polished black above these and pearly white pubescent below; cheek polished black, sharply contrasting with whitish face. Frons, mesonotum and scutellum subshining granulose, scutellum somewhat transversely microrugulose; abdominal terga smooth and shining, lengths of terga 2–5 as 10:10:12:15. One pair of long dorsocentral bristles plus three shorter ones anteriorly in series and some small scattered acrostichal hairs. Scutellum broader than long, moderately convex dorsally, the marginal bristles arising from distinct tubercles; apical scutellars long, the anterior pair only half as long. Wing long and narrow; second vein very long and paralleling costa, costal index 6.7, submarginal cell narrowed distally; fourth vein index 1.7; fifth vein straight bordering discal cell.

FEMALE.—Unknown.

DISTRIBUTION.—Colombia, Panama.

TYPES.—*Holotype male*, 2 paratypes, CERRO CAMPANA, PANAMA PROV., PANAMA, July 1967, W. W. Wirth (Type no. 70665, USNM). COLOMBIA: Bogota vicinity, 8700 ft., February 1958, M. R. Wheeler, 1 male paratype; Medellin, 8000 ft., February 1958, M. R. Wheeler, 3 male paratypes.

DISCUSSION.—This species resembles *P. maldonadoi* in wing venation, pale halteres, long convex face with long facials, but differs in the nearly bare arista, black tibiae, and the shining black upper facial area.

I take pleasure in naming this species in honor of Dr. G. B. Fairchild of the Gorgas Memorial Laboratory in Panama City, Panama, in recognition of his outstanding contributions to our knowledge of Neotropical Diptera.

Physemops maldonadoi Wirth, new species

MALE.—Length of wing 2.34 mm. Large shining black species; third antennal segment, all of tibiae except apical spot, and first two tarsomeres yellow; halter whitish; wing grayish hyaline, the veins brown. Face long, with pronounced median hump, two moderately long submedian facials placed at the apex of the hump; face clothed with scattered short, microscopic hairs; surface shining black, with sparse pearly white pubescence becoming heavier towards lower margin. Third antennal segment longer than broad; arista slightly shorter than width of vertex, with short dorsal rays. Frons, mesonotum and scutellum with sparse but coarse, scalelike tomentum, appearing moderately shining; only one pair of long dorsocentrals, other hairs in dorsocentral and acrostichal series short and fine. Scutellum broader than long, convex dorsally, basal scutellar a little more than half as long as apical pair. Abdominal terga 2–5 with lengths as 8:13:10:3. Wing with second vein long but running straight to costa distally, costal index 3.3; fourth vein index 2.1; fifth vein in straight line behind distal cell.

FEMALE.—Identical to male, except abdominal terga 2–5 with lengths as 10:8:8:8.

DISTRIBUTION.—Puerto Rico.

TYPES.—*Holotype male*, allotype female, 10 male and 6 female paratypes, YAUCO-LARES ROAD KM 29, PUERTO RICO, 20 January 1954, J. Maldonado and S. Medina (Type no. 70666, USNM).

DISCUSSION.—The wing venation, pale halteres, long convex face with long facials and yellow third antennal segment ally this species with *P. fairchildi*, but that species differs in the nearly bare arista, black tibiae and the shining black upper facial area.

This species is named for Dr. J. Maldonado Capriles of the University of Puerto Rico in Mayaguez in recognition of his many contributions to our knowledge of Puerto Rican Diptera.

PHYSEMOPS NEMOROSUS (Cresson)

Psilephydra nemorosa Cresson, 1914, Entomol. News, 25: 244 (Costa Rica; fig. head); Cresson, 1918, Trans. Amer. Entomol. Soc., 44: 64 (redescribed; fig. head).

Physemops nemorosus (Cresson); Cresson, 1934, Trans. Amer. Entomol. Soc., 60: 211 (combination; type species of new genus *Physemops*); Wirth, 1968, Cat. Diptera Amer. S. of U. S. 77: 20 (distribution).

MALE.—Length of wing 2.00 mm. Entirely shining black with faint submetallic luster, or somewhat obscured by sparse brown pollen and granulose or scorbiculate surface, especially of thorax and scutellum. Wing brownish hyaline; halter black; legs black, trochanters, apices and bases of tibiae, and tarsomeres 1–4 yellowish. Head bristles absent except for strong inner and outer verticals. Face densely pubescent, appearing brownish above and whitish to golden on lower portion; broadly convex without pronounced median hump, with scattered microscopic hairs, no enlarged facials on upper portion. Antenna with third segment brown, broader than long; arista very long, longer than breadth of vertex, with dorsal and ventral feathering of minute hairs. Mesonotum and scutellum with dense, coarse granulation; one pair of long dorsocentral bristles, others in dorsocentral and acrostichal series reduced to fine, short, seta-like hairs; scutellum broader than long, convex dorsally, anterior scutellar half as long as apical pair. Abdomen dorsally with coarse scalelike tomentum appearing subshining; terga 2–4 with lengths as 20:20:10, tergum 5 not visible from above, but quite prominent and convex from caudal or ventral aspect. Fifth tarsomere of anterior leg dilated, with an apical fan of eight or more hairs, the claws long and stout, so spread laterally as to oppose each other, their pulvilli also enlarged. Wing broad; second vein long and paralleling costa; costa index 4.6; fourth vein index 1.7; fifth vein sinuate.

FEMALE.—As for male, except abdominal terga 2–4 with lengths as 30:30:7, and shape of fifth tarsomere of anterior leg.

DISTRIBUTION.—Mexico to Ecuador and Brazil, Dominica.

SPECIMENS EXAMINED.—BRAZIL: Juquia, Sao Paulo, December 1938, J. Lane, 1. COSTA RICA: Higuito, San Mateo, P. Schild, 1; La Suiza, 1923, P. Schild, 1. DOMINICA: Fond Figues River, January–March 1965, W. W. Wirth, rain forest, 11; 17 March 1964, D. F. Bray, 1. ECUADOR: Bugna, Chimborazo, July 1955, R. Levi-Castillo, 1; Camarones, Manabi, 9 September 1955, R. Levi-Castillo, 3; Estero Balsa, Manabi, 9 September 1955, R. Levi-Castillo, 3; Los Rios, Guare, August 1955, R. Levi-Castillo, 2; Santo Domingo de los Colorados, March 1958, M. R. Wheeler, 1. EL SALVADOR: Los Chorros, December 1953, W. B. Heed, 1; Santa Tecla, 12 km nw, December 1953, W. B. Heed, 1. HONDURAS: Lancetilla, April 1954, W. B. Heed, 1. MEXICO: Valle Nacional, Oaxaca, 16 May 1963, collector unknown, 1. NICARAGUA: El Recreo, June 1954, W. B. Heed, 1. PANAMA: Balboa, Canal Zone, February 1958, M. R. Wheeler, 1; Barro Colorado Island, C. Z., July 1967, W. W. Wirth, 7; Cerro Campana, Panama Prov., July 1967, W. W. Wirth, rocky stream, 11; Gamboa, C. Z., Rio Agua Salud, July 1967, W. W. Wirth, rocky stream, 42; Hermita, Cocle Prov., 18 September 1952, F. S. Blanton, 1; Las Cruces Trail, C. Z., February 1958, M. R. Wheeler, 5; Pedro Miguel, C. Z., 10 April 1923, R. C. Shannon, 1.

Physemops panops Wirth, new species

MALE.—Length of wing 2.40 mm. Large multicolored species; integument of face yellowish; antenna, tibiae and first two tarsomeres yellow; wing deeply yellowish including veins; halter creamy white. Body black; frons subshining brown with fine granulosity; mesonotum and scutellum coarsely granulose; scutellum and narrow median line on mesonotum and notopleura deep blue, remainder of mesonotum greenish. Four pairs of dorsocentrals, last two becoming well developed; acrostichal hairs short and fine. Scutellum as long as broad, flattened above and pointed distally, apical bristles close together; basal scutellars half as long as apical pair. Face long and markedly convex but hump low, submedian pair of long facials on hump; face with scattered, short, fine, black hairs, with white pubescence becoming thin on mid and upper portions. Antenna with arista shorter than breadth of vertex, with moderately long dorsal rays. Wing long and slender, with well developed anal angle and axillary lobe; second vein long and paralleling costa, costal index 4.1; fourth vein index 2.0, fifth vein in straight line behind discal cell. Abdomen with lengths of terga 2–5 as 16:20:15:20 in males; shining black, second tergum slightly granulose, the distal segments with sparse, scalelike tomentum.

FEMALE.—Identical to male, except abdominal terga 2–5 with lengths as 18:15:15:20.

DISTRIBUTION.—Haiti.

TYPES.—*Holotype male*, allotype female, 1 male paratype, KENSCOFF, HAITI, 4000 ft., February 1956, W. B. Heed (Type no. 70667, USNM).

DISCUSSION.—This species is closely related to *P. maldonadoi* from

Puerto Rico with the same wing venation, pale halteres, long convex face with long facials, and yellow antenna and tibiae, but the yellow facial integument and the brilliant metallic blue and green granulosity of the thorax are quite distinctive. The facial aspect suggests the name *panops*, after *Pan*, the chimpanzee.

Physemops wheeleri Wirth, new species

FEMALE.—Length of wing, 2.90 mm. Large uniformly dull black species, including tarsi and halteres; wing dark smoky brown with blackish veins, with very coarse microtrichia. Third antennal segment much shorter than its breadth; arista sparsely feathered with moderately long dorsal and ventral rays. Face long and appearing more vertical than the other species of the genus, with submedian upper facials well developed; integument transversely microrugulose, appearing subshining, with scattered, fine short hairs, two widely spaced elongate hairs on oral margin. Frons, mesonotum and scutellum finely granulose; ocellar bristles absent. Only one pair of long dorsocentrals, the anterior dorsocentrals and the acrostichals appearing as short fine hairs. Scutellum broader than long, posterior margin rounded, basal scutellars very small, less than a third as long as apical pair. Abdomen with sparse scalelike tomentum and scattered erect fine hairs; lengths of terga 2–5 as 22:32:10:5. Wing broad, posterior margin rounded with broadly rounded anal angle more or less paralleling the deeply bowed fifth vein; marginal cell broad; costal index 10.0, this value so high due to the narrowing of submarginal cell by the anteriorly bowed second vein; third vein nearly straight; fourth vein index 1.7.

MALE.—Unknown.

DISTRIBUTION.—Ecuador, Panama.

TYPES.—*Holotype female*, LAS CRUCES TRAIL, CANAL ZONE, PANAMA, February 1958, M. R. Wheeler (Type no. 70668, USNM). Paratypes, 25 females, as follows: ECUADOR: Santo Domingo de los Colorados, March 1958, M. R. Wheeler, 1. PANAMA: Balboa, C. Z., February 1958, M. R. Wheeler, 5; Barro Colorado Island, C. Z., July 1967, W. W. Wirth, 2; Gamboa, C. Z., Rio Agua Salud, July 1967, W. W. Wirth, 1; Las Cruces Trail, C. Z., February 1958, M. R. Wheeler, 15; Las Cruces Trail, ex bracket fungi, 21 July 1967, W. W. Wirth, 1.

DISCUSSION.—This species is dedicated to Dr. Marshall R. Wheeler of the University of Texas in recognition of his outstanding contributions to our knowledge of Acalyptrate Diptera.

P. wheeleri belongs to the group with *P. azul* and *P. nemorosus*, all with short stocky bodies, broad wing with posteriorly bowed fifth vein, dark halteres and arista feathered or pubescent above and below. It differs from the other two in its larger size, longer hairs on the arista, presence of a well developed pair of facials and lack of pubescent vestiture on the face.

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The Type Locality of *Bombus franklini* and Notes on Putative Arizona Records of Other Bombini

(Hymenoptera: Apidae)

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The type locality and distribution of *Bombus franklini* (Frison) is an enigma. Frison (1921) based his description on two queens sent to him by Mr. E. J. Oslar and labelled as collected by Oslar at Nogales, Arizona in July 1917. However, all subsequent specimens assignable to this species (Frison, 1923, 1926; Stephen, 1957; and Thorp unpublished) have been taken within a 60 mile radius of Grants Pass, Oregon.

Frison (1921, 1923) published additional records of Bombini reputedly collected by Mr. Oslar in June and July 1917 at four localities in southern Arizona (Nogales, Oracle, Catalina Mountains and Patagonia Mountains).

It is my contention that these southern Arizona records, including the type localities for *B. franklini* and the new varieties of *B. sylvicola* and *B. balteatus*, published by Frison (1921, 1923) are not valid. Lines of evidence used in reaching this conclusion include: the known distributions of the species involved; the number of incongruous records involved; and the lack of confirmation through subsequent collections that any of these species occur in southern Arizona.

The Oslar material recorded by Frison (1921) contained the following: *Bombus* (as *Bremus*) *o. occidentalis* Greene, *B. o. nigroscutatus* Franklin, *B. appositus* Cresson, *B. edwardsii* Cresson (as *fernaldae* Franklin), *B. vosnesenskii* Radoszkowsky, *B. flavifrons dimidiatus* Ashmead (as *ambiguus* Franklin), *B. californicus* F. Smith, *B. franklini* (Frison) and *Psithyrus crawfordi* Franklin. The Oslar material recorded by Frison (1923) contained: *B. balteatus* (as *kirbyellus*) vars. *alexanderi* (Frison) and *arizonensis* (Frison), *B. sylvicola* var. *lutzi* (Frison) and *B. pleuralis* Nylander.

Thanks to Dr. W. E. LaBerge of the Illinois Natural History Survey I have had an opportunity to examine most of the types and specimens

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listed by Frison. Frison (1921) failed to recognize two additional species included in the material he recorded: *B. mixtus* Cresson (misidentified as *fernaldae* in part) and *B. caliginosus* (Frison) (misidentified as *vosnesenskii* in part). I also found one queen each of two other species with the same collection data on them. One was *B. nevadensis* Cresson and the other *B. morrisoni* Cresson both correctly identified by Frison.

Six of the species bearing the Oslar, June or July 1917, southern Arizona labels are principally Boreal in distribution: *B. balteatus* Dahlbom is circumpolar, in the Nearctic it extends southward only in the higher mountains to California and New Mexico where it occurs principally above 10,000 feet (Thorp, 1962); *B. sylvicola* Kirby occurs from Alaska to Labrador with southward extensions similar to those of *B. balteatus* (Thorp, 1962); *B. pleuralis* is known only from Alaska, Northwest Territories, Yukon Territory, and northern British Columbia; *B. o. occidentalis* occurs throughout the mountainous areas west of 103° W. longitude from Alaska south to the northern portions of California, Arizona and New Mexico; *B. appositus* occurs throughout the mountains west of 103° W. longitude from British Columbia and Alberta south to the central portions of California, Nevada, Utah, and New Mexico; *B. mixtus* occurs in the mountainous areas west of 105° W. longitude from Alaska south to California, Nevada, Utah and Colorado. The lower elevational limit for all these species increases as their ranges extend southward so that at their southern limits they occur only above 9,000 feet.

Bombus californicus is also principally Boreal, but extends into the Transition zone in California and northwestern Baja California, Mexico. It is found only sparingly in the Rocky Mountains of Idaho, Montana, Wyoming and northern Colorado and appears to be replaced by *B. fervidus* (Fabricius) in Nevada, Utah, southern Colorado, Arizona, New Mexico and east of 100° W. longitude.

Most of the remaining species occur principally west of the crest of the Sierra Nevada and Cascade Range in California, Oregon and Washington, with two extending to northwestern Baja California and one into Alaska: *B. o. nigroscutatus* is restricted to the San Francisco Bay region of California; *B. franklini* is restricted to the Siskiyou Mountain region of southern Oregon and northern California; *B. caliginosus* is restricted to the coastal region of California, Oregon and Washington; *B. edwardsii* occurs in northwestern Baja California, is widespread in California and southwestern Oregon and is replaced by *B. melanopygus* Nylander to the north; *B. vosnesenskii* ranges from northwestern Baja

California to southwestern British Columbia and extreme western Nevada; *B. flavifrons dimidiatus* occurs from the Sierra Nevada and North Coast Ranges of California through the Cascade Range into southern British Columbia and is replaced to the north and in the Rocky Mountain region by *B. f. flavifrons* Cresson; *Psithyrus crawfordi* occurs in the North Coast Ranges, Sierra Nevada and Warner Mountains of California, extreme western Nevada and southern and western Oregon, and is replaced to the north and east by *P. insularis* (F. Smith).

Apparently Frison omitted the records of *B. nevadensis* and *B. morrisoni* from his lists since both of these species had been recorded in Arizona by Franklin (1913). *Bombus nevadensis* is a widespread Boreal-Transition species with several color variants occurring from British Columbia to New York and in the west south into the mountains of California, Nevada, southern Utah and northern New Mexico. *Bombus morrisoni* is principally a Great Basin-Sonoran species which is abundant in Arizona and occurs in the area in question. Perhaps the most significant omission is that of *B. sonorus* Say which is the most abundant species in my experience in the area between Nogales and Oracle. The lack of any specimens of this species bearing the same collection data is another indication that the Oslar locality data reported by Frison (1921, 1923) were based on specimens with erroneous labels.

Many of the species listed from the putative Oslar localities, coexist in areas of comparable size (horizontal distance—85 miles and vertical range—3,900 to 9,200 feet), but only west of the Sierran-Cascade crests. Further, several of the species have mutually exclusive ranges separated by 100 miles or more, e.g. *B. pleuralis-franklini-o. nigroscutatus* and *B. balteatus-franklini-o. nigroscutatus,* and *B. balteatus-caliginosus.*

Frison (1923) evidently had more information than is available on the specimen labels since he states "According to Mr. Oslar, the bumblebees labelled 'Patagonia Mountains, Arizona,' were found feeding on the blossoms of wild blackberry and mesquite at altitudes from 5,500 to 6,000 feet." My own experience suggests that mesquite does not reach this elevation in the Patagonias, but is replaced first by oaks (4–5,000 feet) and then conifers (5–6,000 feet). In addition none of the Bombini in question occur in or near areas containing mesquite.

According to Mr. R. Martin Brown (*pers. comm.*) "He (Oslar) exchanged widely with other professional and amateur collectors and labelled his material to sell." Neither Mr. Brown nor I have been able to determine whether Oslar ever visited the area in question personally or whether he received the material from another collector.

Among the 10 species of *Bombus* and one *Psithyrus* listed by Frison

(1921, 1923) as having been collected by E. J. Oslar in the Nogales to Oracle area of southern Arizona, not one has been subsequently collected in this area and only one species record has been definitely confirmed for the state. The latter is based on specimens of *B. o. occidentalis* taken above 9,000 feet in the San Francisco Mountains which is about 200 miles north of and 4,500 feet higher than Oracle. Of the additional species I found in the Illinois Natural History Survey collection, only *B. morrisoni* definitely occurs in the area between Nogales and Oracle. Franklin's (1913) putative record of *B. nevadensis* from Arizona based on one male, and his supposition that *B. californicus* should occur in Arizona have not yet been confirmed by subsequent collections.

In 1962 I discussed the distributions of *B. balteatus* and *B. sylvicola* and suggested that the Patagonia Mountain records were incongruous for varieties of these species. However, being unaware of any contrary evidence, I accepted the records. Based on the evidence at hand I now suggest that all the species recorded by Frison (1921, 1923) as being collected by E. J. Oslar in 1917 in southern Arizona be disregarded until confirmed by subsequent collections. *Bombus o. occidentalis* should be retained in Arizona lists since it has been taken in the northern part of the state. I also propose Gold Hill, Jackson County, Oregon as the new type locality for *B. franklini*, since it is in the approximate center of the known distribution of the species and specimens of all castes have been taken there. Frison's (1923) varieties of *B. balteatus* and *B. sylvicola* most closely resemble color variants from the Rocky Mountains of Colorado, however I do not consider these varieties as valid subspecies and do not propose to select new type localities for them.

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A New Species of Scorpion Belonging to the Pumilis Group of Genus *Vejovis*

(Scorpionida: Vejovidae)

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During the summer of 1968 an entomological expedition through Baja California, Mexico led by S. C. Williams and M. A. Cazier collected a number of new species of scorpion. Of special interest was one subsequently described as *Vejovis pumilis* Williams. This was of special interest because: it was one of the smallest species of the genus, appeared to be endemic to the Magdalena Plain (a terrestrial habitat of relatively recent formation) and apparently was quite unrelated to the other members of the genus. Also among the specimens collected on this expedition, but not discovered until recently, was a much less abundant and undescribed species of special interest because it appears to be an ecological counterpart of *Vejovis pumilis* in the Viscaino Desert of Baja California, and because it appears to be the only close known relative of *Vejovis pumilis*. This new species is here described and named *Vejovis pseudopumilis*.

Vejovis pseudopumilis Williams, new species

(Figures 1, 2)

DIAGNOSIS.—Tiny pale yellow species of *Vejovis*. Only close relative known is *Vejovis pumilis* Williams from which it differs in the following ways: pectines distinctly larger and with more numerous teeth; telson shorter than metasoma segment I; vesicle proportionally larger, twice aculeus length (three times aculeus length in *V. pumilis*); telson light amber not contrasting orange; pedipalp fingers not scalloped, but with tiny gap when chela closed (scalloped and with large gap in *V. pumilis*).

HOLOTYPE MALE. *Coloration*: uniform pale yellow, pedipalp fingers light pink, telson light amber, pectines whitish. Carapace with anterior border convex; each group of lateral eyes with two large anterior eyes and third obsolescent one. Mesosoma with stigma tiny, long oval; last sternite with one pair of irregularly granular keels; last tergite with two pairs of irregularly granular lateral keels and poorly developed median keel. Metasoma with dorsal and dorsolateral keels not strongly raised, these irregularly crenulate to dentate; inferior lateral keels smooth to faintly crenulate on segments I to III, irregularly crenulate on IV, irregularly serrate on V; inferior median keels on segments I to III smooth, smooth to faintly crenulate on IV, irregularly serrate on V; inferior median keels set with 3/4/4/5 pairs of stout red hairs on segments I to IV respectively; segment I slightly longer than wide, segment II definitely longer than wide. Telson elongate; long slender vesicle almost twice aculeus length; entire telson shorter than

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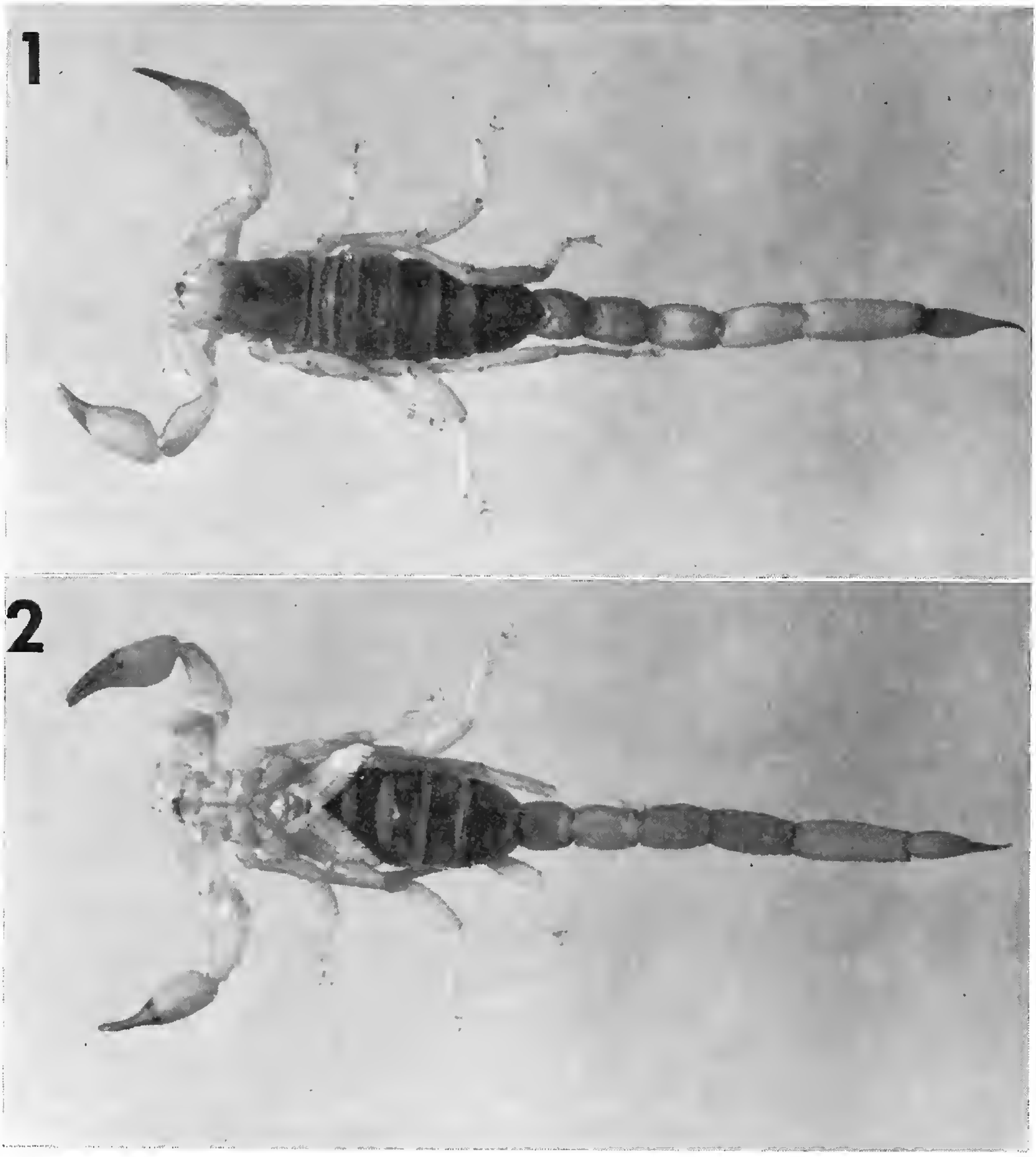

Figs. 1 and 2. *Vejovis pseudopumilis* Williams, new species, holotype male. Fig. 1. Dorsal view. Fig. 2. Ventral view.

metasomal segment V; ventral surface of vesicle with several large rounded tubercles including large subaculear tubercle; this surface with about 10 pairs of long stout hairs. Chelicerae with inferior border of movable finger completely lacking denticles. Pedipalps with small chelae, these slightly swollen and with short fingers; movable finger ⅔ carapace length and shorter than carapace width at median eyes; fingers essentially unscalloped inwardly but leave tiny proximal space when chela closed; palm with smooth to crenulate keels.

Standard measurements.—Table 1.

The *holotype male* was collected at San Angel, 13 miles west of San Ignacio, Baja California Sur, Mexico, 28 June 1968 by S. C. Williams,

TABLE 1. Measurements (in millimeters) of *Vejovis pseudopumilis* Williams, new species, holotype.

	Holotype (male)
Total length	27.0
Carapace, length	3.4
width (at median eyes)	2.3
Metasoma, length	12.9
segment I (length/width)	1.8/1.7
segment II (length/width)	2.1/1.6
segment III (length/width)	2.1/1.4
segment IV (length/width)	2.9/1.4
segment V (length/width)	4.0/1.4
Telson, length	3.6
Vesicle (length/width)	2.3/0.9
depth	0.8
Aculeus, length	1.3
Pedipalp	
Humerus (length/width)	2.4/0.9
Brachium (length/width)	2.6/1.2
Chela (length/width)	4.2/1.4
depth	1.6
movable finger, length	2.0
fixed finger, length	1.4
Pectines	
teeth (left/right)	18/18

M. A. Cazier and party. The holotype is permanently deposited in the California Academy of Sciences.

This species is named "pseudopumilis" because it closely resembles its own known close relative *Vejovis pumilis* Williams.

ACKNOWLEDGMENTS.—The field and laboratory research involved in the discovery, collection and study of this species was supported by the systematics branch of the National Science Foundation by research grant number GB 7679 and by a Faculty Research Leave from San Francisco State College. Thanks are due Christie Steketee for clerical assistance in the preparation of this manuscript.

Tardigrada of Santa Cruz Island, California

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Schuster and Grigarick, in a previous study of the Tardigrada fauna of Western North America (1965), recorded 38 species from the California mainland. Since that report, extensive collections have been accumulated from Santa Cruz Island, Santa Barbara County, and now the major features of that insular fauna can be identified.

Santa Cruz Island is 25 miles south of Santa Barbara, and 18 miles west of Port Hueneme. It is 25 miles long and over 2,400 feet in elevation. A central valley and several permanent freshwater streams are notable features of the island, and these are responsible for locally modifying the climate and for increasing the variety of habitats.

Samples, mainly of algae, lichens, and mosses, were collected and the tardigrades were extracted from them by using simple Baermann funnels. Core samples of intertidal sand were washed and decanted through sieves of 325 mesh per sq. inch. The specimens are mounted on slides in a Hoyer's type medium, and are in the museum of the Department of Entomology at Davis.

Most of the collection sites may be found on United States Geological Survey quadrangles Santa Cruz Island A, B, C, and D. These sites are identified by number on the accompanying may (Map 1), and the separate collections at each site bear letter designations. Some collections of plant material were too small or too intermixed to allow easy identification, and the tardigrade species recovered were referred simply to the site number.

ACKNOWLEDGMENTS

We greatly appreciate the kindness of Dr. William A. Weber of the University of Colorado Museum for providing determinations of the lichens and mosses, and of Dr. Paul C. Silva, University of California, Berkeley, for naming the marine algae. Michael R. Benedict of the Channel Island Field Station, University of California, identified the ecologically distinctive areas of the island and succeeded in transporting us to most of them. Dr. Donald S. Horning, Jr. collected samples, especially in the pines at Centinela, a habitat not sampled by the authors. Joanne S. Wasbauer and Susan K. Senser also assisted in the survey.

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COLLECTION DATA

Tardigrades were found at sixteen of the localities surveyed (Map 1) and only a few unusual situations (for example, water troughs) did not yield tardigrades. Specimens were recovered from approximately one-half of the 45 plant species collected and these associations are summarized following the collection data.

PELICAN BAY.—Collections labeled Pelican Bay were from the slopes east of the Bay, from near sea level to about 600 feet, and were collected on 4 May 1969.

1 A *Homalothecium pinnatifidum* (Sull. et Lesq.) Lawton.
1 B *Physcia* sp.
1 C *Ramalina ceruchis* (Ach.) deNot.
1 D *Ramalina homalea* Ach.
1 E *Ramalina reticulata* (Noedh.) Krempelh.

PRISONERS HARBOR.—These collections were made near the beach, at or to the west of the pier. Sample (C) was collected on 9 May 1968, and the others on 28 April 1969.

2 A Intertidal
2 B *Physcia* sp.
2 C *Ramalina ceruchis* (Ach.) deNot.
2 D *Ramalina homalea* Ach.

COCHES PRIETOS.—The 1968 samples (A–D) were from moderately luxurious growth on cliffs to the west of the beach. The 1969 collections (E–G) were from the higher and somewhat drier hills to the east.

3 A *Parmelia arnoldii* Du Rietz.
3 B *Ramalina ceruchis* (Ach.) deNot.
3 C *Ramalina homalea* Ach.
3 D *Selaginella bigelovii* Underw.
3 E *Caloplaca* sp.
3 F *Homalothecium pinnatifidum* (Sull. et Lesq.) Lawton.
3 G *Parmelia cristifera* Say.

JOHNSTON CANYON.—

4 Intertidal collections only were made at this locality.

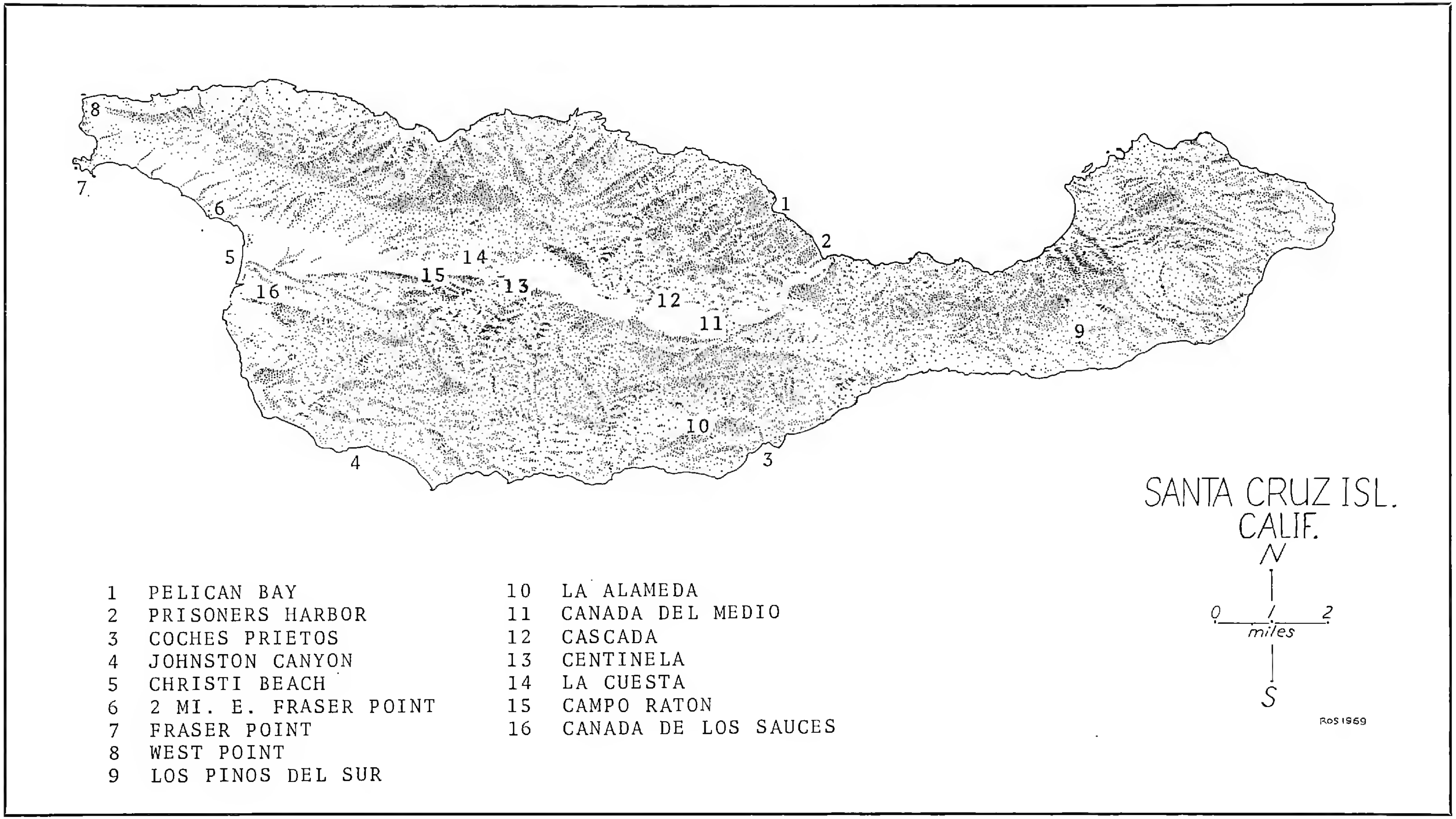
CHRISTI BEACH.—Numerous intertidal core samples did not reveal marine species. Terrestrial species were recovered from lichens collected by D. S. Horning, Jr., 14 May 1969, on the ridge above Christi airport.

5 A *Parmelia caperata* (L.) Ach.
5 B *Ramalina reticulata* (Noedh.) Krempelh.

TWO MILES EAST OF FRASER POINT.—This locality is a canyon protected from the prevailing wind. A considerable quantity of material was processed from both spring and fall collections with very few specimens being recovered. Sample number 6 was collected 11 May 1968, and samples A and B were collected 30 April 1969.

6 A *Ramalina homalea* Ach. on rocks.
6 B *Selaginella bigelovii* Underw.

FRASER POINT.—A considerable amount of rocky shoreline is exposed at low



MAP 1. Santa Cruz Island tardigrade collection sites.

tide. Two genera of marine tardigrades were recovered from samples collected 30 May 1969, and 28 September 1969.

7 Intertidal algae (May).

7 A Mixed *Rhodoglossum affine* (Harv.) Kylin and *Gigartina canaliculata* (Harv.) Harv., and *Porphyra perforata* J. Ag. (Sept.).

West Point.—Rocks on the cliffs at this locality had luxuriant lichen growth of many species but few specimens of tardigrades were recovered. The samples were collected on 21 September 1968.

8 *Ramalina* sp.

Los Pinos del Sur.—Collections at this locality were of lichens on branches of *Arctostaphylos insularis* and *A. tomentosa subcordata*, in May, 1969.

9 *Ramalina* sp.

La Alameda.—Small rocks covered with lichen were collected at this locality on 11 May 1968.

10 *Parmelia* (*Xanthoparmelia*) sp.

Canada del Medio.—This locality includes samples from the floor of Canada del Medio near the field station, but mostly from a south facing canyon opening near the station. The canyon has a small stream and is shaded in the afternoon. Samples were taken from the lower elevations where *Quercus agrifolia* was present, and were collected in May of 1968, and April and May of 1969.

11 A Algae in stream.
11 B *Azola* sp.
11 C Moss.
11 D *Parmelia* (*Xanthoparmelia*) sp.
11 E *Physcia callosa* Nyl.
11 F Moss near stream.
11 G *Porella navicularis* (Lehm. et Lindenb.) Lindb.
11 H *Salix lasiolepis* roots and algae.
11 I *Selaginella bigelovii* Underw.

Cascada.—Cascada is about a mile west of the field station. The situation differs from that locality mainly in greater stream flow, extensive sandy stream bottom, and a more open canyon with less shade.

12 A *Cardionema ramosissima* (Weinm.) A. Nels. & MacGr.
12 B *Parmelia* nr. *mexicana* Gyel.
12 C *Selaginella bigelovii* Underw.

Centinela.—This locality is in a coniferous forest and the samples were from the bark and twigs of *Pinus remorata* and *Heteromeles arbutifolia.* Collections were by D. S. Horning, Jr., 14 May 1969.

13 A *Parmelia caperata* (L.) Ach. on *Pinus.*
13 B *Usnea* sp. on *Heteromeles.*

La Cuesta.—La Cuesta is a grade between Campo Raton and Centinela. The collected area is east of, and at higher elevation than, Campo Raton. Collections were by D. S. Horning, Jr., 14 May 1969.

14 A *Ramalina reticulata* (Noedh.) Krempelh.

Campo Raton.—This area is at the eastern end of Christi Canyon and consists of a small stream shaded by oaks. Moss and lichens collected from oak in 1967 were not identified.

15 A Moss.
15 B Lichen.

CANADA DE LOS SAUCES.—Sauces is a canyon south of, and parallel to, Christi Canyon. Lichens were collected from Monterey Cypress on 14 May 1969 by D. S. Horning, Jr.

16 Lichen.

SUMMARY OF TARDIGRADE AND PLANT ASSOCIATIONS

BATILLIPES SP.: mixed *Rhodoglossum affine* (Harv.) *Kylin* and *Gigartina canaliculata* (Harv.) Harv., *Porphyra perforata* J. Ag.

ECHINISCOIDES SIGISMUNDI: marine algae, interstitial.

ECHINISCUS ARCTOMYS: Caloplaca sp., *Parmelia arnoldii, P. caperata, P. cristifera, Physcia callosa, Porella navicularis, Ramalina ceruchis, R. homalea, Selaginella bigelovii, Usnea* sp.

HYPSIBIUS CANADENSIS: *Ramalina homalea, Physcia callosa.*

HYPSIBIUS DUJARDINI: freshwater algae.

HYPSIBIUS CONVERGENS: *Porella navicularis, Selaginella bigelovii.*

HYPSIBIUS OBERHAEUSERI: *Parmelia arnoldii, Porella navicularis, Ramalina ceruchis, Selaginella bigelovii, Usnea* sp.

MACROBIOTUS AREOLATUS: *Porella navicularis.*

MACROBIOTUS DISPAR: freshwater algae, *Azola* sp.

MACROBIOTUS HARMSWORTHI: *Caloplaca* sp., *Parmelia caperata, Physcia* sp., *Ramalina ceruchis, Selaginella bigelovii, Usnea* sp.

MACROBIOTUS HUFELANDII: *Caloplaca* sp., *Cardionema ramosissima, Homalothecium pinnatifidum, Parmelia cristifera, Physcia* sp., *Porella navicularis, Ramalina ceruchis, R. homalea, R. reticulata, Selaginella bigelovii.*

MACROBIOTUS INTERMEDIUS: *Physcia* sp., *Ramalina ceruchis.*

MILNESIUM TARDIGRADUM: *Cardionema ramosissima, Homalothecium pinnatifidum, Parmelia caperata, P. cristifera, P.* nr. *mexicana, Physcia callosa, Ramalina ceruchis, R. homalea, R. reticulata, Selaginella bigelovii.*

The tardigrade species are neither equally abundant nor uniformly distributed on the island. Marine, freshwater, and terrestrial environments have characteristic tardigrade inhabitants. The majority of species collected were terrestrial. Existing host-plant associations appear inadequate to explain observed distributional patterns of these terrestrial species. Habitat or host specificity may be expressed at a particular site, but the same plant species may harbor different tardigrade species at other localities.

SYSTEMATICS

BATILLIPEDIDAE Ramazzotti, 1962

BATILLIPES Richters, 1909

Specimens of this genus are either very uncommon or occupy a niche consistently missed in random sampling of the intertidal habitat. More than 400 interstitial core samples, each of 100 cc minimum volume, were collected from Prisoners Harbor, Coches Prietos, Christi Beach and Fraser Point. These samples included sands of different texture, were taken from high to minus tide levels, and were all tardigrade negative. Three specimens were recovered from washings of three algae (samples 7, 7A). This low density may be indicative of these collections being from an atypical habitat for the genus.

Batillipes ? similis Schulz, 1955 (Figs. 1, 2). Three available specimens show instability in some taxonomic characters, particularly the dorsal spines and the leg spines, and have not been identified with certainty. The species is very similar to *B. similis* in respect to body shape, and in size and form of the cephalic appendages.

OREELLIDAE Ramazzotti, 1962

ECHINISCOIDES Plate, 1889

Echiniscoides sigismundi (M. Schultze, 1865). This marine tardigrade is easily recognized by the number of claws, usually eight, on each leg. It is most abundant in the green algae growing in and around barnacles but infrequently may be found in washings from other intertidal habitats. We have specimens from sites 2A, 4, and 7, and presume the species may be found whenever the coast is rocky and suitable algal growth is present.

ECHINISCIDAE Thulin, 1928

ECHINISCUS C. A. S. Schultze, 1840

Echiniscus arctomys Ehrenberg, 1853. The genus *Echiniscus* is easily recognized as it is the only one on Santa Cruz Island having the dorsum covered by distinct plates. A single species, *E. arctomys*, is widely distributed on the island. It has been recovered from samples 1B, 3A, 3B, 3C, 3D, 3E, 3G, 5A, 11C, 11E, 11G, and 13B. The species appears to be equally prevalent in lichens, mosses, and hepatics.

MACROBIOTIDAE Thulin, 1928

This family is represented on Santa Cruz Island by two genera, *Macrobiotus* and *Hypsibius*. *Macrobiotus* is distinguished by the mouth tube having a ventral supporting structure (fig. 7VS) and by the claws of each leg being similar. Species of *Hypsibius* generally do not have the buccal tube support and the two claws of each leg are dissimilar. The species of both genera can be recognized by the diameter of the mouth tube, by the placement of the stylet supports, by the number and relative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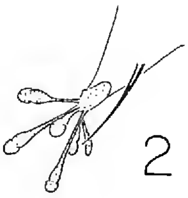
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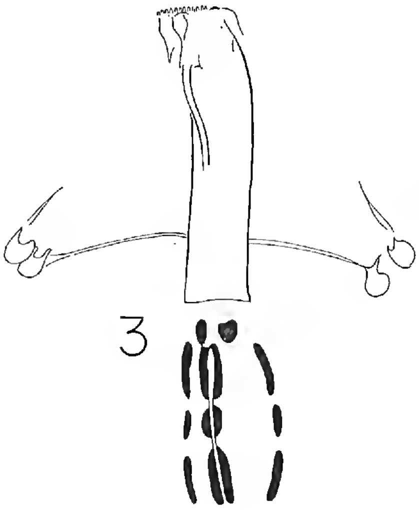
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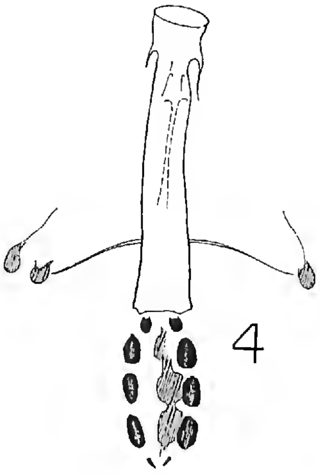
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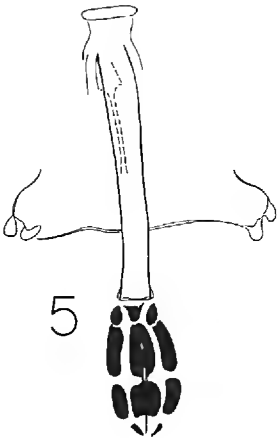
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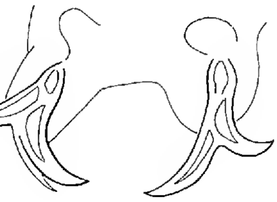
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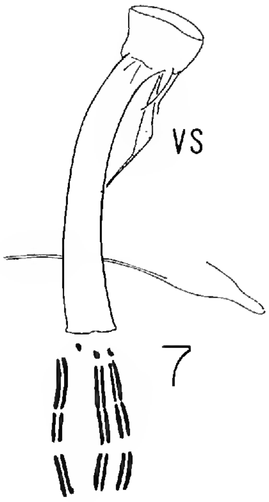

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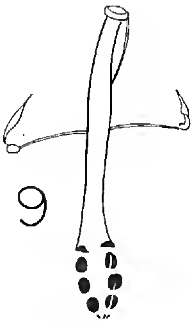
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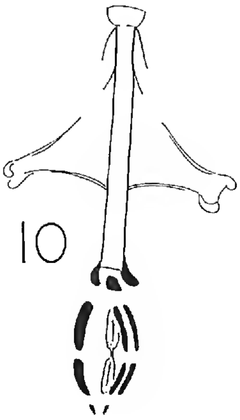
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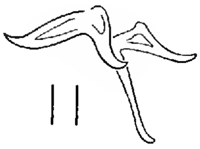
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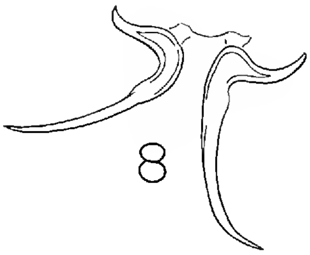
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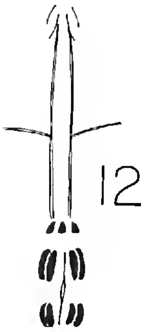
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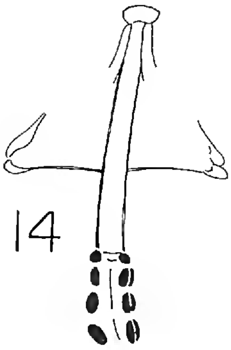
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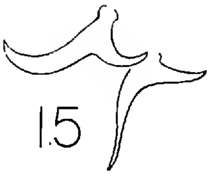
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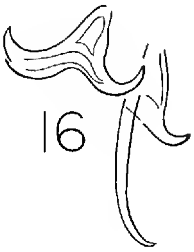
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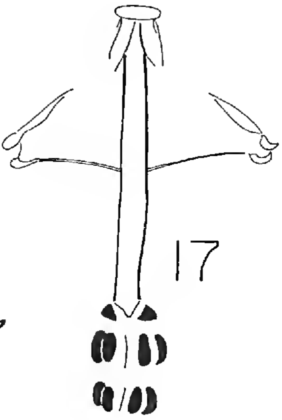
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size of the placoids (apophysis and placoids are inked solid in the figs.), and by the shape of the claws. These structures are figured for the relatively few Santa Cruz Island species.

MACROBIOTUS C. A. S. Schultze, 1834

Macrobiotus areolatus Murray, 1907 (Fig. 3). The specimens from mainland California that were considered to be *M. areolatus* were determined on the basis of eggs which were typical of that species. The macroplacoids of these specimens were somewhat atypical, the second being distinctly shorter than the first and third. The Santa Cruz Island population has placoids of the same proportion, but differ slightly in the location of the stylet supports which are often attached at a distance from the base equal or greater to the mouth tube diameter. The eggs of the Santa Cruz population are of the *M. areolatus* form although the processes are somewhat shorter and more conical than those of the mainland population. Most of the specimens have eyes and the microplacoids are absent, typical of *M. areolatus*.

Specimens were found in samples 11F, 11G, 14, 15, and 16. The only identified host was the hepatic, *Porella navicularis*, and the remaining samples were unidentified moss.

Macrobiotus harmsworthi Murray, 1907 (Fig. 4). *Macrobiotus harmsworthi* is easily distinguished from the other Santa Cruz species by the wide mouth tube, the three subequal macroplacoids and the presence of a microplacoid. Specimens segregated by this combination of characters can be further separated into two distinct forms. One form has no eyespots and the claws are typically Y-shaped with the branches of each claw united in the basal one-half. This was the form most frequently found, the one exception being at Coches Prietos.

The Coches Prietos specimens have eyespots and the macroplacoids

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←

FIG. 1. *Batillipes ? similis*, cephalic appendages. FIG. 2. *Batillipes ? similis*, leg IV. FIG. 3. *Macrobiotus areolatus*, mouthparts. FIG. 4. *Macrobiotus harmsworthi*, mouthparts. FIG. 5. *Macrobiotus hufelandii*, mouthparts. FIG. 6. *Macrobiotus hufelandii*, claws of leg IV. FIG. 7. *Macrobiotus dispar*, mouthparts. FIG. 8. *Macrobiotus dispar*, claws of leg IV. FIG. 9. *Macrobiotus intermedius*, mouthparts. FIG. 10. *Hypsibius dujardini*, mouthparts. FIG. 11. *Hypsibius dujardini*, claws of leg IV. FIG. 12. *Hypsibius convergens*, mouthparts. FIG. 13. *Hypsibius convergens*, claws of leg IV. FIG. 14. *Hypsibius canadensis*, mouthparts. FIG. 15. *Hypsibius canadensis*, claws of leg IV. FIG. 16. *Hypsibius oberhaeuseri*, claws of leg IV. FIG. 17. *Hypsibius oberhaeuseri*, mouthparts.

tend to be thicker. The claws are V-shaped, and the branches diverge from less than 50% of the claw length. This form is present also on San Nicholas Island and at Camarillo, Ventura Co. *M. harmsworthi* was present in samples 1B, 1C, 3D, 3E, 5, 6B, 8, 13A, and 13B. The species was moderately common and no host preference was apparent among terrestrial plants.

Macrobiotus hufelandii C. A. S., Schultze, 1834 (Figs. 5, 6). A wide mouth tube, two macroplacoids of unequal length, and the presence of a microplacoid characterize *M. hufelandii.* Our determination is based on both adults and eggs. *M. hufelandii* was one of the most frequently recovered species, and occurred in about the same number of samples as *Echiniscus arctomys* and *Milnesium tardigradum.*

Specimens recovered from *Selaginella* at Cascada and at Coches Prietos lack eyes, the first macroplacoid is constricted, and the secondary branch of the claw is frequently reduced and more distal. The remaining specimens have eyes, the first macroplacoid is somewhat shorter and not constricted and the claws are of the typical *M. hufelandii* form. Specimens were collected at 1A, 1C, 1D, 1E, 2B, 2D, 3D, 3E, 3F, 3G, 6A, 11G, 11I, and 12A.

Macrobiotus intermedius Plate, 1888 (Fig. 9). This species is represented in our collections by few specimens and no eggs. None of the characters requisite for positive identification (the egg, or granulation and punctation of the cuticle) are available in our material. However, the general facies—small size, eyes, structure and size of mouthparts—provides sufficient information for reasonably certain identification. The specimens were recovered at Pelican Bay from samples 1B and 1C.

Macrobiotus dispar Murray, 1907 (Figs. 7, 8). This freshwater species has been recovered from algae and *Azola* sp. in the canyon across from the field station, and it could be expected to occur in the other small streams. However, it was not found in numerous samples from Cascada and Canada del Puerto. We considered this species to be *M. macronyx* in our 1965 study, a species characterized by its eggs being laid within the exuvia. Ramazzotti (1967) states that he has never seen *M. macronyx* and doubts the existence of the species. We have never seen eggs deposited within the exuvia, and now believe the name *dispar* should be applied to the Californian populations. This determination is based on the generally favorable agreement of our specimens with the descriptive information on *M. dispar*, and particularly on the presence of a chitinous band connecting the two claws of each leg. Specimens were present in samples 11A, 11B and 11H.

HYPSIBIUS Ehrenberg, 1848

Four species of *Hypsibius* were identified from our collections. Also, an apparently undescribed species similar to *H.* (*C.*) *castri* was found at Coches Prietos. Additional examples of this species will be necessary to confirm the relationship.

Hypsibius (*Hypsibius*) *oberhaeuseri* (Doyère, 1840) (Figs. 16, 17). The specimens of this species are less granular and less pigmented than those from most mainland collections. However, the color and sculpture of the cuticle are known to be quite variable and the mouthparts and claws are distinctly those of *oberhaeuseri.* Collections were from 1C, 3A, 3D, 11G, and 13B.

Hypsibius (*Hypsibius*) *convergens* (Urbanowicz, 1925) (Figs. 12, 13). *Hypsibius convergens* is distinguished from *H. oberhaeuseri* by the principal branch of the external double claw, which for *H. convergens* gradually tapers from the base and appears thicker. Also, the placoids are thinner. It was collected at 11G and 12C.

Hypsibius (*Hypsibius*) *dujardini* (Doyère, 1840) (Figs. 10, 11). This is essentially an aquatic species. It is best recognized by the elongate macroplacoids and the presence of a microplacoid. A single specimen was recovered from collection 11A.

Hypsibius (*Isohypsibius*) *canadensis* Murray, 1910 (Figs. 14, 15). The three macroplacoids, which increase slightly in length from first to third, and the absence of a microplacoid, distinguish this species. It was present in samples 6A and 11E.

MILNESIIDAE Ramazzotti, 1962

MILNESIUM Doyère, 1840

Milnesium tardigradum Doyère, 1840. The very wide mouth tube and the absence of placoids allow easy recognition of this species. It was recovered more frequently than any other species and was present in samples 1A, 1B, 1D, 2C, 3G, 5A, 9, 10, 11E, 11F, 12A, 12B, 12C, 14A, and 15.

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A List of the Odonata of Washington with Additions to and Deletions from the State List

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The Odonata of Washington, like those of most of the western States, have been little studied. Kennedy (1915) surveyed the odonates of the Yakima River Valley, but no other section of the State has been sampled adequately. The Seattle-Olympia region received much attention from early entomologists, and probably most of the species occurring in that region have been reported in scattered publications. My field work in the State has extended thus far from September 1967 to June 1969, mostly east of the Cascades. The present list was based on literature records, specimens in the University of Washington Burke Memorial Museum (UW), and specimens in my collection (DRP), many of which have been deposited in the Florida State Collection of Arthropods (FSC). I would like to thank my wife Mary Lynn, for her help in the field and laboratory; Donald P. Frechin, who turned over to me Odonata collected by him in western Washington; Melville H. Hatch, who allowed me to examine specimens in the Burke Museum; and Minter J. Westfall, Jr., who assisted me in searching the literature for records of Washington Odonata. Much of my field work in Washington was made possible by National Science Foundation Grant GB-7361 to Gordon H. Orians, to whom I am grateful.

ADDITIONS

COENAGRION RESOLUTUM Hagen.—*Stevens Co.*, Coffin Lake, 3.8 mi. S Middleport, 3300 ft., 8 July 1968 (3♂ 3♀ DRP, 1♂ FSC); *Pend Oreille Co.*, Niles Lake, 5.8 mi. SW Tiger, 3400 ft., 8 July 1968 (5♂ 1♀ DRP, 4♂ FSC); slough at Usk, 2200 ft., 9 July 1968 (2♂ 1♀ DRP); *Chelan Co.*, pond 1.2 mi. E Stevens Pass, 3700 ft., 7 August 1968 (3♂ 1♀ DRP, 2♂ FSC).

NEHALENNIA IRENE Hagen.—*Okanogan Co.*, Black Pine Lake, 4200 ft., 18 June 1969 (10♂ 5♀ DRP, 10♂ 5♀ FSC); *Chelan Co.*, Soda Springs, 25 June 1939 (1♀ UW); *Pend Oreille Co.*, Niles Lake, 5.8 mi. SW Tiger, 3400 ft., 8 July 1968 (5♂ 4♀ DRP, 4♂ FSC).

AESHNA CONSTRICTA Say.—*Spokane Co.*, Turnbull National Wildlife Refuge, 19 September 1967 (1♀ DRP); 9 July–28 September 1968 (18♂ 12♀ DRP, 11♂ 5♀ FSC); also many exuviae. Previous records of this species (Calvert, 1901–08) from the State were referred to *A. palmata* and *A. umbrosa* by Walker (1912).

AESHNA EREMITA Scudder.—*Pend Oreille Co.*, Niles Lake, 5.8 mi. SW Tiger, 3400 ft., 8 July 1968 (3 exuviae DRP). Adults of a large *Aeshna*, presumably this species, were seen at this locality.

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AESHNA JUNCEA Linnaeus.—*King Co.*, pond 5.5 mi. W Stevens Pass, 2200 ft., 23 September 1967 (1♂ DRP); *Chelan Co.*, pond 1.2 mi. E Stevens Pass, 3700 ft., 7 August 1968 (2♂ DRP, 1♂ FSC).

AESHNA TUBERCULIFERA Walker.—*Mason Co.*, "oak patch," 23–29 August 1959 (2♂ 2♀ DRP, 1♀ FSC).

CORDULEGASTER DORSALIS Selys.—"Western Washington" (1♂ 1♀ UW).

SOMATOCHLORA MINOR Calvert.—*Stevens Co.*, Hande Creek, 1.0 mi. S and 0.6 mi. W Middleport, 3300 ft., 8 July 1968 (1♂ DRP).

SOMATOCHLORA WALSHI Scudder.—*Stevens Co.*, Hande Creek, 1.0 mi. S and 0.6 mi. W Middleport, 3300 ft., 8 July 1968 (1♀ DRP).

LEUCORRHINIA GLACIALIS Hagen.—*King Co.*, Redmond, 17 July 1966 (1♀ DRP).

SYMPETRUM DANAE Sulzer.—*Spokane Co.*, Turnbull National Wildlife Refuge, 19 September 1967 (1♂ DRP); 2–29 September 1968 (10♂ 4♀ DRP, 8♂ FSC).

TRAPEZOSTIGMA LACERATUM Hagen.—*Spokane Co.*, Turnbull National Wildlife Refuge, 21 July 1968 (1♂ DRP); *Grant Co.*, Columbia National Wildlife Refuge, 19 September 1967 (1♂ DRP); 5–7 July 1968 (1♂ 1♀ DRP). Emerged in large numbers from Coot Lake on Columbia Refuge.

Of these species, *Coenagrion resolutum*, *Aeshna constricta*, *Cordulegaster dorsalis*, *Somatochlora minor*, *Leucorrhinia glacialis*, and *Sympetrum danae* were to be expected in the State because of their known distribution in the West. *Aeshna eremita* and *A. juncea* range south in the Rockies to Utah and/or Colorado (Needham and Westfall, 1955; Kormondy, 1960) but were not known from the Pacific States. *Nehalennia irene* and *Somatochlora walshi* occur entirely across southern Canada but have not been reported from the western United States. *Aeshna tuberculifera* was known in the West from an isolated population on Vancouver Island (Walker, 1958), and the present records indicate it may be more widespread in this region. *Trapezostigma laceratum* is the only southern species involved in the above list; it was known previously as far north as California, Nevada and Utah (Needham and Westfall, 1955).

DELETIONS

ARCHILESTES GRANDIS Rambur.—Calvert (1899) and Muttkowski (1910) listed this species for Washington before Kennedy (1915) clarified the relationship between it and *A. californica* McLachlan, to which all Washington records of the genus should be referred.

AMPHIAGRION SAUCIUM Burmeister.—All early records of *A. abbreviatum* Selys were listed under this name; *A. saucium* is eastern in distribution and does not occur in the State.

CORDULEGASTER ERRONEA Hagen.—This eastern species, recorded from Washington by Fraser (1929), is very unlikely to occur in the State. Probably Fraser's specimens were *C. dorsalis*.

LEPTHEMIS SIMPLICICOLLIS Say.—This species, recorded widely from the West by Needham and Westfall (1955), does not occur west of the Great Plains, and all records of it from this region should be referred to *L. collocata* Hagen. The confusion between these two species was terminated by Gloyd (1958), and all western specimens of this genus checked since that time by the author, L. K. Gloyd, and M. J. Westfall, Jr., have proven to be *L. collocata.*

SYMPETRUM SEMICINCTUM Say.—Early records of this species from Washington (Ris, 1909–1919; Kennedy, 1915) refer to *S. occidentale* Bartenef (Walker, 1951).

WASHINGTON LIST

The following list includes all species known to occur in Washington. A "W" (west) or "E" (east) indicates species which occur on only one side of the Cascades. Species known from only the boreal areas north of Spokane or in the Cascades are indicated by an "S" or "C" respectively.

CALOPTERYGIDAE: *Calopteryx aequabilis californica* (W); *C. a. yakima* (E).

LESTIDAE: *Archilestes californica* (E), *Lestes congener, L. disjunctus disjunctus, L. dryas, L. unguiculatus.*

COENAGRIONIDAE: *Amphiagrion abbreviatum, Argia emma* (E), *A. vivida* (E), *Coenagrion resolutum* (S, C), *Enallagma boreale, E. carunculatum, E. clausum* (E), *E. cyathigerum, E. ebrium* (E), *Ischnura cervula, I. erratica* (W), I. *perparva, Nehalennia irene* (S, C).

PETALURIDAE: *Tanypteryx hageni* (C).

AESHNIDAE: *Aeshna californica, A. canadensis* (S), *A. constricta* (E), *A. eremita* (S), *A. interrupta interna, A. juncea* (C), *A. multicolor, A. palmata, A. tuberculifera* (W), *A. umbrosa occidentalis, Anax junius.*

GOMPHIDAE: *Gomphus graslinellus* (S), *G. kurilis confraternus* (W), *Octogomphus specularis* (W), *Ophiogomphus occidentis, O. severus* (E), *Stylurus* sp. (probably *olivaceus*) (E).

CORDULEGASTRIDAE: *Cordulegaster dorsalis* (W).

MACROMIIDAE: *Macromia magnifica.*

CORDULIIDAE: *Cordulia shurtleffi* (S, C), *Epitheca canis, E. spinigera, Somatochlora albicincta* (C), *S. minor* (S), *S. semicircularis* (S, C), *S. walshi* (S).

LIBELLULIDAE: *Ladona julia, Lepthemis collocata, Leucorrhinia glacialis* (W), *L. hudsonica, L. intacta, L. proxima* (S, C), *Libellula forensis, L. nodisticta* (known only from "Washington"), *L. pulchella, L. quadrimaculata, Pachydiplax longipennis, Plathemis lydia, Sympetrum corruptum, S. costiferum, S. danae, S. illotum* (W), *S. internum* (E), *S. madidum, S. obtrusum, S. occidentale occidentale, S. pallipes, S. vicinum,* and *Trapezostigma laceratum* (E).

DISCUSSION

Of the 69 species now known from the State, 13 occur only in montane regions, of which three are restricted to the Cascades and five to the mountains north of Spokane. Additional collecting may reveal that these upland areas share more species than is presently known. Of 55 lowland species, 38 occur on both sides of the Cascades, seven are known from only the west side, and ten are known from only the east side. Thus 69% of the species are found on both sides of the major biogeographic barrier in the State. With more field work this figure may be raised, as only a few areas in the eastern part and none in the western part of the State have been working intensively. This percentage is higher than those of terrestrial vertebrates, both flying (59% of 138 land birds; 56% of 16 bats) and flightless (50% of 66 mammals, not including bats; 33% of 21 reptiles; 22% of 18 amphibians).

Two factors are important in contributing to the widespread distribution of odonate species in this region and in general. First, odonates, especially anisopterans, have strong powers of flight, and many species could fly across the Cascade mountain passes. Weaker-flying species could be transported passively by the strong winds through these same passes. Second, dragonflies are aquatic for much of their life history, and when they attain sexual maturity the adults respond again to aquatic habitats, which may be similar in regions of very different terrestrial ecology. To an *Aeshna*, a shallow cattail-bordered pond in a sagebrush desert may be equivalent to a similar pond in a humid coniferous forest, yet few terrestrial organisms would inhabit both of these environments. In this group, as in others, combinations of historical and ecological factors have produced present-day biogeographies, and the differences in environments on either side of physical barriers may be more important than the barriers themselves in determining the respective biotas.

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Notes on the Saprophagous Activity of *Bufolucilia silvarum* (Meigen)

(Diptera: Calliphoridae)

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Bufolucilia silvarum (Meigen) is known to be a parasite of toads and frogs. Hall (1948) regarded the species as an obligatory parasite. However, more recent literature suggests that *B. silvarum* may be a saprophage and only a facultative parasite. Fly population data obtained by Dicke and Eastwood (1952) and Schoof, Savage, and Dodge (1956) show a substantially high population, much greater than could be supported by parasitism alone. Dodge (1952) reported the most significant evidence that *B. silvarum* may be a saprophage by rearing this species from a rat carcass which had egg masses in its fur at the time it was shot. To my knowledge, no other observations supporting saprophagous behavior have been reported. The following notes are based on observations I made during the spring of 1968 while studying fly populations in Santa Clara County, California.

OBSERVATIONS AND RESULTS.—Observations were made on a levee separating a commercial salt flat and a tidewater slough at the south end of the San Francisco Bay, one mile northeast of Alviso, Santa Clara County. Commercial salt flats, tidal marsh, and a tidewater slough occupy a one mile radius around the site.

On 24 May 1968, a fresh carcass of a young duck was found on the slough side of the levee. The carcass was matted with numerous egg masses around a mangled neck and other parts of the body. While observing the flies attracted to the carcass, two *B. silvarum* were observed near it. On the premise that some of the eggs may be those of *B. silvarum*, the duck carcass was taken for further study.

A few eggs were taken from each of five unhatched egg masses that

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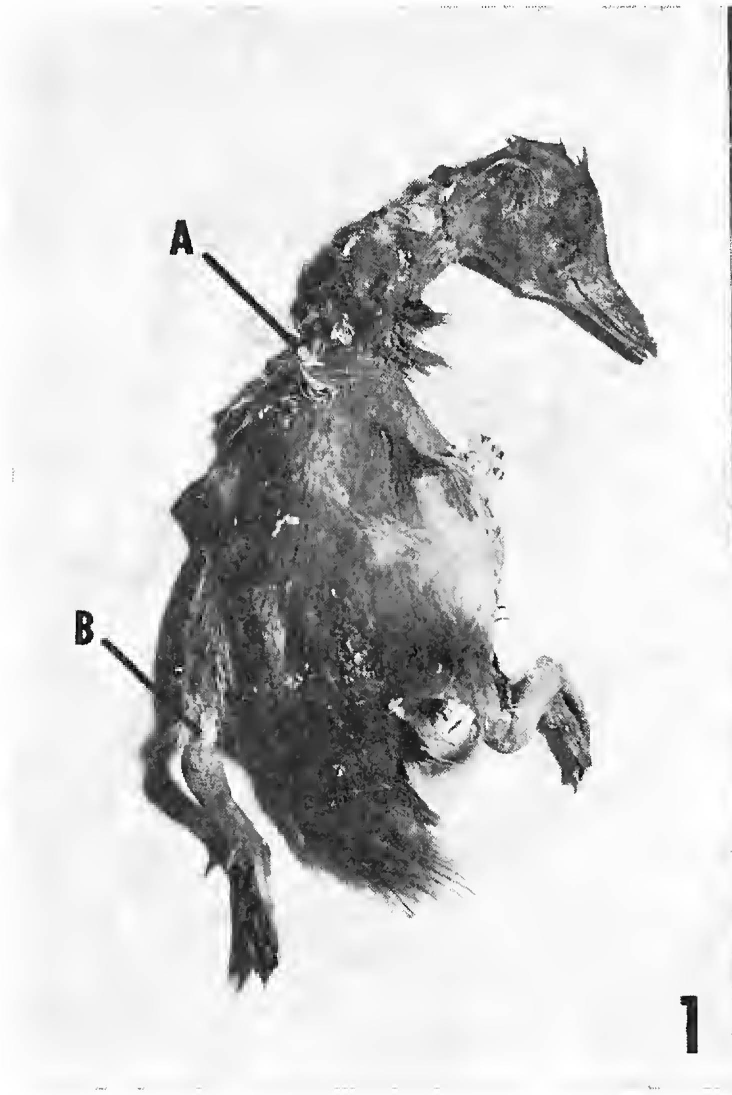

FIG. 1. Position of *Bufolucilia silvarum* egg masses on the carcass of a young duck found on a levee, one mile northeast of Alviso, Santa Clara County. FIG. 2. *Bufolucilia silvarum* egg mass at A on Fig. 1. FIG. 3. *Bufolucilia silvarum* egg mass at B on Fig. 1.

were found on the duck carcass and placed separately on lean beef in cotton-plugged test tubes. All eggs hatched, and the larvae developed normally. As the larvae matured, crumpled paper toweling was placed in the tubes to serve as pupation sites. After pupation the puparia were placed in test tubes containing paper strips for use by the emerging adults. Two of the five egg samples developed into *B. silvarum* adults. The remainder were *Phaenicia sericata* (Meigen).

After the egg samples had been taken, the remainder of the eggs were allowed to mature on the duck carcass in a gallon container. Seven hundred and seven adults emerged. Of these, 103 were *B. silvarum* and 604 were *P. sericata.*

As a result of finding the duck carcass infested with *B. silvarum* in that localized environment, I made additional observations in the same area.

Two fly traps, after the design of Scott and Littig (1962), baited with beef liver were employed from 30 May to 3 June 1968, to determine the density of the *B. silvarum* population in the area. A total of 6,309 flies was taken. *Bufolucilia silvarum* was represented by 1,078 specimens, making up 17.1% of the total collection. Other flies taken were as follows: *P. sericata*—4,798 or 76%; *Calliphora* spp.—295 or 4.7%; and *Phormia regina*, *Sarcophaga* spp., and others—138 or 2.2%.

The saline surroundings support very few, if any, anuran populations for parasitism by this species, however numerous carcasses of gulls, ducks, shore birds, and fish litter the levees. Adults of *B. silvarum* were found on all of these types of animal carcasses. While observing a dead gull for a short time on 30 May, I collected ten adult female *B. silvarum* that landed on it.

CONCLUSION.—The presence of a high population density of *B. silvarum* in an environment with insufficient live anuran hosts to parasitize led to further observations. The large number of animal carcasses available, the attraction of these flies to them, and the rearing of this species from a fly-blown duck carcass leads to the conclusion that *B. silvarum* is primarily a saprophage in this area.

Bufolucilia silvarum adults collected during this study are deposited at San Jose State College, Washington State University, and the California Academy of Sciences in San Francisco.

ACKNOWLEDGMENTS.—Special thanks are due to Mr. Tibor Banathy of San Jose, who found the duck carcass and brought it to my attention. I thank Dr. J. Gordon Edwards of San Jose State College and Dr. Maurice T. James of Washington State University for critically reading the manuscript.

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New Species, Synonymy and Lectotype Designations in North American Bembicini

(Hymenoptera: Sphecidae)

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During a survey of the bembicid fauna of California, several new species have come to light and these are described below. Holotypes are in the Museum at Davis and in the California Academy of Sciences. The opportunity is taken also to establish lectotypes and point out synonymy for some North American Bembicini. Remarks on the Handlirsch types were made possible through the kindness of Dr. Claude Besuchet of the Museum d'Histoire Naturelle in Geneva, Switzerland; and by Dr. Max Fischer of the Natural History Museum in Vienna, Austria.

Bembix frommeri R. Bohart, new species

MALE HOLOTYPE.—Length 17 mm. Black, marked with whitish and pale yellow; principal whitish areas on mandibles, clypeus, foretibia, foretarsus, scutellum, metanotum and tergites. Pale markings: face except mandible tip, quadrate frontal spot, and band across vertex connected with back of head; scape and flagellum beneath; outer orbital stripe widened toward mandible; pronotum; pleuron except for spots on mesopleuron; scutum laterally and 2 small discal stripes anteriorly; posterior scutellar band and metanotum; posterior half of propodeal enclosure followed by black band, then practically all yellow; legs mostly, but with black stripes behind femora and small spots on tibiae; broad apical tergal bands anteriorly tri-emarginate, 3 separate spots on V, double median spot on VI and apical half of VII; sternite I except for 2 black spots, II medially and basolaterally, III–V with lateral spots, VII–VIII apically. Wings clear, veins mostly brown. Pubescence mostly pale, rather long and shaggy on head.

Labrum a little shorter than eye height, slightly humped at basal third in profile; mandible with strong denticle, scape two-thirds as long as clypeus, midocellus a narrow but translucent lunule, flagellum with shiny tyloides beneath articles II and following, last article with welt-like tylus on basal half; front basitarsus with 8 rake setae; midtibia irregular beneath and with few minute denticles toward apex; first intersubmarginal vein of forewing nearly straight; tergite VII longitudinally wrinkled, distinctly angled out basolaterally, spiracular lobe slender and reaching only as far as basolateral angle; sternites II and VI without carinae or projections; gonostyle tapering gradually toward apex, covered with rather fine hair; digitus slender, widening gradually to truncate and slightly emarginate apex; cuspis slender, finger-like.

Holotype male (CAS), 5 MI. SOUTH OF DEEP SPRINGS COLLEGE, INYO COUNTY, CALIFORNIA, 11 July 1967 (Saul and Suzy Frommer).

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Paratype male, Wyman Canyon, Inyo Co., California, 25 June 1966 (Saul and Suzy Frommer, UCR).

A close relationship is indicated with *B. dentilabris* Handlirsch in which the male also has an irregular clypeal profile, nearly straight first intersubmarginal vein, wrinkled and basally angled tergite VII, and simple sternites II and VI. The 2 species differ in markings, *B. dentilabris* being yellow and having a u-shaped scutal mark. In *B. frommeri* the markings are extensively whitish and the scutum is nearly all dark discally. More significant are a few structural characters. In *B. frommeri* the tylus beneath the last flagellomere is a shiny welt but is confined to the basal half rather than tapering toward the apex of the article. Also, the midfemur is sparingly spiculate beneath. The genitalia show critical differences. In *B. frommeri* the gonostyle is large, conical and finely haired, rather than ligulate and spinose apically. Furthermore, the cuspis is narrowly finger-like rather than blade-like.

The species is named for Saul Frommer who has made many interesting collections of bembicids in California.

Microbembex californica R. Bohart, new species

MALE HOLOTYPE.—Length 11 mm. Black, extensively marked with yellow as follows: lateral strip on labrum, pronotal band all across, lateral spot over wing base, lateral third of scutellum, metanotum, broad band across propodeum, lateral propodeal angles, irregular upper mesopleural spot, legs partly, foretibia basally and posteriorly, midtibia except ventrally, hindtibia entirely, fore basitarsus posteriorly, mid and hind tarsi mostly, tergites except narrow basal bands and 2 black dots at summit of I, arcuate band across sternite II, lateral spots on III–IV. Wings lightly stained, veins light brown to black, basal half of forewing costa pale, veins of first submarginal cell brown except narrowly at base. Pubescence short, pale, mostly inconspicuous; moderately silvery on face, long and erect on frons and propodeal angles. Punctation close, scutum and mesopleuron with punctures separated by 1 diameter or less. Last 7 flagellar articles polished beneath; fore basitarsus 3 times as long as broad; hindfemur regular in outline; median projection of sternite II moderately large, keel-like, outline rounded at summit, then nearly flat to an acute posterior point; tergite VII incised apically, incision about half as broad as length of third hindtarsal article; sternite VIII curving gently, bluntly spear-shaped. Digitus with broadly rounded apical part not projecting backwards.

FEMALE.—Length 8 to 13 mm. Black, marked with white or occasionally pale yellow as follows: mandible and clypeus partly, labrum laterally or mostly, outer orbits narrowly, pronotum laterally, rest of notum sparingly, spot on upper mesopleuron usually, legs as in male, moderately narrow tergal bands on I–V, lateral spots on sternites II–III. Wings as in male but usually darker. Pubescence as in male except on mesopleuron where appressed silvery hair partially obscures punctation. Tergite VI narrowly and sharply emarginate at apex.

Holotype male (UCD), DAVIS, YOLO COUNTY, CALIFORNIA, 5 August 1964, in dry sand creekbed (R. M. Bohart). Paratypes, 29 males, 62 females (all from central California) : Davis, Sacramento, and Antioch. Paratype dates are May to September. Additional specimens have been examined from many other localities in California, and from other western states east to Wyoming (Sweetwater Co.), Utah (Cornish), and New Mexico (Embudo). It occurs also in Baja California Del Norte, Mexico.

The species has previously been confused with *M. monodonta* (Say) which occurs east of the Continental Divide. Females seem to be indistinguishable but males of *M. californica* have the antenna shiny beneath toward the apex rather than dull, the sternal keel nearly always with a sloping flat top rather than evenly rounded, and the digitus with the broadly rounded apical part not projecting backwards.

Microbembex argyropleura R. Bohart, new species

MALE HOLOTYPE.—Length 10 mm. Black, extensively marked with light yellow as follows: pronotal band all across, broad lateral scutal stripe, pair of discal scutal dots, scutellum and metanotum mostly, band across summit and other small dots on propodeum; legs partly and especially on hindleg, tergites mostly, and lateral dots on sternites II–III. Abdominal venter mostly reddish brown; wing membrane clear, costa mostly and most other veins basally white; first submarginal cell with radius white and other veins yellowish to light brown. Pubescence silvery, moderately prominent on propodeum, mesopleuron, scutum and frons. Punctation close, scutum and mesopleuron with punctures separated by 1 diameter or less. Last 4 flagellar articles rather dull beneath, not polished; fore basitarsus 4 times as long as broad; hindfemur regular in outline; median projection of sternite II small, acute, keel-like, evenly curved; tergite VII incised apically, incision about half as broad as length of third hindtarsal article; sternite VIII curving gently, bluntly spear-shaped. Digitus with bluntly rounded apical part not projecting backwards.

FEMALE.—Length 9 to 12 mm. Black, marked with whitish yellow as follows: mandible, labrum and clypeus mostly, thin lines along inner and outer orbits, scape partly, thorax about as in male but scutum usually dark discally, tergites with broad bands which are edged basally with dark brown or reddish brown, tergite VI banded or with 2 spots, sternites with small lateral spots on II–IV or II–V imposed on reddish brown background. Wings as in male. Silvery pubescence forming dense coat on mesopleuron, scutum and frons. Tergite VI narrowly and sharply emarginate at apex.

Holotype male (UCD), 18 MI. WEST OF BLYTHE, RIVERSIDE COUNTY, CALIFORNIA, 16 October 1965 (R. M. Bohart). Paratypes, 43 males, 37 females (all from southern California): near Blythe, Borrego Valley (San Diego Co.) Cronise Valley (San Bernardino Co.), Palo Verde (Imperial Co.) and 13 mi. east of Ocotillo Wells (Imperial Co.).

Paratype dates are April to October. I have seen material also from California (Heber, 1000 Palms Oasis, Palm Springs, Olancha, Antelope Springs in Inyo Co.), Arizona (Yuma, Toltec, Eloy, Grand Canyon floor, Willow Ranch in Mojave Co.), Nevada (Nixon, Pyramid Lake, Wadsworth), Utah (12 mi. south of Eureka), and Baja California, Mexico (28 mi. south of El Arco).

The species has previously been confused with *M. hirsuta* J. Parker which occurs in New Mexico and Texas. I am unable to separate females of the 2 species but males offer no problems. In *M. argyropleura* males the sternites have short and rather inconspicuous pubescence, whereas in *M. hirsuta* there is a dense erect pile which extends in gradually increasing length from the sternal keel onto sternite VII. A superficial resemblance exists between males of *M. argyropleura* and *M. californica.* The white radius on the first submarginal cell and the narrower fore basitarsus of *M. argyropleura* are distinguishing. The silvery mesopleural mat of female *M. argyropleura* is distinctive among Californian species.

Variation in color pattern occurs as would be expected. However, the face of the male is always entirely black, contrary to the case in *M. californica.* The scutum is usually black discally, the scutellum and propodeum may each have 2 large spots rather than bands, and the abdominal ground color varies from nearly black to brownish red, especially in females.

Microbembex rufiventris R. Bohart, new species

MALE HOLOTYPE.—Length 13 mm. Black, extensively marked with yellow as follows: pronotal lobes, spot over wing base, large scutellar spots, metanotal band and one across summit of propodeum, legs partly but foreleg nearly all black, tergites mostly, small lateral spots on sternites II–V; ground color of sternites reddish brown. Wings nearly clear, forewing costa pale to stigma, veins of first submarginal cell brown, a little yellowish at base of cell. Pubescence short, pale, mostly inconspicuous; moderately silvery on face, long and erect on frons and propodeal angles. Punctation close, scutum and mesopleuron with punctures separated by 1 diameter or less. Last 4 flagellar articles not polished beneath; fore basitarsus 3.5 times as long as broad; hindfemur regular in outline; median projection of sternite II a raised carina, sharp posteriorly; tergite VII shallowly emarginate apically, incision about as broad as length of third hindtarsal article; sternite VIII curving gently, bluntly spear-shaped. Digitus stout, broadly rounded apical part not projecting backwards.

FEMALE.—Length 9 to 13 mm. Black, marked with greyish white as follows: labrum and mandibles mostly, clypeus broadly, scape partly, narrow orbital streaks, pronotal lobes, spot over wing base, metanotal spots, legs partly, narrow apical tergal bands, broadened laterally, lateral dots on pygidium; sternites as in male but redder; ground color of tergites mottled with reddish. Wings as in male but a little darker. Punctation and pubescence as in male. Tergite VI narrowly and sharply emarginate at apex.

Holotype male (UCD), COALINGA, FRESNO COUNTY, CALIFORNIA, 22 May 1936 (R. M. and G. E. Bohart). Paratypes, 1 male and 2 females, same data as type; 1 male, Cawelo Junction, east of Shafter, Kern Co., California, 24 July 1952 (T. R. Haig, UCD).

There is considerable resemblance to darker forms of *M. californica*. However, the male of *M. rufiventris* has the undersurfaces of the last 4 flagellomeres rather dull, the sternal keel cariniform, and tergite VII much broader at the apex. The female has dorsal markings greatly reduced. In the few females of *M. californica* which approach this condition the face is extensively dark in contrast to *M. rufiventris*. It remains to be seen whether this difference in the females will hold up when more specimens of *M. rufiventris* are collected.

Genus BEMBIX

Bembix amoena Handlirsch, 1893. The lectotype male here designated is in the Vienna Museum, "Nevada."

Genus BICYRTES

Bicyrtes annulata J. Parker, 1917. The holotype female is in the collection of the University of Kansas at Lawrence, "Oak Creek Canon, Ariz. 6000 ft." This is a synonym of *B. capnoptera* (Handlirsch), 1889. It represents the more yellowish western variety.

Bembidula capnoptera Handlirsch, 1889. The lectotype female here designated is in the Vienna Museum, "Kentucky."

Bembidula capnoptera mesillensis Cockerell, 1898. The holotype male is in the U. S. National Museum, "Las Cruces, N.M." It is a synonym of *Bicrytes capnoptera* (Handlirsch), 1889.

Bembidula diodonta Handlirsch, 1889. The holotype is a male in the Geneva Museum, "Mexiq. Orizaba." This is a distinctive species of *Bicyrtes* related to *B. discisa* (Taschenberg) but with serrate midfemur, broader foretarsus and dentate sixth sternite.

Bembidula fodiens Handlirsch, 1889. The lectotype male here designated is in the Vienna Museum, "Dallas, Texas."

Bicyrtes gracilis J. Parker, 1917. The holotype male is in the collection of the University of Kansas, Lawrence, "Santa Rita Mts., Ariz., 5–8000 ft." This is a synonym of *B. viduata* (Handlirsch), 1889.

Bembidula insidiatrix Handlirsch, 1889. The lectotype here designated is a female in the Vienna Museum, "Kentucky."

Bembidula odontophora Handlirsch, 1889. The lectotype here designated is a male in the Vienna Museum, Nauta, "E. Peru."

Bicyrtes oribates Pate, 1936. The holotype is a male in the Cornell University collection. "Compostela, Nayarit, Mexico." This is a synonym of *B. diodonta* (Handlirsch), 1889.

Bicyrtes parata Provancher, 1889. The holotype female is in the collection of Laval University, St. Foy, Quebec, "Los Angeles (Coquillett)." It is a synonym of *B. ventralis* (Say), 1824 and represents the more yellow western variety.

Bicyrtes tristis C. Fox, 1923. The holotype is a male bearing no data but presumably from La Paz, Baja California, in the California Academy of Sciences, San Francisco. It seems to be a rather dark specimen of *B. capnoptera* Handlirsch.

Bembidula viduata Handlirsch, 1889. The lectotype here designated is a female in the Geneva Museum, "Huastec," Mexico. This large *Bicyrtes* is fairly abundant in southwestern United States and northern Mexico.

Genus MICROBEMBEX

Microbembex monodonta deltaensis Johnson and Rohwer, 1908. The lectotype here designated is a male in the U. S. National Museum labeled "cotype" by Rohwer, "Delta, Col. 7 20 98." This is a synonym of *M. nigrifrons* (Provancher), 1889.

Microbembex monodonta neomexicana Johnson and Rohwer, 1908. The lectotype here designated is a female in the U. S. National Museum labeled "cotype" by Rohwer, "Las Cruces, N.M., flo. *Solidago*, Aug. 30 (Twns.)." This has rather shiny yellow spots on the scutum and is a synonym of *M. nigrifrons* (Provancher).

Microbembex monodonta occidentalis Johnson and Rohwer, 1908. The lectotype here designated is a female in the U. S. National Museum labeled "cotype" by Rohwer, "Paris Tx XI-26 1904, C. R. Jones collector." This is a synonym of *M. monodonta* (Say), 1824.

Bembex nigrifrons Provancher, 1889. The lectotype here designated is a female *Microbembex* in the collection of Laval University, St. Foy, Quebec, "Los Angeles (Coquillett)." It has a pair of rather shiny discal yellow spots on the scutum.

Genus STICTIELLA

Monedula mammillata Handlirsch, 1890. The lectotype here designated is a male in the Geneva Museum, "Georgie." It is a synonym of *Stictiella emarginata* (Cresson), 1865, as previously supposed.

Monedula plana W. Fox, 1895. The holotype is a male in the U. S.

National Museum, "Custer, South Dakota (Aldrich)." This is apparently a synonym of *Stictiella serrata* (Handlirsch), 1890, differing only in having the bands on tergites II–VI complete rather than narrowly broken medially.

Monedula serrata Handlirsch, 1890. The holotype is a male in the Geneva Museum, "Georgie." It is a rather abundantly yellow-marked *Stictiella* agreeing with previous interpretation.

Observations on the Behavior and Biology of *Microbembex californica* Bohart

(Hymenoptera: Sphecidae)

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During July 1969, observations were made on a colony of *Microbembex californica* R. Bohart in the dunes 5 miles south of Samoa, Humboldt County, California. *M. californica,* limited mostly to the Pacific coastal states, is a general scavenger, taking dead arthropods as "prey" for nest provisioning. Although no previous work dealing with *M. californica* has been recorded, the behavior and biology of the wasp is very similar to that of an eastern species, *Microbembex monodonta* (Say) described by Evans (1966) and Parker (1917).

The nesting site, approximately 6 × 15 meters, was located in a large blowout free of vegetation and surrounded by plants typical of the dune ecology: *Artemisia pycnocephala, Eriogonum latifolium,* and *Haplopappus racemosus.* The area was shared with three other species of wasps: *Bembix americana comata* Parker, *Oxybelus uniglumis quadrifasciatus* Say, and *Philanthus pacificus* Cresson.

The female, usually in the early afternoon, begins to dig at a series of sites, particularly in crusted sand, before choosing the true nest site. A few females may begin digging in uncrusted sand and may spend more than an hour digging. The digging action of the female resembles that of a teeter-totter. Balanced on her middle legs, the female bobs her head down, scrapes sand loose and kicks it out behind her. After several scuffs, she bobs back to a normal position and continues to bob up and down until she has started the burrow. Every few minutes she

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returns to the entrance to scrape away any sand that may have built up during her excavation of the burrow and to make flights about the nesting site. The expelled sand is kicked outward approximately 10 cm, which disperses it and leaves no trace of a mound. It appears that the nests of *M. californica* are one-celled, as in the other known North American species. The burrow, descending at a 30 degree angle from the surface, is approximately 25 cm in length. The cell is approximately 2.5 cm long and 1.0 cm high and lies 5 to 17 cm below the surface, depending upon the moisture level. Construction of the nest and the initial closure takes about 2 hours.

The female lays the egg (in 2 cases examined) before any attempts at provisioning. Temporary outer closures of the nest during provisioning are merely a few scuffs of sand thrown behind her into the entrance, leaving the entrance still visible. An inner closure near the cell was found in a single burrow. It is highly unlikely that the closure was an artifact due to my excavation, but possibly the beginning of the final closure of the burrow. Even this explanation seems questionable since the female was still attempting to provision the nest after my excavation had begun. All other burrows were free of an inner closure, which indicates that normally no inner closures are maintained.

Evidence that *M. californica* is a general scavenger, provisioning the nest with dead arthropods, is exhibited by the prey recorded from the cells. In one nest, representatives of the following families were found: Cercopidae, Carabidae, Curculionidae, Asilidae, Therevidae, Formicidae, and a spider. Earwigs were quite commonly used as larval food, and in every case the appendages had been removed before the female flew into the nesting area. The body of the earwig seemed flexible as if it were recently killed. The females appear to hunt most often within 10 meters of the colony in the peripheral areas of the blowout where vegetation is most abundant. When hunting, the female skims several cm above the sand, rapidly zig-zagging back and forth across a small area. When "prey" is discovered the female hovers over it, picks it up with her forelegs, then rolls it end over end several times as if to inspect it. She then tucks the carcass under her and flies off. The simulation of the stinging of prey as observed by Evans (1966) and Parker (1917) in other *Microbembex* species was not observed in *M. californica.* The female upon entering the nest continues inward without releasing the carcass, if it is small enough. However, if the nest entrance is too large to accommodate both, she drops the carcass at the entrance, enters the burrow and pulls it in with her mandibles. Females return to the nest with provisions about every 40 minutes.

Male *M. californica,* as in other species in the genus, appear to construct some type of burrow for sleeping. Male activity, other than burrow construction, is limited to feeding and mating.

Microbembex californica at the Samoa site appeared to be free of parasites. However, several cocoons contained unidentified nematodes.

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A New, Narrowly Polylectic, Autumnal Species of *Dialictus* from the Flowers of *Jepsonia heterandra*, an endemic California saxifrage

(Hymenoptera: Apoidea)

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During the autumns of 1967, 1968 and 1969, Professor Robert Ornduff has intensively investigated the reproductive biology of the fall-blooming *Jepsonia heterandra* Eastw. (Saxifragaceae) at two localities within its restricted range along the western foothills of the Sierra Nevada in central California. The results of these studies, which are being reported elsewhere (Ornduff, 1970), record the discovery and role of an undescribed species of the genus *Dialictus* which is involved in the pollination of this locally endemic and late flowering perennial (Ornduff, 1969). The bee has not been observed to visit the flowers of *J. heterandra* before the anthers dehisce in mid or late morning. At the two study sites there is a paucity of other plant species in flower when *J. heterandra* flowers (late September and October) and repeated surveillances of these potential pollen and nectar sources (Compositae) have revealed the presence of only an occasional male or female bee. It is thus unclear whether these visits represent a temporary and opportunistic departure from the usually observed pollen and nectar collections source (*Jepsonia*) or if in fact such sources are less attractive than is *Jepsonia.*

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At the latter source both the males and females are conspicuously abundant suggesting that the flowers of that plant provide the preferred nectar and pollen source of the bee. Although repeated attempts to locate the nests of this bee have been disappointingly unsuccessful, it is anticipated that their discovery will make it possible to determine the sources of pollen and their relative amounts by analysis of cell provisions. Analysis of pollen from the scopae and metasoma of females collected from the flowers of *J. heterandra* revealed pollen of Compositae in only one of the five individuals examined. This individual was taken at 12:30 p.m. by which time most of the available pollen of *Jepsonia* had already been collected (Ornduff, 1970). These observations suggest that *Dialictus ornduffi* is a narrowly polylectic species. Its apparent restriction to *Jepsonia heterandra* as the primary source of pollen and nectar and its apparently secondary dependence upon the pollen and nectar of certain Compositae may simply reflect the relative competitive attractiveness of the late flowering plants present in the flora superimposed upon the lack in the flora of other potentially competitive sources of pollen and nectar.

It is with much pleasure that I dedicate this new species to Professor Robert Ornduff, University of California, Berkeley, who introduced me to this interesting bee-plant relationship and with whom I have spent many enjoyable and profitable hours in the field on this and other pollination projects.

Dialictus ornduffi Hurd, new species

FEMALE.—Length 4–4.5 mm. Head, and thorax, dark bluish-green; metasoma brownish-piceous without metallic reflections; wings with three submarginal cells, subhyaline, veins including stigma mainly testaceous though somewhat more brownish along anterior wing margin; tegulae brownish, not enlarged, rounded behind, minutely punctured except on posterior third where glabrous, impunctate and shining; legs piceous except brownish tarsal segments; pubescence short, thin, chiefly white, somewhat more dense along sides of metasoma and on discs of terga III–V; head slightly longer than broad, densely and very nearly confluently punctured except vertexal areas adjacent to ocelli and on lower parocular areas where more sparse and shallowly punctate; eyes moderately convergent below (33:25); cheeks about as broad as eyes in width as seen in lateral view, finely and reticulately punctate; maximum interorbital width somewhat less than distance from anterior ocellus to apical margin of clypeus (38:42); lateral ocelli much nearer to eyes than to each other and removed from posterior margin of vertex by more than their diameters; clypeus piceous, without metallic reflections, broader than long, slightly convex, projecting about two-thirds below suborbital line, punctures large, coarse, irregular in outline, separated by less than maximum diameter; supraclypeal area piceous, faintly metallic, somewhat swollen, much wider than long, punctures rather coarse and sparse, interspaces finely tessellated; hypostomal carinae parallel, adjacent ventral surfaces of head shining and sparsely punctate; mesoscutum and scutellum shining, interpunctational spaces tessellate, punctures fine, deep, well separated medially, especially on scutellum, but becoming quite close and crowded at extreme lateral sides; pleura coarsely reticulo-punctate anteriorly, more finely rugoso-punctate medially and becoming striato-punctate along posterior margin; posterior face of propodeum rugosely striato-punctate, very nearly though incompletely, delimited by lateral and dorsal carinae, carinate dorsal rim low, weakly defined medially, lateral carinae obsolete dorsally; dorsal area of propodeum with striations incomplete, not attaining posterior rim, rather incomplete and irregularly striate medially, but becoming more distinct laterally; lateral sides of propodeum dull, finely and irregularly roughened; metasomal terga rather shining, almost imperceptibly though finely striato-reticulate, punctures minute, scarcely evident, sparse except near base of tergum II, apical rims neither impressed nor glabrous.

MALE.—Length 3.5–4 mm. Head and thorax greenish, propodeum darker above rather bluish, metasoma piceous somewhat paler ventrally and along apices of metasomal terga; clypeus entirely piceous; antennae yellowish-brown below, fuscous above; tarsi yellowish-brown; pubescence similar to that of female, though considerably denser on face, but sparser generally on metasomal terga medially; punctation of head, thorax including propodeum and metasoma essentially like that of female, though punctation on metasomal terga less obscure and not as sparse; pleura with punctures more distinct and less rugose, medial area shining between sharply defined punctures; sculpturing of propodeum, especially that at dorsal and lateral sides of posterior face, less well defined, but that on dorsal area and sides essentially as in female; antennal segments short, less than twice as long as broad.

Holotype female, allotype and 17 paratypes (14♂♂, 3♀♀), along ROCK CREEK, 4 MILES EAST OF MILTON, CALAVERAS COUNTY, CALIFORNIA, 1 October 1969, at flowers of *Jepsonia heterandra* Eastw. (R. Ornduff). The primary types are deposited in the collections of the California Academy of Sciences, San Francisco. Additional paratypes (17) were collected at the type locality on 8 October 1967 by R. W. Thorp (11♂♂, 5♀♀) and by R. Ornduff (1♂) on 10 October 1968, from the same population and 2 other specimens (1♂, 1♀) also designated as paratypes were collected on 10 October 1968, by R. Ornduff and the author at Sullivan Creek, 3 miles south of Stent, Tuolumne County, California.

Dialictus ornduffi closely resembles *D. brunneiventris* (Crawford, 1907:194) and is apparently its nearest described relative. It differs most conspicuously from that species in having the disc of the third metasomal tergum of the female entirely pubescent and in having the clypeus of the male entirely dark in coloration. Further *D. brunneiventris*, which was originally described from Ormsby County, Nevada, is a summer species to judge from the available records.

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Biology and Structure of Some California Bristletails and Silverfish

(Apterygota: Microcoryphia, Thysanura)

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A variety of observations were made recently on Microcoryphia and Thysanura, both in the field and among laboratory rearings. These ectognathous Apterygota are relict descendents of the Pterygote Precursor, and closely resemble immature Hemimetabola. The Microcoryphia (bristletails) are the more generalized, and include 2 extant families: the Machilidae and Meinertellidae. As a whole, machilids are morphologically the more primitive. Modern Thysanura, the silverfish or firebrats, include the Lepidotrichidae, Lepismatidae and the Nicoletiidae. The taxonomy of both orders is unsettled, and the unidentified species considered here have been referred to the genera "*Machilis*"[1] and *Mesomachilis* (Machilidae); *Machilinus* (2 species: Meinertellidae); and two species of *Ctenolepisma* (Lepismatidae).

Machilids (Fig. 1) bear "styli" on either or both the meso- and metathoracic coxae, and abdominal coxites II–IX (the thoracic and abdominal styli are not homologous—the former being coxal endites or exites, the latter telopodite rudiments). "*Machilis*" *strenua* has thoracic styli on both the meso- and meta-thoracic coxae. There are 2 eversible vesicles on each abdominal coxite II through V, and 1 vesicle on I, VI and VII. The males lack gonapophyses VIII. The species of *Mesomachilis* had thoracic styli only on the metathoracic coxae and but 1 vesicle on each

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[1] The "*Machilis*" here referred to apparently was described as *Machilis strenua* Silverstri. However, since the genus *Machilis* now has been restricted to the European fauna, this California species presumably belongs to an undescribed genus (Wygodzinsky, pers. comm. 1969). Taxonomic confusion led me originally to put this species in *Pedetontus* by mistake, and designate it as such in Fig. 2 of Smith 1969.

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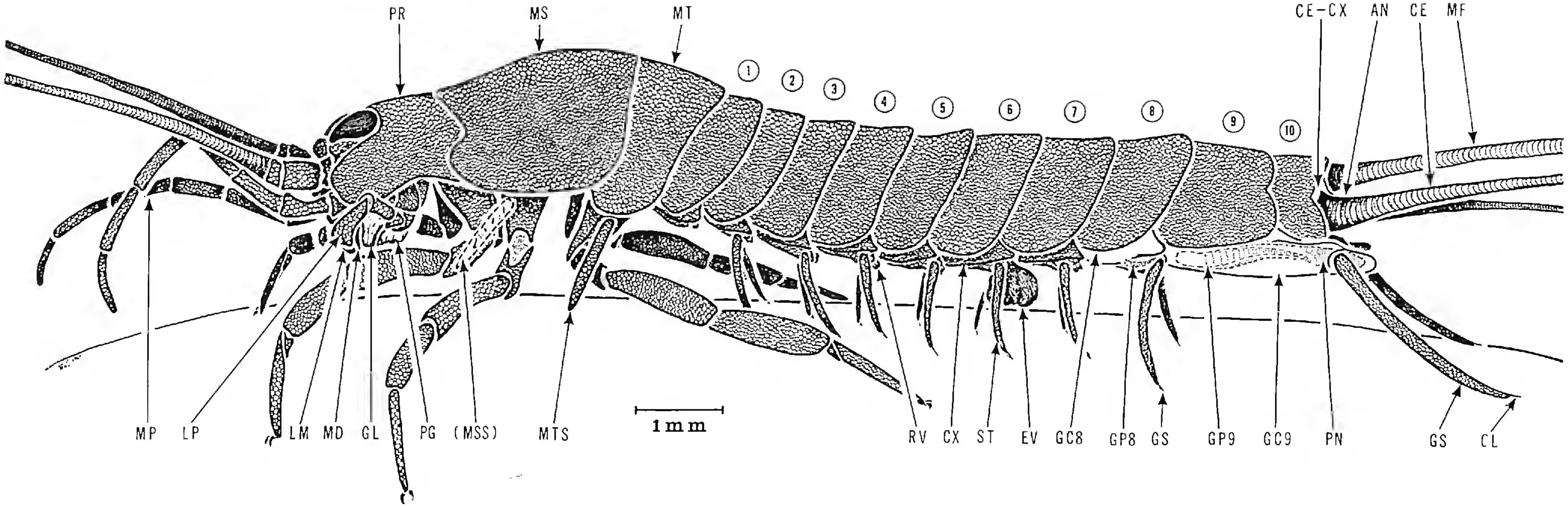

FIG. 1. Male *Mesomachilis* (Microcoryphia: Machilidae). The posture is natural but for the following. The maxillary endites have been pulled back slightly to show the mandible, and 1 vesicle has been illustrated everted. Gonopophyses VIII and IX and the penis are outlined and shaded. The entire abdominal coxite VI is stippled. The mesothoracic stylus found in some other machilids but lacking in this genus is outlined. *Abbreviations*: AN, anus; CE, cercus; CE-CX, cercal coxite; CX, coxite; EV, everted vesicle (endite?); GC, gonocoxite; GP, gonapophysis (endite?); GS, gonostylus (telopodite); GL, glossa (outer endite) of 1st maxilla; LM, labrum; LP, palp (telopodite) of 2nd maxilla (labium); MD, mandible (coxite + endite); MF, median filament (tergite XI); MP, palp (telopodite) of 1st maxilla; MS, mesothorax; MSS, mesothoracic coxal stylus (endite?); MT, metathorax; MTS, metathoracic coxal stylus (endite?); PG, paraglossa (endite) of labium; PN, penis (fused papillae of IX); PR, prothorax; RV, retracted vesicle; ST, abdominal stylus (telopodite). Abdominal segments are identified by numbered circles.

abdominal coxite I–VII. Males possessed grossly reduced gonapophyses VIII. The antennal flagella of these 2 genera are scaly, and this characteristic separates them from perhaps the other most common genus (*Pedetontus*) in the Sacramento area, the flagella of which lack scales.

Members of Machilidae have 1 or 2 eversible vesicles on each of the abdominal coxites. Females (and some males) bear 2 sets of multisegmented (or annulated) gonapophyses on the coxites of the genital segments (abdominal somites VIII, IX). These structures are homologous with the eversible vesicles of pregenital somites. The 2 pairs of gonapophyses of the female remain interlocked as is usual among the more primitive insect groups. Those of males are disengaged, and gonapophyses VIII greatly reduced or entirely absent (Smith, 1969 and unpublished). The gonostyli (telopodites of coxites VIII and IX) are prominent and heavily musculated in both sexes. The abdominal sternites are distinct and may wholly separate the coxites on either side from each other. The coxites, however, are flexibly attached more or less completely to the sternites along at least their proximomesal margins. This overall pattern of abdominal appendages is the most generalized known among both Apterygota and Pterygota.

California meinertellids (Fig. 2) have no abdominal vesicles, but some found in other areas have 1—never 2—on some coxites. All Meinertellidae lack thoracic styli. They have the usual abdominal styli on segments II through IX. Male Meinertellidae lack either pair of gonapophyses, and only a bilobed median penis remains. A penis is present in Machilidae as well, but it lies between either gonapophysis IX. The abdominal sternites of Meinertellidae are reduced to narrow straps at the bases of the coxites, an ordinal character of the family.

Thysanura have no thoracic styli. According to Wygodzinsky (1961), the relict *Tricholepidion gertschi* Wygodzinsky (Lepidotrichidae) retains abdominal styli on segments II–IX, and eversible vesicles on II–VII. This is the microcoryphian pattern. Other Thysanura have abdominal styli only on segments VII, VIII and IX, or just VIII and IX. Some Nicoletiidae have eversible vesicles as well. When present, gonapophyses IX of male Thysanura apparently are reduced to a single segment (radix), the pterygote condition. A median phallus similar to that in Microcoryphia Meinertellidae usually replaces gonapophyses IX. Except for Lepidotrichidae, male Thysanura lack gonapophyses VIII.

Microcoryphia have prominent ocelli and large, often holoptic compound eyes which give them a remarkably intent expression. Their eyes glow mysteriously in the dark when illuminated with a flashlight. Thysanura have reduced or no compound eyes and, except for Lepido-

FIG. 2. Laboratory colony of *Machilinus* Sp. (Microcoryphia: Meinertellidae) clustering on pine bark under a bright light. Apart from the dark scales on the mesothorax, this species is relatively unpatterned. There are 4 individuals in the top picture and 5 in the lower. The average size is 8 mm, excluding appendages.

trichidae, no ocelli. Microcoryphia have maintained the primitive hypognathous head posture, and retain the prominent telopodite of the (1st) maxillae as a locomotory and grasping appendage. The maxillary palpi are used most often to manipulate food and to examine the substrate, but sometimes they may be used in climbing. These "maxillipeds," taken with the long, mobile abdominal styli (especially the 9th), give the creatures a most "un-insectan" aspect as they scuttle about. Except for Lepidotrichidae, Thysanura are hypognathous in early instars, but become prognathous after a few instars. Both groups continue to moult periodically after reaching sexual maturity.

EVERSIBLE VESICLES: WATER ABSORBING ORGANS

Many myriapodan and insectan arthropods can protrude 1 or 2 membranous sacs from some of the coxites. Among these structures are the individual eversible vesicles of Protura, Microcoryphia, Symphyla, and Diplopoda, and the combined pair forming the collophore of Collembola. All are everted by blood pressure and withdrawn by 2 to 4 muscles. In machilids, 1 muscle set originates within the subcoxa and the other in the coxa. The corium of machilid vesicles is opaque in preserved material, but the everted sacs in life are so transparent that blood cells can be seen within them. The protrusible vesicles are apparently homologous with the coxal vesicles of Megaloptera: Corydalidae, and the fleshy prolegs of larval Hymenoptera, Mecoptera and Lepidoptera.

The exact homology of the vesicles themselves, and their counterparts on the genital segments (the gonopophyses) is problematical. Gustafson (1950) suggested they were modified coelomoducal papillae which originally bore the gonopores. Sharov (1966) suggested that both vesicles and gonapophyses were coxal exites (epipodites). I suspect that both the vesicles and the gonapophyses represent reduced coxal endites. All of these conclusions assume the vesicles and their presumed counterparts are homologous in all groups where they appear, and the evidence overwhelmingly favors this (Smith, 1969). Regardless of structural origin, however, the purpose of these eversible sacs is clear: water absorption. Heeg (1967a) reviewed some of the commentary supporting this. I should like to describe the actual use of the protrusible vesicles to sponge up water.

Around midnight during a dry August weekend in the California Coast Ranges west of Sacramento, I collected many large (13 mm body length, 40mm antennae + body + terminal filament) machilids of at least 2 genera. They were put in several jars with only paper toweling. The following afternoon I began to place each lot in a common terrarium. This container had lichens and dry forest litter in the bottom, and several pieces of wet maple and cascara bark. As the insects scattered, the majority sooner or later came in contact with the damp bark, and halted abruptly. After a moment's examination of the moist surface, they would lower their abdominal coxites against the surface, and protrude the vesicles with a pronounced front to rear contraction of the body. After a minute or two of inactivity, all vesicles would be retracted simultaneously, and the eversion process repeated, often with a change of body position. They sponged only on the heavily fissured, rough maple bark, or on damp, compact clay. They consistently rejected moistened smooth bark, moss, lichens, leaves, or sand. Actual drops of water were avoided, and simulated rain caused an immediate rush for cover.

The following evening I returned to the collection site, and poured water down the bark of a maple stump on which I had seen the insects running up and down. In less than 5 minutes, 2 machilids were busy sponging up the water. Such was their preoccupation that I was able to pick them up with my fingers. The same preference for substrate texture seen in the laboratory was demonstrated in the field.

It is significant that most nocturnal, forest-floor dwellers in the insect and myriapod groups possess water absorbing vesicles. Moreover, many diurnal members of these taxa such as the North American *Machilinus* lack them. The machilids I reared did not appear to drink water, and they avoided drops of it. However, Heeg (1967a) reported *Machiloides* (a vesicle-bearing Meinertellid) normally drank water, and seemed to use vesicles only when no other source was available. My Meinertellid *Machilinus* did drink, and commonly died within 2 or 3 days if deprived of water in droplet form, whether or not moist earth or bark were present. While most Thysanura lack vesicles, those I was rearing showed greater tolerance to dessication than *Machilinus*. Heeg (1967b) found *Ctenolepisma* capable of cuticular absorption of water vapor at levels as low at 60% relative humidity, but no such ability in *Machiloides*.

THE USES OF STYLI

While the abdominal styli of both apterygote adults and pterygote immatures are undoubtedly telopodite rudiments, the identity of the unmusculated styli borne more or less laterally on the thoracic coxae is uncertain. They superficially resemble both the musculated lateral abdominal styli as well as the mesal unmusculated styli of Symphyla. Sharov (1966) felt they were exites and thus not homologous with the abdominal styli. However, some past workers have also suggested that all styli are exites. There is still another possibility: the thoracic styli are not truly lateral, but angle about 45° away from the body axis. They describe a considerable arc as the insects walk. Machilids use the thoracic styli (which, while unmusculated, are well-supplied with sensilla) to orient themselves in crevices: they try to keep at least 1 on

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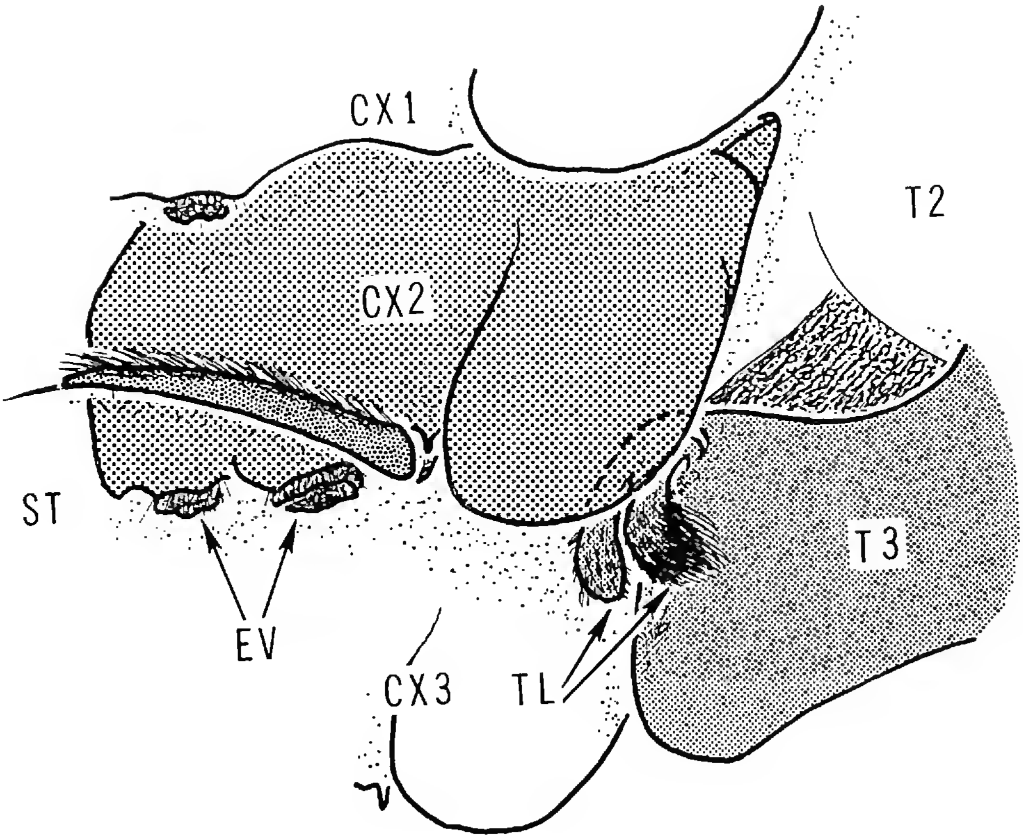

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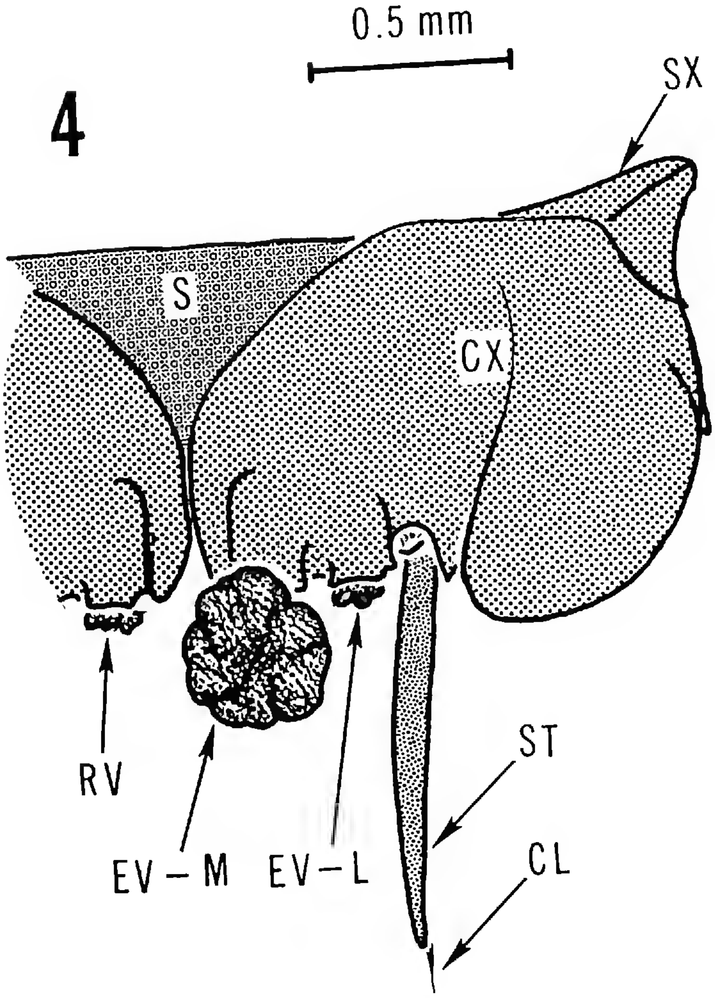

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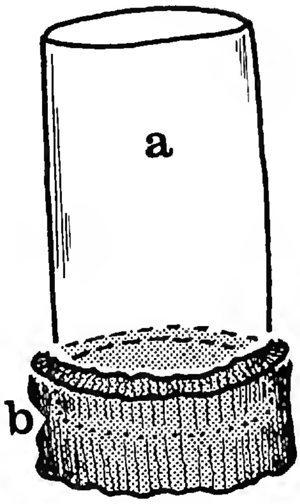

either side in contact with their surroundings. A slight rotation of the coxae (or minor shift in the position of the styli) would place them in the same position as the Symphylan stylus. One could make at least a consistent argument that the mesal stylus and adjacent eversible vesicle of symphylans, and the thoracic styli and paired eversible vesicles of machilids are endite derivations and therefore homologous with the gnathal endites. Such an arrangement would make the palpi, legs and abdominal styli all telopodites or their rudiments. This proposal has as much morphological support as the all-exite or exite-telopodite theories, which is to say all are inconclusive at present.

While they are movable, the abdominal styli of Microcoryphia and Thysanura act as rigid skis upon which the abdomen is borne. The actual gliders are the scale-like hairs covering the anterior faces of the styli (Fig. 3, ST). However, the gonostyli on VIII and IX can be truly locomotory. When these animals climb objects, the 9th styli actually push, and bristletails trying to climb a smooth surface such as glass prop themselves up on the rear styli and grapple overhead with the thoracic legs and maxillary palps. Some males of Nicoletiidae (Thysanura) may use the 9th styli as clasping organs during reproduction, the characteristic role of the appendages among male Pterygota.

Female Pterygota usually employ the 9th gonostyli as sensory palps or as a scabbard for the ovipositor, which apparatus is derived from the 8th and 9th gonapophyses (8th gonostyli are absent in male and female pterygotes). However, Grylloblattodea, Orthoptera and Raphidida use the gonostyli along with the gonapophyses to penetrate the substrate during oviposition. Machilids may use the gonostyli while egg-laying in a manner reminiscent of these groups. The female will back up in loose duff, and vigorously excavate along the surface with the 9th gonostyli by flipping the appendages laterally in unison. The styli move synchronously much as one uses the arms to swim the breaststroke. Dirt and litter may be tossed over an inch away. The flexible, interlocked

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FIG. 3. Tergal lobe (TL) on ventrolateral margin of abdominal tergite III of male "*Machilis*" *Strenua* Silvestri (Machilidae). FIG. 4. Idealized machilid abdominal coxite, ventral aspect. *Abbreviations*: Fig. 3, 4: CL, claw; CX, coxa; EV, eversible vesicle; EV-L, lateral vesicle; EV-M, mesal vesicle; RV, retracted vesicle; S, sternite; ST, stylus; SX, subcoxa; T, tergite; TL, tergal lobe. FIG. 5. Collection jar (Machilitrap) for Microcoryphia and Thysanura. *Abbreviations*: *a*, plastic vial approx. 8 cm tall, 5 cm dia. (e.g., Thornton Plastic Co., Salt Lake City, Utah, No. 55-40) ; *b*, polyeurethane skirt approx. 1 cm thick glued to free edge and projecting about 2 cm beyond lip.

gonapophyses extend between the longer gonostyli, and twist and thrust side to side between the earth particles as the styli rake along before and to either side of them.

Aggregation and Other Behavior

Delany (1959) found a weakly developed asexual sociality in *Pterobius* (Machilidae), and apparent sleep aggregations. The microcoryphians I observed (but not the thysanurans) behaved similarly. While there was ample room in containers and terraria for relatively uniform dispersion under individual shelters, invariably the entire population of machilids (some 25 males and females) gathered under 2 or 3 shelters. Their antennal tips might be crossed, and body contact was common. All of the machilids would aggregate together, regardless of genus, but the *Machilinus* in the same terrarium would cluster elsewhere. There was a definite avoidance reaction between members of the 2 families.

Aggregation in favored localities was seen both in the laboratory and field. If the insects were removed forcibly from these refuges, they eventually would return. There appears to be some trail marking substance involved: in nature, the machilids (but not the meinertellids or thysanurans) followed definite paths on both tree trunks and on the forest floor. There were some areas where they would run back and forth in a seemingly aimless fashion. On occasion they would chase each other. If one scuffed away the litter in the middle of one of these trails, the machilids using them would halt and cast about. Some turned around and ran back the way they came; others crossed the disrupted zone and continued on. Such habits can be a boon to the collector: after such a machilid run is located, one can sit down and catch them as they scamper by.

A peculiar exhibition may be related to emission of sex pheremones. Several times I found solitary male machilids (genus undetermined) sitting on exposed rocks near the trails they frequented. They had their abdomens raised in an arc and deflexed over their thoraces, exposing the abdominal sternites. The posture occasionally was accompanied by a grotesque rowing motion of the styli and a flipping of the cerci. Conceivably, some secretion was being emitted. This exhibition was observed during the course of the oviposition period. Unfortunately, I did not observe actual courtship or mating.

A bilobed tergal process (Fig. 3, TL) which may have something to do with reproduction can be found on the proximoventral edge of either tergite III of "*Machilis*" *strenua*. The upper ½ of the bifurcate projection is covered by a dense mat of black, scale-like hairs. It is filled with fat body and apparently is not movable. Since Microcoryphia are generally believed to mate by spermatophore transfer without direct body contact, a sexual role for these pairs of recurving lobes is difficult to envision. I suggest it mainly because I can think of no other, and since they are found only in adult males.

The arched position of the abdomen, but without the stylar movement, is the usual offensive posture in both sexes of Microcoryphia and some Thysanura. The cerci and longer caudal filament (tergite XI) are thrust far beyond the head in a rather scorpion-like pose, and then rapidly vibrated. The antennae may be pulled back along the sides of the body into what is normally a resting position for the insect. Bristletails I have seen in motion hold their antennae at an acute angle ahead of themselves and scan at intervals by swinging the long flagellum a half a dozen times in a tight circle. At rest, the antennae are held next to the body but with the projecting tips often crossing the antennae of an adjacent machilid.

ECDYSIS

One of the most bizarre habits of Microcoryphia is their moulting behavior: they glue themselves down before shedding. The cement appears to be fecal material, and it attaches the underside of the end of the abdomen to the substrate. Then the head and thorax emerge through the usual median slit in the vertex and thorax as the legs and abdominal styli thrust the body forward. Next, the legs and maxillary palps are used literally to walk the abdomen and its appendages out of the old integument. I have seen several instances with both machilids and meinertellids where either the cement failed or the wrong substrate was chosen (e.g., sand). None of these unfortunates completed ecdysis (normally undertaken at dawn), and all died by mid-morning regardless of temperature and humidity. Entangled specimens I attempted to free also died: the appendages did not expand when the stuck cuticle was removed, apparently from rapid irreversable damage due to the tourniquet effect of the uncast integument.

Microcoryphians normally are covered with scales and scale-like hairs, often in elaborate patterns. For instance, there is a very common *Machilinus* throughout the drier areas of northern California with a buff background, brown reticulations, and paired black bands running down its back. The effect is ludicrously like a miniature Volkswagen with racing stripes. The scales of bristletails and silverfish generally provide excellent crypic coloration amid forest litter. That *Machilinus* mentioned is nearly invisible among pine needles. If one descales a microcoryphian, and it has not recently moulted, it will shed in a few days. The detachable scales also may foil a predator since the aggressor most likely would get only scales unless a sclerite or appendage were gripped. Apart from the gliding surfaces provided by the scaly hairs on the styli, the preceding appear to be the only major roles played by the pelage on the integument of bristletails. Heeg (1967b), for instance, found they had nothing to do with water conservation.

HISTOLOGICAL DIFFERENCES BETWEEN APTERYGOTA AND PTERYGOTA

The tissues of Microcoryphia and Thysanura have fixation and staining properties very different from Pterygota. Living or fixed unabraded pterygote cuticle (sclerotized or otherwise) which has not been treated with a lipid solvent cannot be stained easily in most water-based histological dyes. This is apparently the effect of hydrophobic wax layers in the pterygote epicuticle. However, methylene blue applied to these apterygotes (living or dead) rapidly penetrates scales, sclerotized cuticle, corium and, given sufficient time, the internal organs. Heeg (1967b) found that whatever cuticular wax layer (if any) is on these insects, it is of little significance in preventing water loss. In a similar vein, the poor preservation of most apterygotes in alcohol seems related to basic biochemical differences in their tissues. Indeed, fixation of living specimens in alcoholic Bouin's solution[2] or F.A.A.[3] is the only practical way to obtain satisfaction preserved material. In alcohol alone, the cuticle softens and shreds, and the hypodermis and muscles fragment and pull away from the integument.

COLLECTION, REARING AND PRESERVATION

Thysanura, and Microcoryphia except Meinertellidae, are crepuscular or nocturnal, and generally photonegative. *Machilinus* spp. in northern California are not only diurnal and phototropic, but can be captured most easily at night by aiming a bright flashlight beam on the forest floor where they have been seen during the day. After about 20 minutes, they will appear in numbers and crawl toward the light. They can be collected during the day, but it means much searching under rocks and in leaf litter. They are very partial to warmth, and will cluster against

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[2] Alcoholic Bouin's solution: picric acid, 5.5 gm (saturated); absolute 2-propanol, 105 ml; formaldehyde, 50 ml; glacial acetic acid, 15 ml; water, 45 ml. Transfer specimens after 6–12 hrs. at room temperature into 70% 2-propanol. Fixation can be enhanced by heating, but specimens harden rapidly. For sectioning or dissections, the picric acid must be removed before staining is possible. Soak specimens or sections in 10% ammonium acetate in 70% 2-propanol until the yellow disappears (5 min. or longer).

[3] F.A.A.: 85% 2-propanol, 80 ml; glacial acetic acid, 10 ml; formaldehyde, 10 ml. Specimens may be kept in solution indefinitely without undue hardening if kept from heat. Material can be imbedded without additional fixation after 24 hrs.

the walls of a container warmed by a lamp. A similar response is obtained with a heating element. They sometimes can be found in considerable numbers on warm surfaces away from direct sunlight. The largest daytime aggregation of *Machilinus* I have ever seen was inside a well-lit men's privy in the Lava Beds National Monument (Modoc County, California) one hot July afternoon!

The machilids studied were not unduly disturbed by strong light at night, and were easily caught by stationing oneself by a rock, stump or run they frequented. Most Thysanura take alarm at light and, while a bristletail will ignore a beam and allow leisurely collection, one must move very rapidly to capture a silverfish. *Ctenolepisma lineata pilifera* (Lucas) often enters homes in rural areas of northern California, and can be spotted when the light is turned on. They prefer warmer areas, and the most fruitful collections I have made of the species were in my garage during the summer. This place is warm during the day since it lacks windows, has west-facing doors often hot to the touch from the inside, and is a veritable silverfish rookery. The insects can be found at all hours, but especially in the late afternoon, scurrying to and fro over the warm doors.

All of these apterygotans are caught easily by use of the vial illustrated in Fig. 5, or an aspirator. The latter has obvious disadvantages with the agile creatures except when they are cornered. The ½ to ¾ in. thick polyeurethane foam wrapped around the vial lip and extending about ¾ in. from it permits complete edge contact of the container on uneven surfaces. If the inner surface of the plastic vial is sanded about ¾ in. down from the outer lip, microcoryphians will climb up the side as far as they can get a grip when the bottle is inverted over them. Thysanurans usually will not climb, and a 3 × 5 card or similarly sized piece of stiff cellulose acetate must be worked between the vial and insect, and the substrate. Once contained, when the vial is quickly turned right side up, the captive will drop to the bottom. If there is a groove around the edge in the bottom of the vial, most individuals will freeze in the crevice and not make an immediate attempt to escape. The insects then can be dropped into a jar by inverting the vial again and tapping it. The lid should be replaced quickly if Microcoryphia are involved and the container is for live storage: the creatures may leap when they land, and can jump a foot.

As noted, Apterygota preserve poorly in alcohol. F.A.A. is the preferred solution, with alcoholic Bouin's solution 2nd choice. Specimens must be dropped in alive. Vesicles can be made to evert by pinioning the insect upside down, pushing down on the abdominal coxites, then flooding with F.A.A. as the vesicles inflate. Sometimes the sacs will evert of their own accord when killed in solution. Scale patterns are obliterated in preservative if not during capture, and photography provides the only practicable record. Specimens descaled when collected can be held until they shed and appear in new vestiture.

The diet of Microcoryphia and Thysanura in nature includes lichens, terrestrial algae, molds, and decaying fruits and insects. They can be reared easily in a jar or terrarium on dried or moist live yeast, and rolled oats. Lichens and wilted lettuce leaves should be added occasionally. A few milliliters of water periodically squirted on rough bark suffice for machilids, but meinertellids require drops of water daily. The environment, however, should be essentially dry. Excess water or food results in mite and Collembola infestations. Loose duff with bark and a few mossy stones provide a satisfactory ground cover.

Species of *Machilinus* like to bask in the "sun," and should be provided with a few hours of it with a lamp, preferably beamed over a rock. They will cluster on warm glass, stones, etc. regardless of the intensity of the visible light, suggesting a definite infra red tropism. This aggregating tendency provides the most convenient time for feeding, observation and photography (e.g., Fig. 2). No Thysanura or Microcoryphia I know of can climb unetched glass, but some screen (*not* a tight fitting glass cover) should be provided.

ACKNOWLEDGMENTS

Without the advice of Robert O. Schuster, Department of Entomology, University of California, Davis, I would never have learned where or how to collect these fascinating beasts. Determinations, references, and needed encouragement and comment came from Pedro Wygodzinsky, American Museum of Natural History, New York. To both, my deepest thanks.

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Resilin in the Sound-Organs of Pyralidae and Cicadidae

(Lepidoptera; Homoptera)

JAMES A. SCOTT

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INTRODUCTION

The purpose of this paper is to chart the distribution of resilin in the tympanal structures of selected insects, and to explain its function where it occurs in these structures.

Resilin is a rubberlike protein, found in the cuticle of insects and crustaceans, which functions as a natural spring. Anderson and Weis-Fogh (1964) give a recent review. Resilin is the most "perfect" rubber known; only 3% of the energy of deformation is lost as heat, and resilin returns to its normal state faster than any other rubber. Dry resilin is unstretchable, but it swells and becomes rubberlike in many solvents including water. Resilin can be dried and hydrated repeatedly without losing its rubberlike properties, and can be heated to 140° C without degrading. Ethanol and histological fixatives harden it, but this effect is reversible in water. It is easily digested by proteases. Resilin absorbs ultraviolet light maximally between 280 and 320 mμ depending upon pH, and fluoresces between 350 and 600 mμ, with a maximum fluorescence at 420 mμ.

PROCEDURE

The sound-organs of *Galleria mellonella* L. (Pyralidae) and *Cacama valvata* (Uhler) (Cicadidae) were tested for the presence of resilin. The tympana of undetermined specimens of Acrididae, Arctiidae, Noctuidae, and Tettigoniidae were also examined, but no large resilin deposits were found, and these insects are not considered further. The structures of *Galleria* and *Cacama* and a known sample of resilin, the prealar arm of

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Locusta migratoria L. (Acrididae) were sectioned after fixing in Lillie's AAF (Lillie, 1954). Before staining, the sections were examined for fluorescence using a Zeiss microscope with exciter filter IIII-UG-1 and barrier filter no. 41. This system illuminates the section with ultraviolet light between 3000 and 4000 Å, and permits all light above 4200 Å to pass through to the observer. Resilin fluoresced blue. Sections were examined on slides for fluorescence before staining since the process of wax removal and staining destroyed fluorescence. The slides were then stained with Mallory's Triple Stain and mounted with Permount. Resilin appears yellow, endocuticle and muscle appear blue, and exocuticle appears red. The presence of resilin was further confirmed by staining dissected specimens with methylene blue or toluidine blue-light green, and by digesting with trypsin for 60 minutes at 37° C and observing the change in fluorescence and elasticity. Staining is less useful than fluorescence. The toluidine blue-light green stain and the methylene blue stain caused endocuticle to appear blue-green and resilin to appear greenish blue. Although resilin stained yellow after Mallory's Triple Stain, other tissues which did not fluoresce were also stained yellow. Fluorescence was more selective, but many small areas within the endocuticle were found to fluoresce. This may only indicate that endocuticle contains resilin, however. Examining sections or whole dissections alone was insufficient to determine the presence of resilin; a combination of the two produced reliable results.

PYRALIDAE

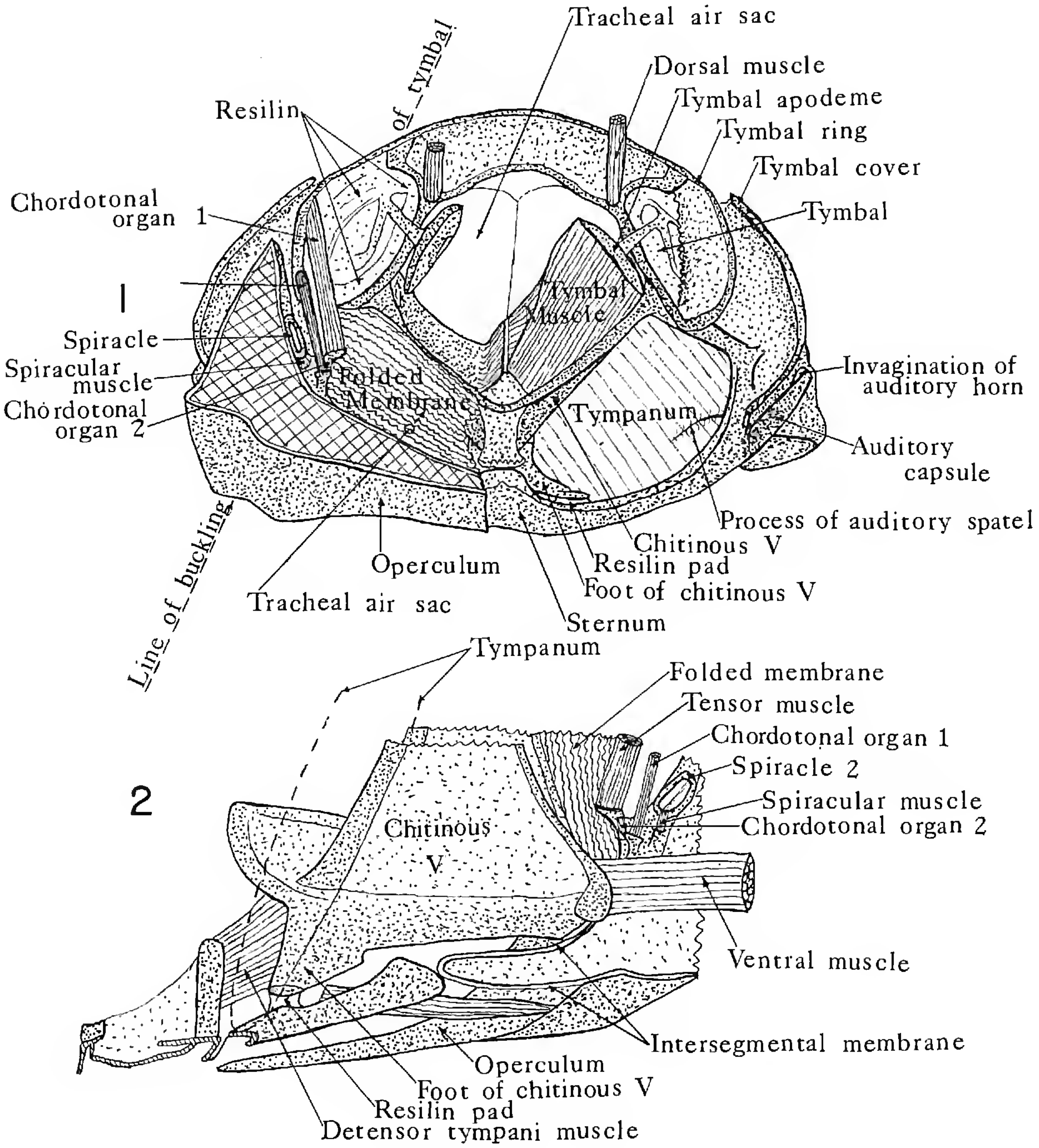
Several small, fluorescent, membranous areas were found upon sectioning and staining fresh *Galleria*, but these areas have not been located on dissected specimens. In the sections a fluorescent, small, rodlike structure was found between the anterolateral corner of each tympanum (which is on the anteroventral part of the first abdominal segment) and the posterior part of the metathorax. This structure ceased to fluoresce after trypsin digestion. The presence of resilin in this structure was also indicated after staining with toluidine blue-light green and with methylene blue. It would seem that this rodlike structure functions as a spring in the hinge formed by the junction of thorax and abdomen; it does not appear to have a role in sound reception by the tympanum.

CICADIDAE

Sections of the anterior part of the abdomen of a male *Cacama* were stained with Mallory's Triple Stain. Fluorescence microscopy revealed the presence of a large membranous area and a large solid pad in addition to many smaller areas of fluorescence for which location remains unknown. These two large areas are located around the tymbal and beneath the toe of the "foot" of the chitinous V (Figs. 1 & 2). The presence of resilin in these areas was confirmed by staining with toluidine blue-light green and methylene blue, and by digesting a dissection with trypsin and comparing it to a non-digested control in buffer. The resilin stained blue, and digestion caused much more freedom of movement, especially in the resilin pad. Pringle (1954) found an elastic tendon in the cicada which he said was stretched when the tensor muscle contracted. He later reinterpreted this as chordotonal organ 1 (Fig. 1). It contains no resilin and is not truly elastic. Furthermore, it is relaxed when the tensor muscle contracts.

The following summary of the structure and function of the sound-organs in the cicada will help the reader to understand the function of resilin in the cicada. The summary is based on Pringle (1954, 1957), Vogel (1923), Wakabayashi and Hagiwara (1953), Hagiwara (1956), and Hagiwara et al. (1954). Pringle speculates that these organs arose in copulatory behavior from transmission of weak sound from one insect to the other or by gradual modification of stridulatory organs.

Sound reception is due to the tympanum (Fig. 1). The ventral opening to the tympanum is covered by a backward extension of the metathorax, the operculum. The tympanum receives the sound and transmits it to the auditory "spatel," which enters the auditory capsule. In the auditory capsule is an invaginated cuticular auditory horn, and between the auditory "spatel" and horn are stretched up to 1500 scolopidia which detect the sound but transmit only the pulse pattern (the "modulation envelope") of the sound, not the primary frequency. The detensor tympani muscle (side view Fig. 2) pulls the chitinous V rearward, buckling the tympanum. Pringle states that this muscle contracts prior to sound production and speculates that buckling may prevent the tympanum from being ruptured by the sound. The ventral muscle (an intersegmental muscle from thorax to abdomen) pulls the chitinous V forward and would tend to oppose the detensor muscle and stretch the tympanum. Vogel found a tensor tympani muscle which originated from a dorso-ventral muscle of the nymph which would stretch the tympanum; however, Pringle finds that the muscle degenerates after emergence in the adult male, and is of importance perhaps only in stretching the tracheal air sac after emergence. Expansion of the air sacs is also aided by many small muscles which degenerate after emergence and by the excretion of large amounts of fluid, which creates a space into which the air sacs expand. Tracheal air sacs cover the tymbal



FIGS. 1–2. Sound-organs of the cicada, *Cacama valvata* (Uhler). FIG. 1. Anterior view of cross-section between thorax and abdomen, × 10. FIG. 2. Right-lateral view of chitinous V, abdominal pleuron and tergum removed, showing points of attachment of tympanum on chitinous V and pleuron, ×15.

muscle, the inner surface of the tympanum and tymbal, and the postero-ventral surface of the "folded membrane." The folded membrane (intersegmental membrane between thorax and abdomen) stretches from the anterior border of the chitinous V to the metathorax and serves as a barrier to hemolymph penetration of the tympanal air sac. The chitinous V is a very large brace consisting of sternum 1 and the anterior part of sternum 2. It attaches solidly to the cuticle wall dorsolaterally and rests ventrally on two small "feet." The chitinous V serves as the dorsal attachment of the tympanum and, especially, as the origin of the tymbal muscle.

Sound production is due to the inward and outward buckling of the tymbal, which is covered outwardly by the tymbal cover, an anteriorly extending flap of the abdomen. The tymbal is surrounded by a ring and consists of a thin cuticular area reinforced by struts, and is buckled along a line through the center. It is moved by the huge tymbal muscle, which wraps around the chitinous V dorsally. The tymbal muscle is thought to be a metathoracic flight muscle which has migrated backward, or a first abdominal dorsoventral muscle. The backward migration of the tymbal muscle (if it occurred) has left the metathorax with inadequate flight muscles; Pringle cut the ventral nerve cord in front of the metathorax and got normal flight due to the wing-coupling apparatus of fore and hindwings. One sound is emitted during the in-buckling, and another during the out-buckling of the tymbal. There is alternate innervation of the two tymbal muscles, so there are twice as many sounds as would be expected if the two muscles contracted simultaneously. Some cicada tymbal muscles are not myogenic; one stimulation of such a muscle results in a damped bimodal pulse of sound. Other cicadas have myogenic tymbal muscles; one stimulation results in a series of bimodal pulses to produce a train of pulses. The frequency and damping of each train of sound is due to the resonating frequency of the tymbal (which is usually the same as the resonating frequency of the air sacs), which depends on the elasticity of the tymbal and the tensor and dorsal muscles. The tensor muscle (originally in the first abdominal segment) arises from the metathorax and inserts on the upper edge of the tymbal. Tetanic contraction of this muscle increases the curvature of the tymbal and therefore requires a greater force to be exerted to cause its buckling. The dorsal muscle appears to act in a similar manner by altering the angle of attack of the tymbal muscle. Thus the tensor and dorsal muscles appear to amplify the sound, especially the in-click, and to decrease the primary frequency. In cicadas which have myogenic tymbal muscles, these muscles prevent tetanic contraction of the tymbal muscle by increasing the force required to buckle the tymbal. The tensor muscle along with many other muscles helps raise the abdomen during sound production. Associated with the tensor muscle are two chordotonal organs, which presumably register the change in tymbal concavity produced by the tensor muscle. There are many variations in sounds due to the tensor and dorsal muscles and due to changes in resonant frequency of the air sacs produced by abdominal muscles and by opening the opercula to different degrees (opercular opening results from lifting the abdomen, since the opercula are rigidly fixed to the thorax). A single species of cicada may have three types of song: 1) calling or congregating song; 2) courtship song; 3) disturbance squawk.

The function of resilin in the cicada can now be understood. Resilin is obviously useful in the tymbal because of the buckling and distortion which this structure undergoes; it prevents cuticle "fatigue" and enables more of the energy to be channeled into sound production and less into heat. It is remarkable that such a massive structure as the chitinous V has only a very small ventral attachment. The resilin pad beneath the "toe" of the "foot" of the chitinous V permits anteroposterior movement of the chitinous V, which increases or relaxes the tension on the tympanum. The tympanum is attached medially to the chitinous V, laterally to the sternum and to a brace supporting the tymbal ring. Around its circumference the foot of the chitinous V is the only point at which movement can occur. Slackening the tympanum by detensor muscle contraction during sound production would compress and rotate the resilin pad; elastic forces would cause restretching of the tympanum again when the detensor muscle relaxes. Another hypothesis that has not been previously proposed is that the ventral muscle contracts in opposition to the detensor muscle, thus stretching the tympanum. The location of the ventral muscle is ideally suited for this purpose. Another speculation is that the ventral muscle alters the tension of the tympanum during the reception of a cicada song. The tympanum receives sound waves which produce standing waves over its surface. Vibration is maximal at the resonant frequency so that reception of sound is probably strongest at the resonant frequency of the tympanum. Therefore, if the tympanum could be stretched and tensed to various degrees by the ventral muscle, a wider range of frequencies could be monitored. The arrangement of scolopidia within the auditory capsule is such that some scolopidia are moved a much greater proportion of their length than are others, so that the scolopidia might be differentially sensitive to various frequencies. The fact that recordings of the auditory nerve have shown that only the "modulation envelope" or pulse pattern is transmitted does not support this hypothesis however, and mere closing or opening of the operculum could accomplish the same effect since the resonant frequency of the air sacs and presumably the tympana also are altered. Clearly these hypotheses need to be tested.

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SCIENTIFIC NOTE

Unique structures in members of *Tachys sensu lat.* (Coleoptera: Carabidae).—The species of the tachyine groups *Tachylopha* Motschulsky, *Tachyphanes* Jeannel, and *Sphaerotachys* Müller are distributed from Africa to East Asia, while those of *Barytachys* Chaudoir are confined to the New World and distributed from Canada to Brazil. Bruneau de Miré has recently revised the African species of *Tachylopha* (1966, Rev. Zool. Bot. Afr., 73(1–2): 59–100), and I am presently studying *Barytachys* and other New World groups. Bruneau de Miré illustrated and noted an interesting structure in the species of *Tachylopha* in his study. I have found this same structure, though less well developed in members of *Tachyphanes* and *Sphaerotachys* and made a further discovery, hitherto unreported, of an interesting structure in some members of *Barytachys*. The purpose of this note is to describe these structures and speculate on their function.

If a specimen of any species of *Tachylopha*, *Tachyphanes*, or *Sphaerotachys* is examined from either side, one will immediately note a small to large hole (Fig. 1) in the body wall at the juncture of the mesepisternum and mesepimeron. This hole is an infolding of the entire body wall forming a tube which passes through the beetle, over the gut, and meets the infolding from the other side. In the specimens I examined, no septum was apparent (but see Bruneau de Miré, p. 63), thus the beetle has a transverse "tunnel" completely through the body. In some specimens one can actually see through the beetle. Inside the tube the thickly sclerotized wall is ridged, the ridges being continuous from one side of the beetle to the other. The tube does not have any macro-openings into the coelum of the beetle and no glands seem to be associated with the structure.

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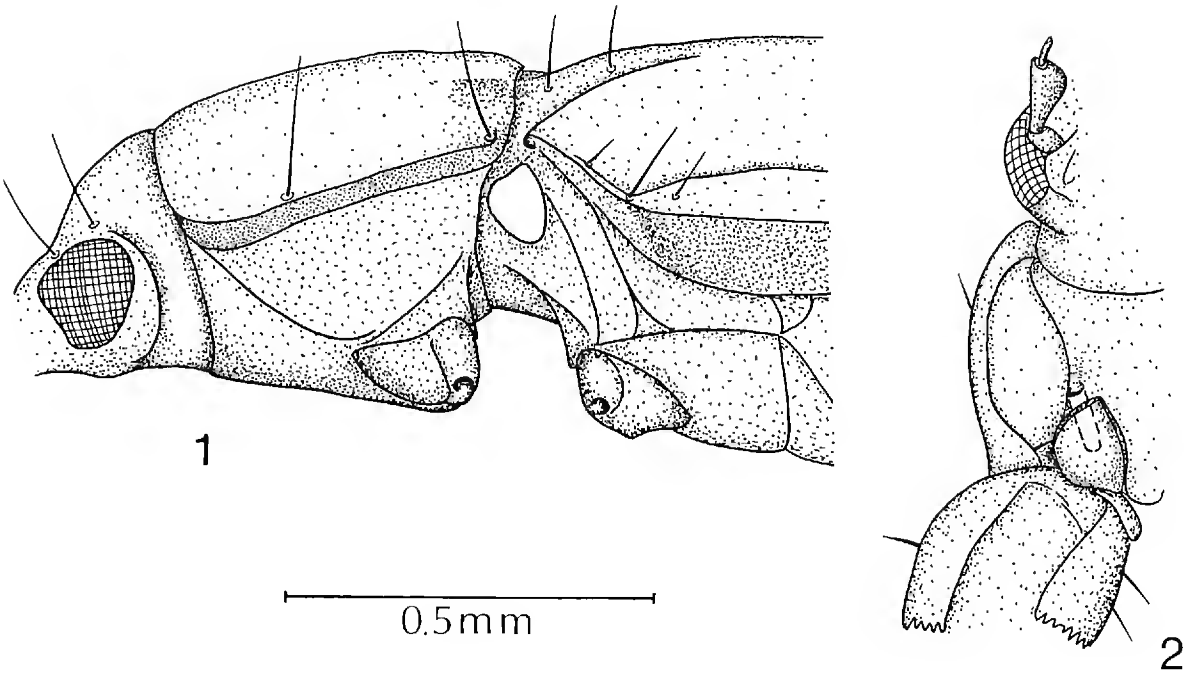

FIG. 1. *Tachylopha ovatus* Motschulsky, male, left lateral aspect. FIG. 2. *Tachyura tripunctatus* Say, male, ventral aspect, left side.

Since I have neither collected these beetles nor seem them alive, I can only speculate on the function of this unique tachyine structure. My first thought was that this may be an exudation source for ants. Many tachyines are myrmecophilous. The lack of glands and internal openings might exclude this explanation. The tube certainly strengthens the structure of the exoskeleton, but this seems an insufficient explanation because no other tachyine has any structure remotely like this one. My last hypothesis must be tested in the field. These holes may be handles whereby ants could carry the beetles about. The ant mandibles would be inserted into these holes and the beetle lifted in this fashion. This is supported by the fact that the elytra of *Tachylopha* members have another unique structure. Above the hole, the humerous of the elytron is deeply notched, forming a tooth. The ant mandibles, when inserted in the hole, could fit over this notch and reinforce the hold.

J. F. Lawrence informed me (per. comm.) that Lea (1917, Trans. Proc. Roy. Soc. South Australia, 41: 121–322, fig. 8a) reported a similar structure in the ptinid beetle *Polyplocotes perforatus* Lea. In these beetles the "tunnel" occurs through the head beneath the clypeus, and its entrances are covered by the antennae when in repose. It is interesting to note that these beetles *are* myrmecophiles, but again no function has been assigned to the structure.

Some members of *Barytachys* have perforations (Fig. 2) of the prosternum, anterior to the coxae, one on each side between the prosternum and proepisternum. This hole is smaller than those in *Tachylopha* and are directed longitudinally rather than transversely. The "pouch" ends abruptly at the dorsal wall of the coxal cavity and has no openings into the coelum. It is much harder to visualize ants using these longitudinal pouches for handles, but it is interesting that many of the *Barytachys* members with pouches *are* associated with ants. Field work is being planned to study this problem.—TERRY L. ERWIN, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

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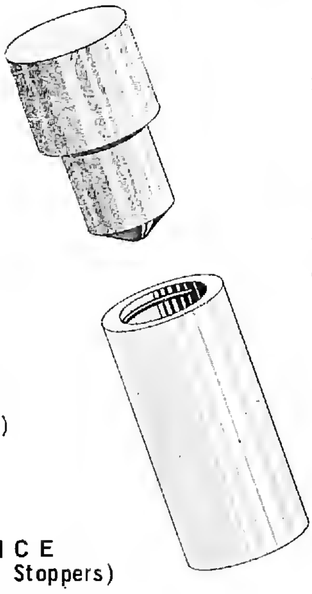

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Thalassotrechus barbarae (Horn) and the Santa Barbara Oil Spill

(Coleoptera: Carabidae)

William G. Evans

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When oil spills from tanker wrecks or off-shore wells occur near the coast, the subsequent effect on marine life may be very conspicuous, such as the high mortality of oil soaked birds (at least 10,000 dead birds were collected after the *Torrey Canyon* wreck according to Bourne, 1968) or the decimation of extensive littoral communities of rocky shores due to oil smothering (Ranwell, 1968). Because of the stranding of oil after high tides an off-shore spill can seriously affect plants and animals in the higher intertidal zone (the high littoral) of the rocky shore habitat, where there are often periods of days between the times of the modifying effects of water. The midlittoral and the infralittoral zones are more subject to wave action and are only temporarily affected by oil (Rützler and Sterrer, 1970). The dominant inhabitants of the high littoral in California consist of those forms found in high tide pools and those on rock surfaces, e.g. littorine molluscs, limpets, barnacles, isopods, and amphipods along with such algal forms as *Enteromorpha, Porphyra, Pelvetia, Fucus, Gigartina,* and *Ulva.* All of these organisms are susceptible to smothering doses of oil, but they could probably survive light doses mainly because of their hydrophilic surfaces. After the *Torrey Canyon* wreck lightly polluted areas of Cornwall, where emulsifiers had not been used, showed only low mortality and limpets and periwinkles apparently grazed away thin layers of oil (Nelson-Smith, 1968).

Another distinct animal association of the high littoral zone, the crevice fauna (Lewis, 1964; Glynne-Williams and Hobart, 1952; Evans, 1968), is probably more susceptible to oil than any other animal association of the marine littoral. The crevices, which can extend into the rock from an inch to perhaps more than a foot, harbor a wide variety of animals that are not normally seen due to their cryptozoic habits.

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Many of these animals, particularly the young ones, use crevices as a protection against wave action, predation, or desiccation while others live on detritus and plankton stranded in the cracks when the tide recedes. Others emerge at night at low tide and scavenge or prey on crustaceans and insects associated with the algae found in this zone. Though the kinds as well as the numbers of species may vary geographically from one place to another, certain groups of animals are characteristically found in high intertidal crevices throughout the world. Pseudoscorpions, mites, and centipedes for instance, are typical crevice dwellers in many areas, including California and, among the insects, carabid, melyrid and staphylinid beetles and chironomid flies are dominant forms. In addition, the usual marine animals such as the ubiquitous isopod *Ligia,* various amphipods and the young of littorine molluscs are common members of the high crevice fauna.

The preponderance among this fauna of terrestrial, air-breathing arthropods which have become adapted to the high intertidal zone is typical for most areas and it is this group that can be extremely sensitive to oil contamination. Some of the reasons for this are: *a.* oil accumulates in crevices rather than being washed away, exposing the inhabitants to a continual dose; *b.* heavy fractions of oil can block the crevice entrances completely, preventing food from being washed in and preventing passage of the inhabitants; *c.* the cuticle of many of the terrestrial forms, particularly of the adults, repels water due to wax layers or dense hair piles but these hydrofuge properties are also oleophilic properties making the cuticle readily wetted by oil. (Petroleum oils are potent insecticides and historically have been used for this purpose very extensively.)

The crevice fauna of the high tide zone could therefore be sensitive indicators of the extent of oil pollution. (There is circumstantial evidence to support this view. In the heavily polluted oil port of Talara in northern Peru I found the high littoral crevice fauna of nearby rocky shores to be completely absent during a survey made in April 1968, though it seemed to be unaffected at the unpolluted region of Paita which is about 40 miles further south.) An opportunity arose to examine this idea after the 28 January 1969 Santa Barbara oil spill. Though the area of Santa Barbara had not been surveyed for the high crevice fauna just previous to the oil spill (an unavoidable shortcoming of many studies of this sort as is illustrated by the extensive surveys taken *after* the *Torrey Canyon* wreck) there was no reason to believe that the composition of the crevice fauna of this region would be much different than that of central California which I had previously surveyed (Evans, 1970). However, because of this uncertainity, I selected *Thalassotrechus barbarae* (Horn) as a representative indicator species of this crevice community. This carabid beetle is distributed on the Pacific coast from northern California to central Baja California and since the adults emerge from the crevices in the evening and disperse over the rocks where they prey on algal-feeding dipterous larvae or small crustaceans, they can be found without destroying the habitat by searching with a flashlight at this time. This method is preferable to splitting open crevices in the daytime, a procedure also followed to obtain this beetle as well as other members of the community. Finally, because these beetles forage widely at night, they are more likely to come into contact with oil, particularly if it is patchily distributed. Thus, they could receive a dose of the oil by walking through it or by contamination of their food, but the oil would probably be fatal in either case.

A survey of the distribution of *T. barbarae* after the oil spill was made from June 1969 through the middle of August 1969 and was confined to rocky shores between Shell Beach, San Luis Obispo County, in the north to Leo Carillo State Beach (about 20 miles north of Malibu), Los Angeles County, in the south, resulting in a discontinuous sampling pattern along the coast because of the prevalence of sandy beaches along this region of coastline. Public beach areas were also sampled more frequently than other areas because of their accessibility. Each locality sampled was visited several times and observations were made at night at low tide for foraging beetles or series of crevices were split open with a geological hammer during low tides in the daytime over what was thought to be representative areas of rocks.

According to Allen (1969a), irregular stretches of coastline amounting to more than 100 miles in length were affected by the oil in the two month period following the oil spill (Fig. 1). "Heavy" deposits (several inches of dark black crude oil over the entire tidal zone) occurred near the Santa Barbara-Ventura area while "moderate" to "light" and "very light" deposits occurred in other areas. The heavy deposits of oil on the intertidal rocks were very evident in the Santa Barbara area even in August, six months after the spill and it was also quite evident that the crevice fauna of the high, oil-covered rocks had been completely killed. The flora and fauna of the mid- and infralittoral zone did not appear to be much affected at this time. Moderate deposits consisted of isolated patches of tar while the light and very light deposits which appeared as iridescent films when the area was surveyed in February and March (Allen, 1969a) were no longer visible.

Thalassotrechus barbarae was not found in the following localities

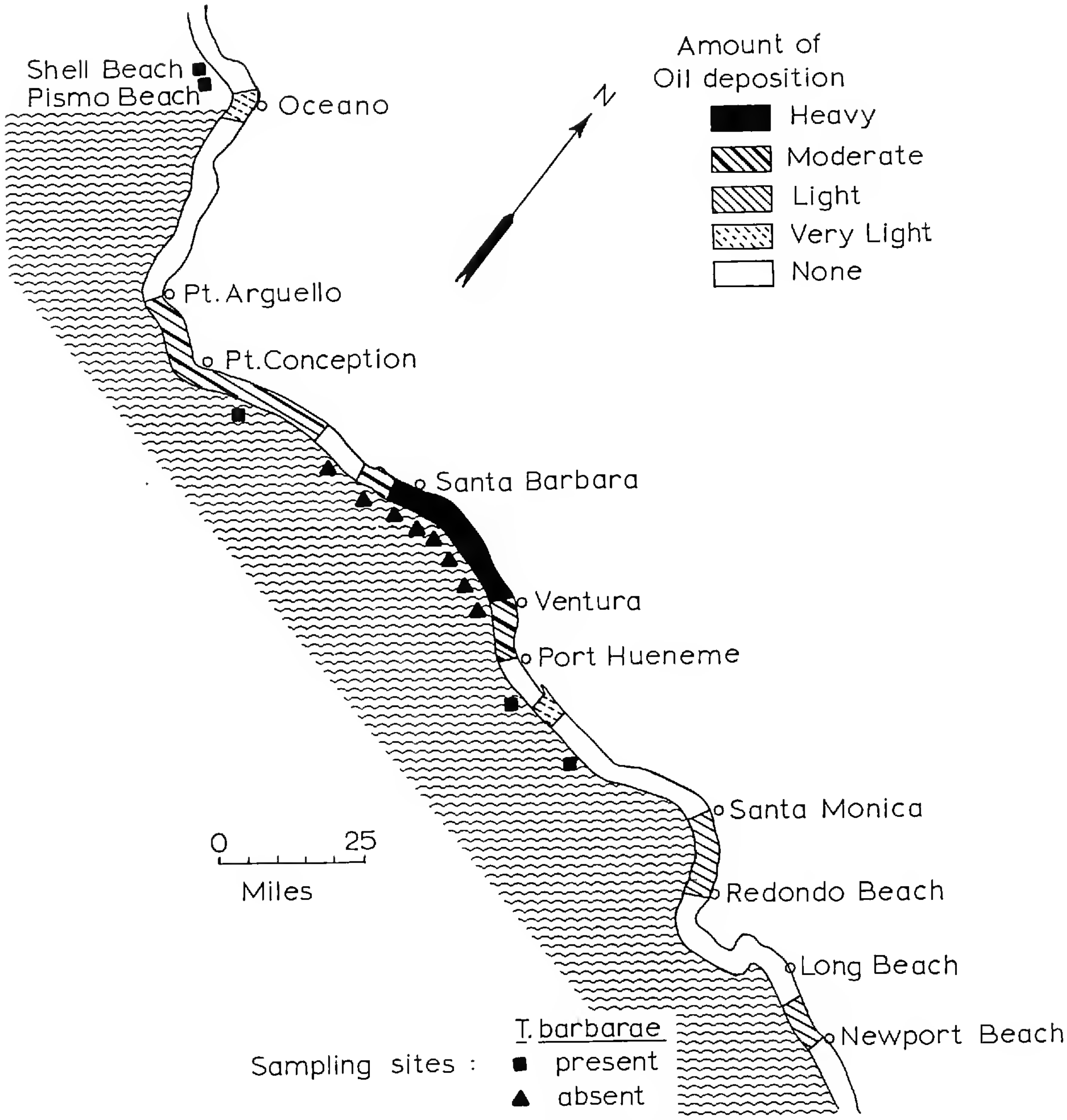

FIG. 1. Extent of oil pollution during the first two months after the 28 January 1969, Santa Barbara oil spill (after Allen, 1969a) and sampling localities for *T. barbarae* for the June–August 1969 survey.

(from west to east) in the region of Santa Barbara: Refugio Beach, El Capitan Beach, Ellwood Beach, Goleta point, Arroyo Burro Beach, Carpinteria and Ventura (Fig. 1). Since all of these localities were subject to heavy or moderate deposits of oil it is very probable that populations of *T. barbarae,* which quite likely existed in these areas before, were killed by the oil along with other members of the high littoral crevice community. And judging by tar residues still remaining on the rocks in most of these areas it may take many years before this community can re-establish itself.

Some natural oil seepage occurs off Coal Oil Point, approximately 10 miles west of Santa Barbara, and other areas along the California coast and this could also contribute to oil deposits on nearby rocks and beaches. But the flow rate from these sources differs by a factor of about 100 when the conservative estimate of five thousand barrels per day for the first 11 days of the oil spill is considered (Allen, 1969a, 1969b). So it is doubtful if these natural seeps could have affected the crevice fauna so seriously in the Santa Barbara region.

Thalassotrechus barbarae was named by Horn (1892) after the type locality, Santa Barbara, California. It seems ironic that this beetle cannot now be found anywhere near Santa Barbara and I think it is about time for biologists and conservationists to become just as concerned about the effects of pollution on insects and other invertebrates as about those on the more familiar larger animals.

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A Redescription of the Scorpion *Vejovis bilineatus* Pocock

(Scorpionida: Vejovidae)

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R. I. Pocock described eight new species of North American *Vejovis* in a brief but very important paper (Pocock, 1898). Among these was *Vejovis bilineatus* Pocock, from "San Diego, Texas." The identity of this species has caused some confusion among scorpion workers ever since the original description. Even Hoffmann, in his systematic monograph of the scorpion fauna of Mexico (Hoffmann, 1931) was not sure he knew this species, and indicated the species he called *Vejovis bilineatus* possibly might not be the same species as that described by Pocock, although he believed them to be the same.

To clarify the status of this species, Willis J. Gertsch, of the American Museum of Natural History, borrowed the types from the British Museum of Natural History. Knowing of my interest in this group also, Dr. Gertsch permitted me to examine the specimens while they were in his custody. Since knowledge of this species is important in understanding the composition of the scorpion fauna of the United States and Northern Mexico, a redescription is here made.

Much appreciation is due W. J. Gertsch for providing me an opportunity to study the type, and to the British Museum of Natural History for the courtesy of making it possible to borrow the type. Thanks to Christie A. Steketee and Charlene F. Williams for clerical assistance. This work was partially supported by research grant GB 7679 from the systematics section of the National Science Foundation.

VEJOVIS BILINEATUS Pocock, 1898

(Figs. 1, 2)

DIAGNOSIS.—Small species of *Vejovis* belonging to the "spinigerus" sub-group. Probably seldom attains body size longer than 35 mm. Coloration: Mesosomal dorsum with one pair of distinct dark, longitudinal stripes; carapace with dark underlying marbling; metasoma with dark stripes in position of inferior median and inferior lateral keels; ventral surface of metasomal segment V somewhat dark. Metasoma with obsolete inferior median keels; inferior lateral keels irregularly smooth and fairly developed; dorsal and dorsolateral keels on segments II to III more crenulate than serrate; ventral surface of vesicle not granular, but may have punctiform depressions; pedipalp hand small, palm not very swollen, movable finger about ⅔ carapace length; pectines with 13 to 16 teeth in females and 15 to 17 teeth in males.

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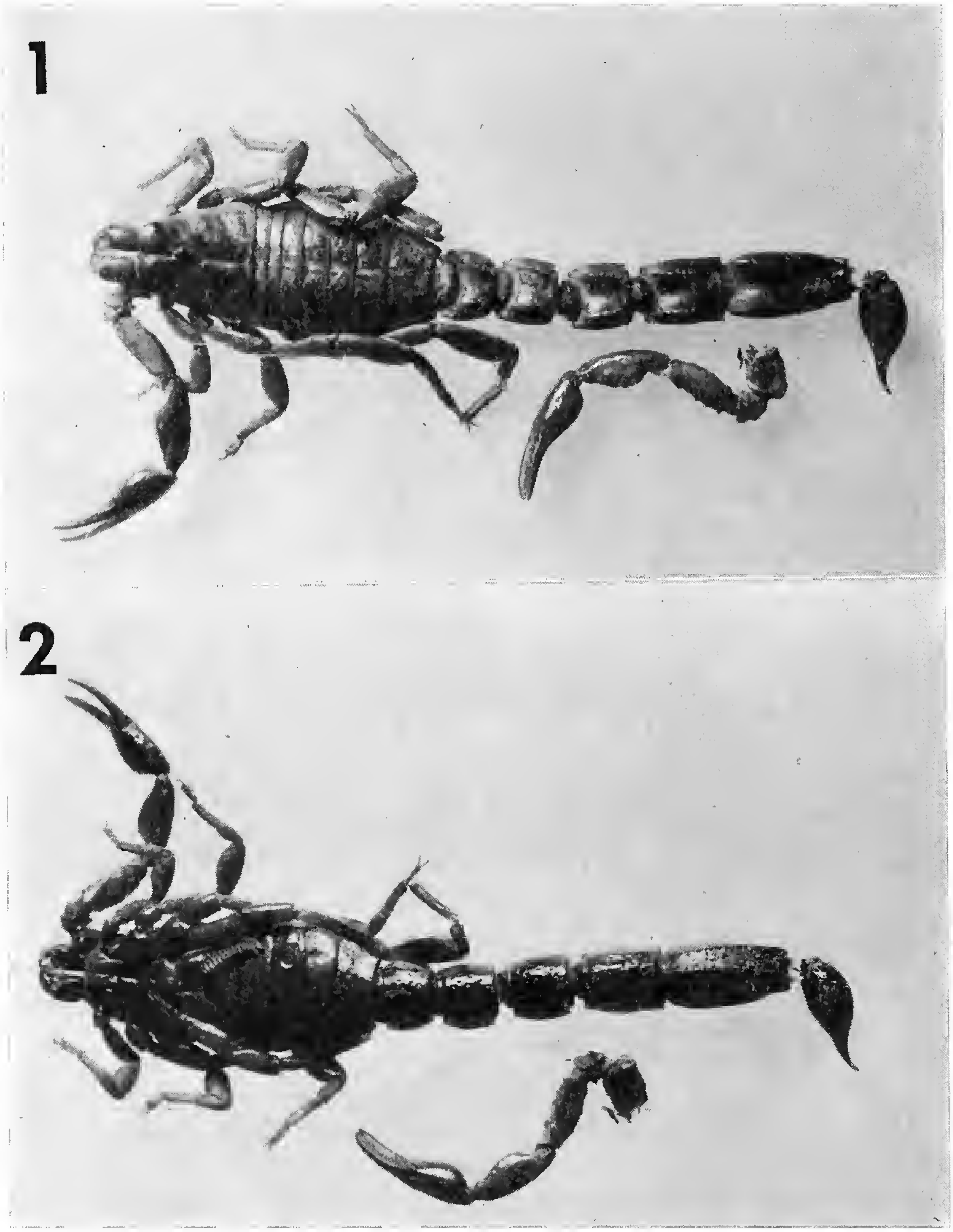

FIGS. 1 and 2. *Vejovis bilineatus* Pocock. Holotype female. FIG. 1. Dorsal view. FIG. 2. Ventral view.

HOLOTYPE FEMALE.—*Coloration.*—Color pattern somewhat obscured by poor preservation. Base color of cuticle deep yellow; some dark underlying markings on carapace; one pair submedian dark longitudinal stripes on dorsum of mesosoma.

Carapace.—Anterior margin straight; lateral eyes 3 per group; median eyes on very subtly elevated ocular tubercle; diad $\frac{2}{9}$ carapace width at that point. Carapace surface granular, slightly lustrous.

Mesosoma.—Tergites granular, somewhat lustrous; tergite 7 with 2 pair of crenulate to serrate lateral keels. Sternites smooth; last sternite lacking lateral keels.

TABLE 1. Measurements (in millimeters) of *Vejovis bilineatus* Pocock, holotype.

	Holotype (female)
Total length	35.0
Carapace, length	3.5
width (at median eye)	2.9
Metasoma, length	11.5
segment I (length/width)	1.6/2.2
segment II (length/width)	1.8/2.0
segment III (length/width)	1.9/2.0
segment IV (length/width)	2.4/2.0
segment V (length/width)	3.8/2.0
Telson, length	3.5
Vesicle (length/width)	2.3/1.6
depth	1.2
Aculeus, length	1.2
Pedipalp	
Humerus (length/width)	2.5/1.0
Brachium (length/width)	2.8/1.2
Chela (length/width)	4.1/1.1
depth	1.2
movable finger, length	2.4
fixed finger, length	1.7
Pectines	
teeth (left/right)	14/14

Metasoma.—Dorsal and dorsolateral keels of segments I to III irregularly crenulate; dorsal keel of segment IV crenulate, dorsolateral keel of IV smooth to crenulate; dorsolateral border of segment V essentially smooth; dorsal and dorsolateral keels of segments II and III terminate posteriorly in an enlarged spine. Inferior lateral keels irregularly smooth and faint on segments I to IV, inferior median keels obsolescent on segments I to IV. Inferior intercarinal spaces of segment V with many granules.

Telson.—Vesicle smooth and lustrous with several punctate depressions. Aculeus very short, broadly attached to vesicle. Very subtle subaculear tubercle.

Chelicerae.—Inferior border of movable finger completely lacking denticles.

Pedipalps.—Palm slightly swollen inwardly. Palm surface smooth and lustrous, lacking keels. Fingers internally unscalloped, opposing teeth of fingers meet closely along entire length when chela closed.

Standard measurements.—Table 1.

TYPE DATA.—Holotype female, "Texas, North America (San Diego), W. Taylor 1889." Type depository, British Museum. Type specimen poorly preserved, telson essentially separated from metasoma, one pedipalp and one walking leg completely separated from prosoma. Specimen darkened from poor preservation.

The original description was very brief, composed of two short paragraphs and not including many important characters. The details of this redescription essentially agree with those of the original description in all but the following ways: pectinal teeth 14 per comb, not 15; total length 35 mm, not 25 mm (however, some of the membranes appear to be stretched now). Pocock did not define the sex which is clearly a female and probably mature.

Hoffmann (1931) discussed a population which he called *Vejovis bilineatus* Pocock, with some reservation, from the state of Aguascalientes, Mexico. Hoffmann had neither opportunity to study the type nor to see material from near the type locality in Texas. Comparison of the holotype with Hoffmann's careful diagnosis indicates his specimens from Aguascalientes, Mexico were *Vejovis bilineatus*.

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New North American *Microdynerus* with Notes on the Nests of Two Species

(Hymenoptera: Eumenidae)

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The North American species of *Microdynerus* Thomson have been treated as species groups in the genus *Leptochilus* Saussure (Bohart, 1955). Parker (1966) removed the *trinodus* and *lissosomus* groups from *Leptochilus* and placed these species in the European genus *Microdynerus*. Additional specimens have accumulated since Bohart's paper was presented and among this material were the 4 new species described below.

The nesting habits of the Nearctic species are undescribed, except

THE PAN-PACIFIC ENTOMOLOGIST 46: 241–253. October 1970

Parker and Bohart (1968) recorded 2 species in this genus that nested in trap stems.

BIOLOGY

M. BAKERIANUS (Cameron)

(Figs. 51, 52)

Nesting site.—All nests of *M. bakerianus* were recovered from trap stems with a bore diameter of ⅛–$\frac{1}{16}$ in. Holes drilled in the end and side of the trap stems were utilized by these wasps.

Nest construction.—The females did not modify the nest, except for removing pith. The prey was placed rather loosely at the end of the burrow. A partition was made above the prey by cementing pieces of gravel and sand with what appeared to be a salivary secretion. Additional prey was stored above the partition and another made so that a series resulted. The length of the cells varied from 3 to 8 mm; generally shorter cells were found in wider burrows.

The number of cells found in each nest varied from one to seven. There were three nests with one cell, 22 with two, 27 with three, four with four and one with seven.

The last partition in most nests served as the entrance plug; which was usually located slightly below the entrance. A typical *M. bakerianus* nest is shown in Fig. 51.

Prey.—Lepidoptera larvae.

Larval habits.—The cocoon was formed by lining the cell with opaque silk that adhered to the cell walls.

Seasonal occurrence.—Collecting records indicate that there are at least 2 generations a year.

Sex ratio.—From the nests observed, 13 males and 22 females emerged.

Parasites.—Fourteen (9.2%) of the 75 *M. bakerianus* cells found contained parasites. In 22 (14.5%) additional cells the wasp failed to emerged; some of these may also have been parasitized. The following six species of parasites and one predator were reared from *M. bakerianus* nests.

Chrysididae.—A nest of *M. bakerianus,* collected from 9 mi. S. of Reno, Nevada, during the winter of 1964, contained three cells from which emerged: cell A, female *M. bakerianus*; cell B, male *Chrysis parkeri* Moore; cell C, male *Chrysis stenodyneri* Krombein. At the same locality the next winter, three cells from three separate nests were parasitized by *Chrysis pattoni* Aaron.

All these chrysidids probably ate the cell provisions and/or early host instars, because no host cocoons were observed in parasitized cells.

Bombyliidae.—Two species of bombyliids were reared from *M. bakerianus* nests: *Toxophora virgata* Osten Sacken and *Anthrax irroratus* Say. The beeflies killed the prepupal stage of the host. In one nest collected during the winter of 1965, one cell contained a tiny larva and another a mature larva of *Toxophora virgata.* This suggests that *T. virgata* overwintered in either a late or early instar.

Mutillidae.—One cell in a *M. bakerianus* nest from Banning, California, contained an unidentified species of mutillid that had killed the prepupa.

Predator.—A larva of *Trichodes ornatus* Say was found in one of 3 cells in a nest from Banning, California.

Supersedure.—One *bakerianus* nest from Patrick, Nevada was superseded by a nest of *Solierella* sp. which had emerged before the nest was collected. Three *M. bakerianus* nests were constructed above bee nests, two above *Proteraides bullifacies* (Michener) and one above *Ashmeadiella* sp.

M. SINGULUS (Bohart)

Nesting site.—Two nests of *M. singulus* were recovered from trap stems with a bore diameter of 1/16 in.; both nests were in holes drilled in the end of the stem.

Nest construction.—In one nest the cells were initiated 11 mm above the bottom of the burrow and in the other the first cell was started at the end of the burrow. Cell partitions and entrance plugs were made by cementing pieces of gravel and sand with what appeared to be a salivary secretion. Additional prey were stored above the partition and another partition was made. The length of the cells varied from 7 to 10 mm. The number of cells found in each nest was two.

Prey.—Lepidoptera larvae.

Larval habits.—The cocoon was formed by lining the cell with opaque silk that adhered to the cell walls.

Seasonal occurrence.—Collecting records indicate that there are at least 2 generations a year.

Parasites.—None of the *M. singulus* nests contained parasitized cells.

SYSTEMATICS

KEY TO SPECIES OF NORTH AMERICAN MICRODYNERUS

MALES

1\. White or yellow markings extending at least ¾ length of scape 6
Scape not pigmented or with small basal spot 2
2\. Antennal hook thick, blunt (Figs. 2, 11) 3
Antennal hook slender, pointed (Figs. 1, 4) 5
3\. Upper propodeal lamellae blunt apically, in profile, lower lamellae without

apical notch (Fig. 18); frons swollen between midocellus and compound eye (Fig. 2) .... *monolobus* (Bohart)

Upper propodeal lamella pointed apically, lower lamella with apical notch (Fig. 14); frons not swollen between midocellus and compound eye (Figs. 5, 8) 4

4\. Vertex with 3 shiny, knob-like swellings, one between lateral ocelli, one at upper posterior margins of each compound eye; vertex round in profile, (Fig. 5) .... *trinodus* (Bohart)

Vertex with single shiny swelling between lateral ocelli; vertex flat in profile, (Fig. 8) .... *singulus* (Bohart)

5\. Head 1⅙ times longer than broad (Fig. 4); upper propodeal lamella blunt, short; tergite II without lateral spot connected to apical band .... *hurdi* Parker, n. sp.

Head as wide as long (Fig. 1); upper propodeal lamella slender, pointed; tergite II with lateral spot connected to apical band .... *bolingeri* Parker, n. sp.

6\. Antennal hook thick, round apically, 1½ times as long as flagellomere IX (Fig. 12) .... *bakerianus* (Cameron)

Antennal hook slender, pointed apically, not longer than flagellomere IX (Figs. 13, 16) 7

7\. Antennal hook minute, only ½ length of flagellomere IX (Fig. 16); flagellomeres VII–IX thick, wider than long; vertex without tubercles, abdomen shiny, without deep macropunctures 8

Antennal hook as long as flagellomere IX (Fig. 13), apical flagellomeres as long or longer than broad; vertex with tubercles; abdomen with deep large macropunctures 9

8\. Apical clypeal margin with small, deep U-shaped notch (Fig. 6) .... *lissosumus* (Bohart)

Apical clypeal margin broadly excised (Fig. 17 .... *inusitatus* Parker, n. sp.

9\. Body marked with red 12

Body without red markings 10

10\. Lateral spot on tergite II isolated or attached to apical band; diameter of midocellus 4 times width of macropunctures on frons; propodeum armed with small tubercle .... *schlingeri* (Bohart)

Tergite II without lateral spot; diameter of midocellus twice width of macropunctures on frons; propodeum armed with prominent tooth or carina 11

11\. Frons, vertex densely pitted, margin of macropunctures connected (Fig. 49); in profile, tergite I without subapical indentation; pronotal lamella raised medially .... *arenicolus* (Bohart)

Frons, vertex with scattered pits, punctures not uniformly connected; in profile, tergite I indented subapically; pronotal lamella not raised medially .... *patagoniae* Parker, n. sp.

12\. Sternite II with median basal depression (Fig. 27) 13

Sternite II without depression (Fig. 25) 14

13\. Pronotal macropunctures as large as lateral ocellus; flagellomeres dark apically, ventrally; dorsal surface of tergite II shiny .... *bechteli* (Bohart)

Pronotal macropunctures not more than ½ diameter of lateral ocellus; flagellomeres yellow ventrally; dorsal surface of tergite II finely shagreen .... *cavatus* (Bohart)

14\. Lateral swellings on vertex prominent; frons between compound eye and

midocellus swollen (Fig. 7); propodeum mostly red; clypeus about as long as wide (Fig. 19) .... *gibboceps* (Bohart)
Frons, vertex without raised swellings (Fig. 3); propodeum mostly black; clypeus wider than long (Fig. 20) 15
15. Apical clypeal margin broadly, shallowly excised (Fig. 10); .... *sayi* (Cameron)
Apical clypeal margin angularly excised (Figs. 20, 36) .... *umbifer* (Bohart)

FEMALES

1. Sternite II with median basal depression (Fig. 28) 2
Sternite II smoothly curved basally, without depression 4
2. Thorax black with yellowish-white markings; head as long as broad (Fig. 35) 3
Thorax red with white markings; head longer than broad (Fig. 34) .... *hurdi* Parker, n. sp.
3. Lower propodeal lamella with subapical notch (Fig. 47); sternite II shiny; pronotal macropunctures as large as lateral ocelli .... *bechteli* (Bohart)
Lower propodeal lamella continuous with upper lamella (Fig. 18); sternite II densely pitted, dull; pronotal macropunctures ¾ as large as lateral ocelli .... *monolobus* (Bohart)
4. Median clypeal lobe with shallow, semicircular emargination (Figs. 38, 46); head longer than broad (Fig. 34) 5
Median clypeal lobe with deep, narrow V- or U-shaped emargination (Figs. 39, 40) 9
5. Vertex with 2 or more shiny knob-like swellings (Figs. 29, 33) 6
Vertex without swellings, or if present, then low and punctured 7
6. Lower propodeal lamella subapically notched (Fig. 48); vertex with 3 swellings (Fig. 33); pronotum black with creamy-white markings .... *cavatus* (Bohart)
Lower propodeal lamella continuous with upper lamella (Fig. 37); vertex with 2 swellings (Fig. 30); pronotum red with light markings .... *sayi* (Cameron)
7. Median clypeal lobe minute, not longer than diameter of midocellus (Fig. 46) .... *lissosomus* (Bohart)
Median clypeal lobe wide, at least 3 times diameter of midocellus 8
8. Body sculpturing smooth, shiny, macropunctures shallow; head as long as broad; vertex not enlarged (Fig. 31) .... *inusitatus* Parker, n. sp.
Body sculpturing coarse, macropunctures deep; head longer than wide; vertex enlarged (Fig. 29) .... *gibboceps* (Bohart)
9. Vertex with swellings only between lateral ocelli 10
Vertex with swellings between lateral ocelli and compound eye; interocellar area with or without swellings 11
10. Vertex swollen between lateral ocelli, depressed medially (Fig. 49); median clypeal lobe with V-shaped notch; upper propodeal lamella broad; body black with yellow to white markings .... *arenicolus* (Bohart)
Vertex with single shiny welt between lateral ocelli (Fig. 50) median clypeal lobe with U-shaped emargination; upper propodeal lamella narrow, blunt; body marked with red .... *singulus* (Bohart)
11. Vertex with 3 shiny knob-like swellings 12
Vertex without distinct raised swellings 13

12. Median clypeal lobe as in Fig. 42; lower propodeal lamella continuous with upper lamella; sternite II with lateral spot attached to apical band; thorax black .... *bolingeri* Parker, n. sp.
    Median clypeal lobe as in Fig. 39; lower propodeal lamella with subapical notch; sternite II without lateral spot; thorax with red markings .... *trinodus* (Bohart)
13. Head as long as broad; lower propodeal lamella with subapical notch 14
    Head longer than broad; lower propodeal lamella continuous with upper lamella .... *umbifer* (Bohart)
14. Median clypeal lobe with U-shaped emargination (Fig. 43) marginal cell stained .... *schlingeri* (Bohart)
    Median clypeal lobe with V-shaped emargination (Fig. 44) marginal cell with apical ⅓ stained .... *bakerianus* (Cameron)

Microdynerus bolingeri Parker, new species

(Figs. 1, 22, 42)

MALE.—Black; the following with yellowish-white markings: clypeus, spot medially on frons, spot in eye emargination, spot behind compound eye, mandible, leg partly, divided spot basally on scutellum, anterior margin of pronotum, spot on mesopleuron, tegula, apical band on tergites I, II, IV, V, tergite II with lateral spot attached to apical band, sternite II with apical band; the following bright red: ventrally on flagellomeres, legs partly, summit of tergite I, wing veins basally. Punctation close, coarse; pits on frons, vertex close, deep, vertex with 3 shiny, knob-like areas above and behind compound eye and between lateral ocelli; rest of body rather uniformly pitted, pits close, deep, surface between pits with fine microsculpture; tergite II finely micropunctate basally, coarsely macropunctate apically. Pubescence white, short, erect on head, notum; setae mat-like on rest of thorax; abdomen with fine, short, appressed setae. Median clypeal lobe with deep V-shaped excision; flagellomeres about as broad as long apically; antennal hook thin, pointed, reaching base of flagellomere IX; vertex with 3 raised knob-like swellings; head as long as broad; pronotal lamella raised along entire margin; hind face of propodeum with stout shiny lateral swellings; upper propodeal lamella projecting, blunt apically, lower lamella rounded, slightly indented apically; in profile, abdominal segment II broader than long; genitalia (Fig. 22) ; length 6 mm.

FEMALE.—Essentially as for male except: mandibles, apical clypeal margin black.

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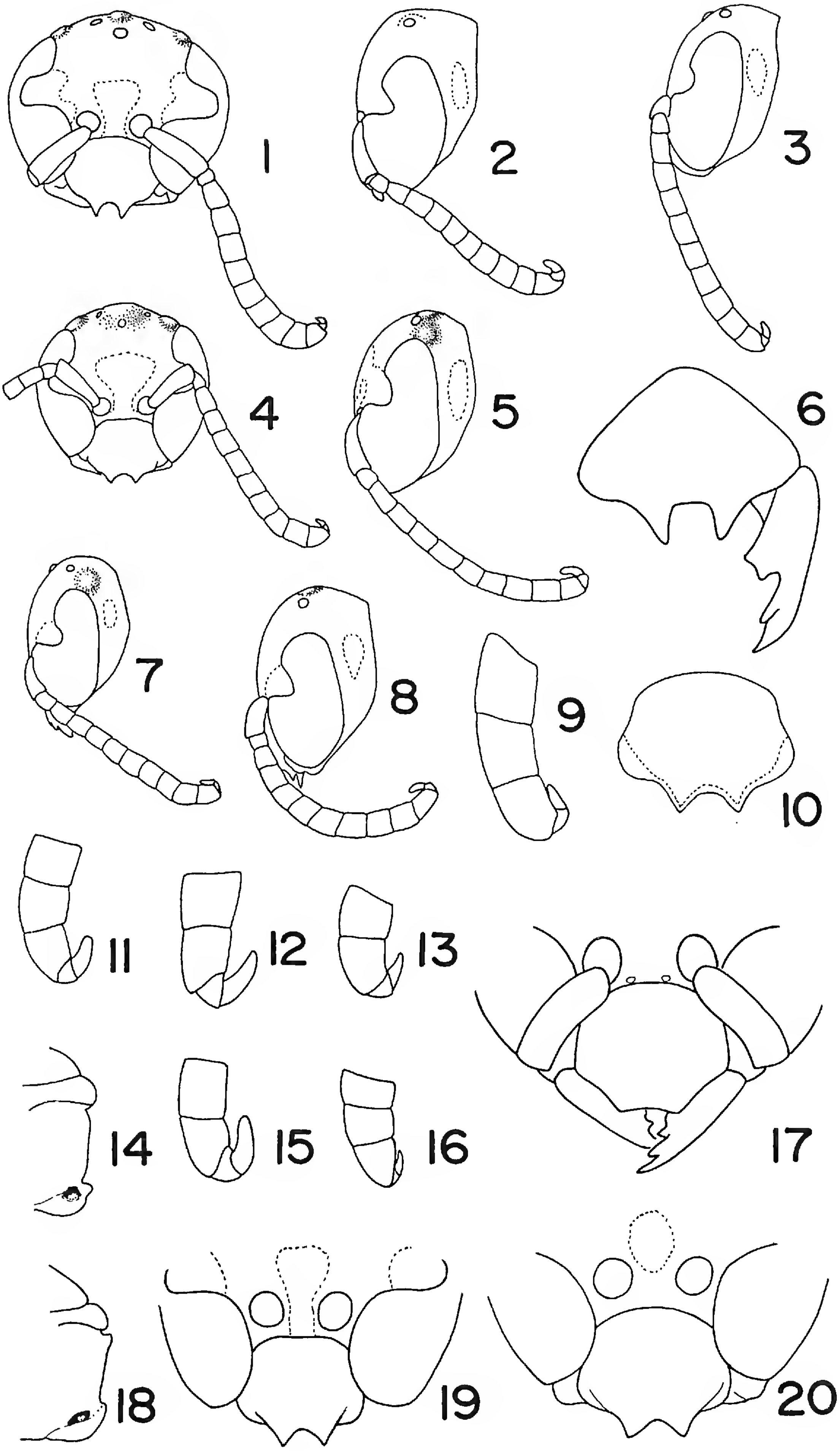
FIGS. 1–5. Front or side view of heads of *Microdynerus* males: 1, *M. bolingeri*; 2, *M. monolobus*; 3, *M. sayi*; 4, *M. hurdi*; 5, *M. trinodus*. FIG. 6. Clypeus male *M. lissosomus*. FIGS. 7–8. Side view of heads of *Microdynerus* males: 7, *M. gibboceps*; 8, *M. singulus*. FIG. 9. Apical flagellomeres of male *M. bechteli*. FIG. 10. Clypeus of male *M. sayi*. FIGS. 11–13. Apical flagellomeres of *Microdynerus* males: 11, *M. monolobus*; 12, *M. bakerianus*; 13, *M. sayi*. FIG. 14. Propodeal outline of male *M. inusitatus*. FIGS. 15–16. Apical flagellomeres of *Microdynerus* males: 15, *M. trinodus*; 16, *M. lissosomus*. FIG. 17. Lower part of head of male *M. inusitatus*. FIG. 18. Propodeal outline of male *M. monolobus*. FIGS. 19–20. Lower part of heads of *Microdynerus* males: 19, *M. gibboceps*; 20, *M. umbifer*.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Holotype male and 3 paratypes (2♂, 1♀) 20 MI. W. DURANGO, DURANGO, MEXICO, June 1964 (D. Bolinger), 7,100 ft. Holotype deposited in the type collection of the California Academy of Sciences.

Superficially *M. bolingeri* and *M. schlingeri* are similar in size and markings. The red markings and narrow clypeal excision will separate the former species.

Microdynerus inusitatus Parker, new species

(Figs. 14, 17, 24, 31, 45)

MALE.—Black; the following with creamy white markings: mandibles basally, clypeus, scape in front, inner orbital spot, postocular spot, front margin of pronotum, mespoleural spot, tegula except central spot, 2 spots on scutellum, legs partly, apical band on tergites I–IV, lateral spots on sternite II; light red ventrally on flagellomeres, legs partly, abdominal segment I, most of II, basally on III–IV; wings stained light brown. Punctation not uniform; micropunctures rather shallow; pits on head, thorax shallow, not well formed, widely spaced; pits on abdomen obscure. Clypeal lobe truncate apically (Fig. 17); antennal hook thin, needle-like reaching base of flagellomere IX; head broad, ocelli large; pronotal lamella not raised laterally, medially; summit of metanotum round in profile; upper, lower propodeal lamellae continuous, not indented; in profile, tergite I weakly depressed subapically; tergite II not indented subapically in profile; genitalia (Fig. 24); length 5 mm.

FEMALE.—Essentially as for male except: less white on clypeus, abdomen.

Holotype male, "GAVID" = THE GAVILAN?, CALIFORNIA, 2 April 1956 (P. H. Timberlake). Paratype female, Perris, California, 14 May 1948 (P. H. Timberlake). Holotype in the type collection of the California Academy of Sciences.

The smooth body sculpturing and the round metanotum separate *M. inusitatus* and *M. lissosomus* from other Nearctic *Microdynerus*. Differences in clypeal and mandibular configuration will separate *M. inusitatus* (Figs. 14, 31) from *M. lissosomus* (Figs. 6, 32).

Microdynerus hurdi Parker, new species

(Figs. 4, 21, 27, 34)

MALE.—Black; the following with white markings: mandibles, clypeus, mediolateral spot on frons, postocular spot, anterior margin of pronotum, mesopleural spot, tegula, divided band on scutellum, legs partly, apical band on tergites I–II,

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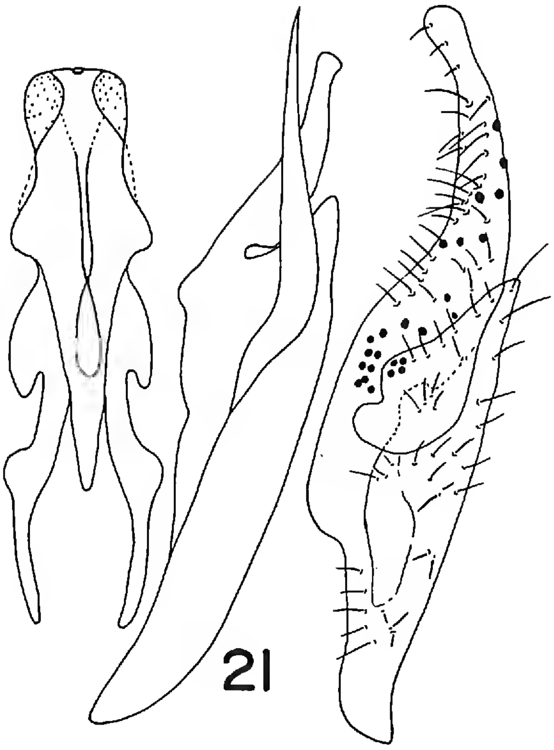
FIGS. 21–24. Genitalia of *Microdynerus* males: 21, *M. hurdi*; 22, *M. bolingeri*; 23, *M. patagoniae*; 24, *M. inusitatus*. FIGS. 25–28. Abdominal segments I–II of *Microdynerus* spp.: 25, male *M. sayi*; 26, female *M. sayi*; 27, female *M. hurdi*; 28, male *M. cavatus*.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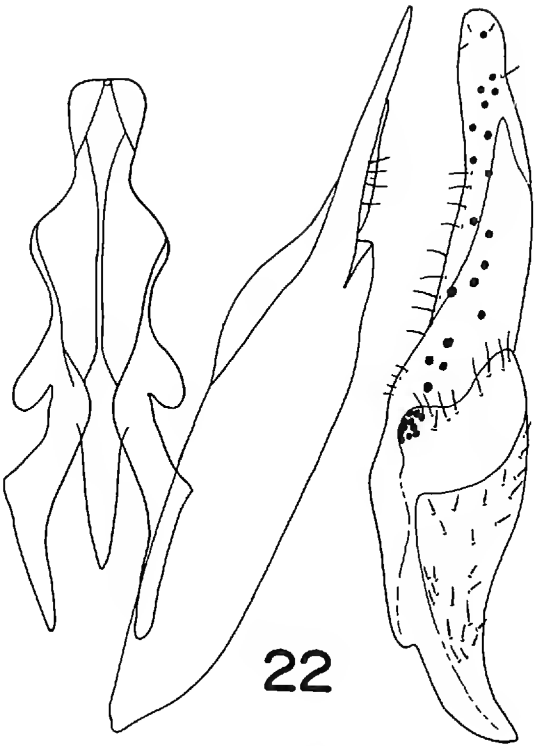
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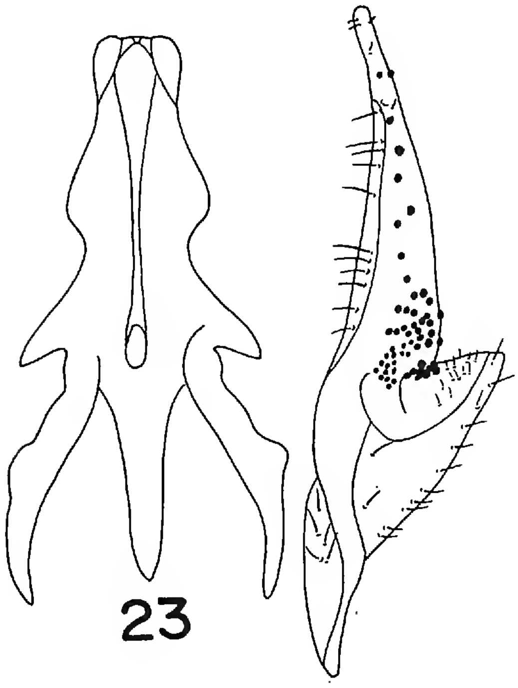
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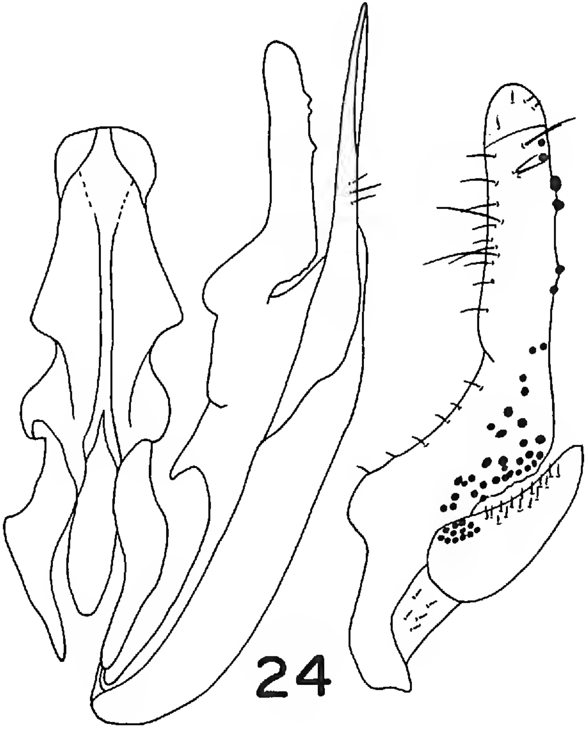
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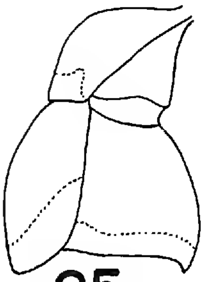
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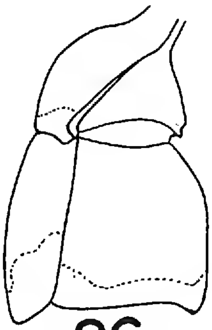
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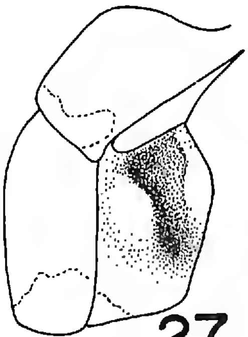
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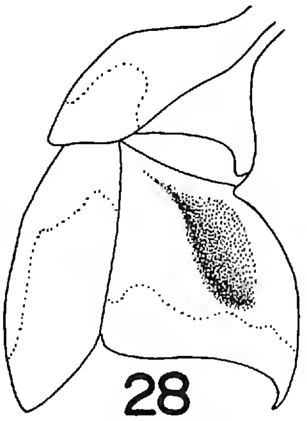
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medially on III, spot laterally on sternite II; the following bright red: flagellomeres, pronotum, parts of mesopleuron, metanotum, legs partly, propodeum, sternite II, abdomen except sternite II laterally, most of tergite II. Punctation moderate; pits on head, thorax deep, separated by about their diameter; sternite II coarsely pitted medioapically. Pattern and color of pubescence same as *M. bolingeri.* Clypeus with wide U-shaped median excision, antennal hook slender, pointed, reaching base of flagellomere IX; head longer than broad; interocellar area swollen with flat summit, lateral ocelli sloping toward compound eye; single knob-like swelling between lateral ocelli, compound eye; pronotal lamella raised laterally, fading medially; propodeal armature weak, punctured; upper, lower propodeal lamellae merging; abdominal segment II as long as wide; sternite II with mediobasal depression; genitalia (Fig. 21); length 4.5 mm.

FEMALE.—Essentially as for male except: mandibles, clypeus, thorax bright red.

Holotype male, 18 MI. N. RODEO, HILDALGO COUNTY, NEW MEXICO, 25 August 1958 (C. G. Moore). Paratypes, 1♂, 2♀ from 18 mi. E. Douglas, Cochise Co., Arizona, 5 September 1958 (P. D. Hurd), *Eriogonum abertianum neomexicanum.* Holotype deposited in the type collection of the University of California, Davis campus.

Metatypes, 9 from the following North American localities: ARIZONA: 12 mi. N. Yuma, 2 October 1958 (T. R. Haig); 5 mi. N. Wickenburg, 11 September 1957 (T. R. Haig); Madera Canyon, 13 July 1958 (R. M. Bohart); 17 mi. E. Douglas, 4 August 1958 (R. M. Bohart); Tucson, 24 October 1939 (R. H. Crandall); 29 mi. E. Ajo, 20 September 1966 (R. Rust). NEW MEXICO: 5 mi. N. Rodeo, 21 August 1962 (Rozen, Statham, Hessel); 11 mi. N. Rodeo, 2 August 1961 (J. G. Rozen), *Euphorbia*; 4.8 mi. N. Rodeo, 4 September 1961 (P. D. Hurd), *Sphaeralcea angustifolia* var. *cuspidata.* BAJA CALIFORNIA: La Paz, 7–8 October 1955 (F. X. Williams). SONORA: Empalme, 26 October 1965 (G. E. and A. S. Bohart); 10 mi. E. Navajoa, 13 August 1959 (Nutting & Werner).

The long head, distorted interocellar area and the shiny knobs on the vertex distinguish *M. hurdi* from other Nearctic *Microdynerus.* The bright red females could be mistaken for the red color forms of both

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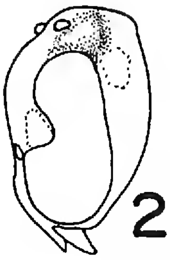
FIGS. 29–35. Front or side view of heads of *Microdynerus* females: 29, *M. gibboceps*; 30, *M. sayi*; 31, *M. inusitatus*; 32, *M. lissosomus*; 33, *M. cavatus*; 34, *M. hurdi*; 35, *M. bechteli.* FIG. 36. Clypeus of female *M. umbifer.* FIG. 37. Propodeal outline of female *M. sayi.* FIGS. 38–46. Clypeus of *Microdynerus* females: 38, *M. cavatus*; 39, *M. trinodus*; 40, *M. arenicolus*; 41, *M. singulus*; 42, *M. bolingeri*; 43, *M. schlingeri*; 44, *M. bakerianus*; 45, *M. inusitatus*; 46, *M. lissosomus.* FIGS. 47–48. Propodeal outlines of *Microdynerus* females: 49, *M. arenicolus*; 50, *M. singulus.*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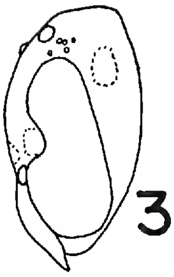
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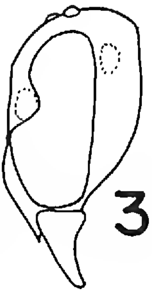
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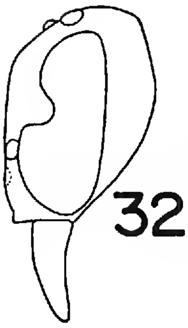
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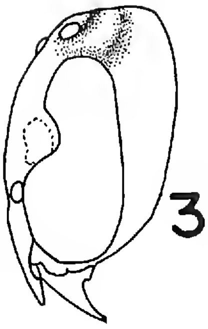
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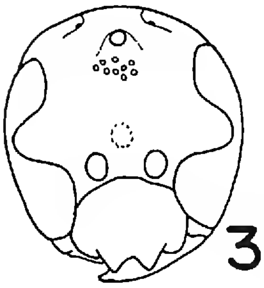
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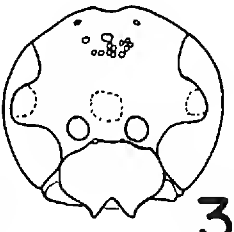
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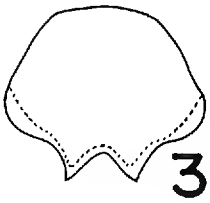
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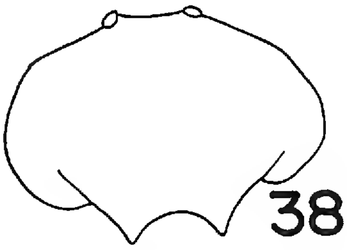
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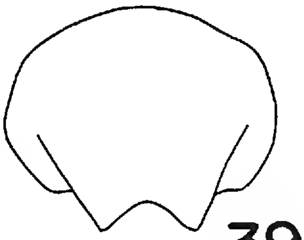
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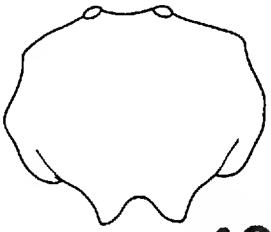
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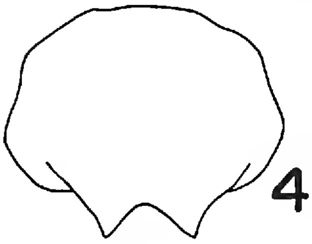
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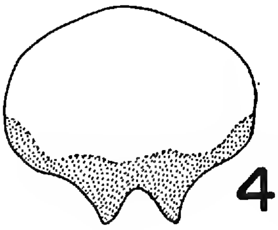
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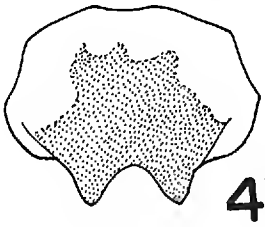
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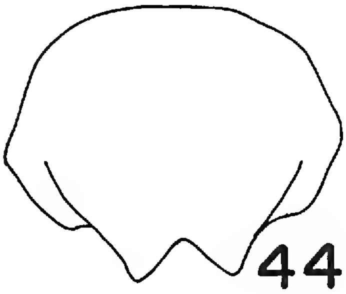
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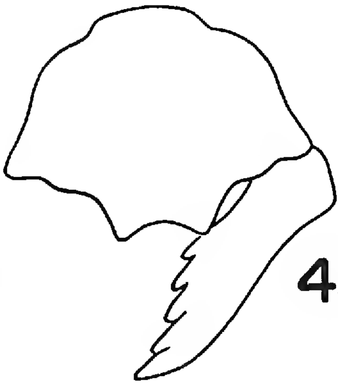
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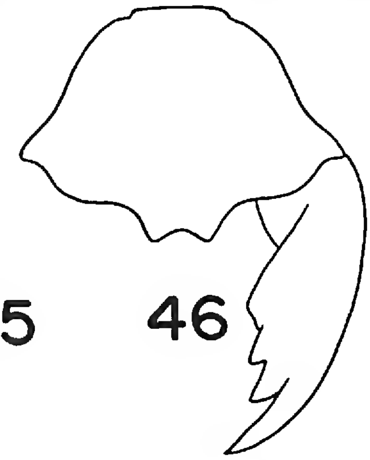
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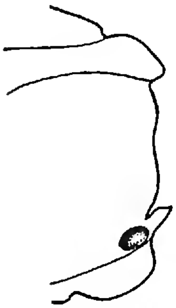
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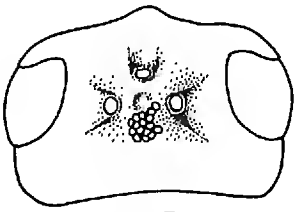
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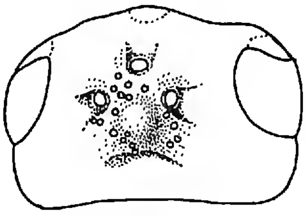
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M. singulus and *M. bakerianus*. The longer head of *M. hurdi* will separate it from the latter species.

Microdynerus patagoniae Parker, new species

(Fig. 23)

MALE.—Black; the following yellowish-white markings: mandibles, clypeus, scape in front, medial bar on lower frons, spot in eye emargination, postocular spot, anterior margin of pronotum, mesopleural spot, tegula partly, band on scutellum, apical band on tergite I, II, IV, V, sternite II; flagellomeres yellowish beneath; wings lightly stained, marginal cell dark apically. Punctation not uniform; macropunctures deep, scattered except tergite II with shallow, obscure, close pits. Pubescence as for *M. bolingeri*. Median clypeal lobe with deep U-shaped excision; antennal hook thin, pointed, reaching base of flagellomere IX; head longer than broad; interocellar area raised, distorted, ocelli slanted; lateral tubercle on vertex indistinct; pronotal lamella not raised medially; semicircular carina on upper lateral surface of propodeum; propodeal lamella fused, not indented; in profile tergite II with subapical indentation; tergite II smooth in outline; genitalia (Fig. 23); length 4.3 mm.

FEMALE.—Unknown.

Holotype male, PATAGONIA, SANTA CRUZ COUNTY, ARIZONA, 10 August 1958 (F. G. Werner). Holotype deposited in the type collection of the California Academy of Sciences.

This species is closely related to *M. arenicolus,* but the two can be separated by differences in sculpture on the frons and vertex. The configuration of tergite I and the upper propodeal lamella are additional characters that differentiate these species.

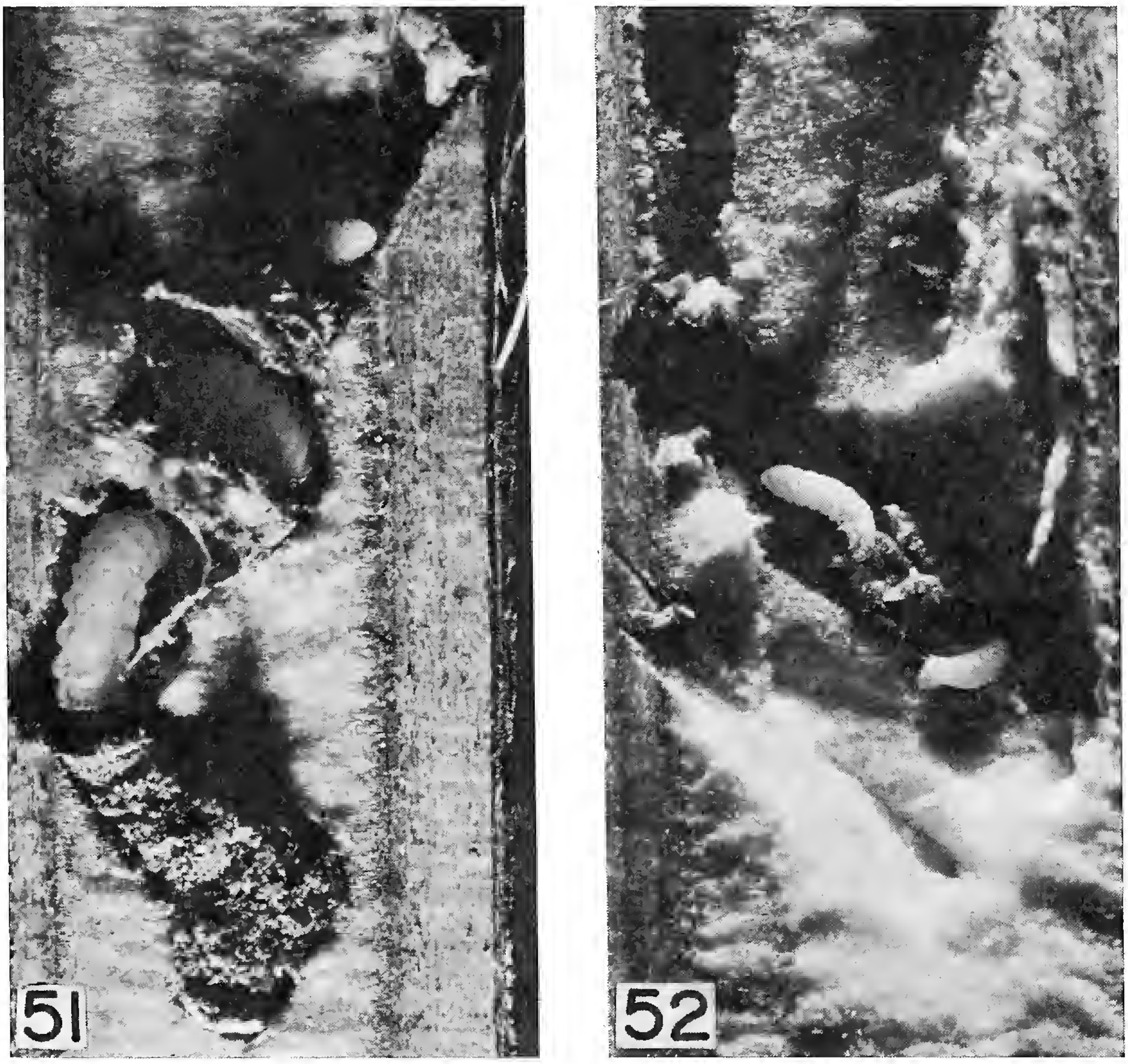
MICRODYNERUS ARENICOLUS (Bohart)

(Figs. 40, 49)

Leptochilus arenicolus Bohart, 1955: 299.

This species was described from a series of specimens collected at Antioch, California. Additional material has extended the range of *M. arenicolus* to include the following localities: CALIFORNIA: Dutch Flat, San Jacinto Mts., 14 August 1934 (C. D. Michener). ARIZONA: 13 mi. N. W. Nogales, 8 September 1967 (T. R. Haig); 2.5 mi. W. Pena Blanca, 26 August 1961 (Noller, Bequaert, Santana); 5 mi. W. Bisbee, 15 August 1958 (P. M. Marsh); 5 mi. E. Fort Apache, 28 August 1964 (M. E. Irwin); S. W. Research Station, 6 September 1958 (P. D. Hurd); Rucker Cyn., Chiricahua Mts., 25 September 1961 (J. C. Bequaert). NEW MEXICO: Rodeo, 6 August 1958 (P. M. Marsh).

The markings on the Arizona and New Mexico specimens are ivory-white whereas California specimens tend to be a creamy-yellow.



Figs. 51–52. Nests of *M. bakerianus* in trap stems: 51, 4-celled nest made in side of stem. Note gravel entrance plug. 52, prey in 2-celled nest.

Microdynerus bechteli (Bohart)

(Figs. 9, 35, 47)

Leptochilus bechteli Bohart, 1955: 294–5.

Bohart (1955) recorded a single specimen from Red Rock, Arizona; additional distribution records from this state are: 2 mi. N. E. Portal, 30 August 1959 (M. Statham); 7 mi. N. W. Gila Bend, 10 April 1961 (R. H. & E. M. Painter).

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Coexistence of Desert Scorpions by Differential Habitat Preference

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The scorpion fauna of Arizona is rich both in abundance and in number of species. About 19 species have been reported from Arizona in the literature, and these represent four of the six living families in the order Scorpionida.

Most of the published research on scorpions has been concerned with systematics, behavior and venoms. Ecological research has been conspicuously lacking in the literature, with population and community studies being especially uncommon. Baerg (1954) recognized population periodicity in relation to reproduction and seasonal activity while observing Jamaican scorpions. Alexander and Ewer (1958) discussed the use of temperature-adaptive behavior. Sreenivasa-Reddy (1959) discussed the function of the pectines, and analyzed pectine morphology in relation to burrowing and humidity. Cloudsley-Thompson (1956, 1961, 1962, 1964) discussed biological rhythms, heat death and adaptation to desert environments. Gertsch and Allred (1965) made an ecological contribution by showing habitat affinities, relative abundances and sex ratios of nine species occurring on the Nevada Test Site. McAlister (1966) discussed the aggregating tendency of *Centruroides vittatus* (Say) and Smith (1966) discussed the life history of *Urodacus abruptus* Pocock with emphasis on its home sites. Williams (1966) discussed the obligate burrowing activities of *Anuroctonus phaeodactylus*, and related this to its ecology. Williams and Hadley (1967) and Hadley and Williams (1968) discussed the habitat preferences, community compositions and nocturnal activities of some populations occurring in Sonora, Mexico.

The purposes of this project were two-fold. The first was to study the influence of several different habitat types on the abundance, distribution and community structure of scorpions. The second was to analyze the changes in scorpion distribution and abundance which occur from year to year.

The field work was carried out at Phoenix South Mountain, Maricopa County, Arizona from September 1964, to January 1967.

Special thanks are due to Mont A. Cazier, David I. Rasmussen, Wendell L. Minckley, and Frank F. Hasbrouck of the Department of Zoology, Arizona State University, for their advice and suggestions.

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Thanks also are due William S. Parker for assistance in the field, to Charlene F. Williams, Christie Steketee, and William Azevedo for clerical help. This project was partially supported by the National Science Foundation through research grant GB 7679, and by the National Institutes of Health through predoctoral fellowship number 5-F1-GM-23, 794-02.

Materials and Methods

An area approximately three square kilometers in size, located at the eastern end of Phoenix South Mountain (30° 26′ N. Lat., 112° 01′ W. Long.), Maricopa County, Arizona, was selected for the field study. This area begins about one kilometer west of the town of Guadalupe, along Guadalupe Road. Selection of this study area involved the following considerations: the ecology was relatively undisturbed; access was convenient; several distinct desert habitats of interest were represented in close proximity; and, the scorpion fauna was abundant and diverse.

The general study area was composed of four subareas, each representing a distinct ecological situation. These subareas differed from one another in topography, soil composition, slope, plant community and sun exposure. Essentially, they represented the following ecological situations: an open desert basin near the base of a mountain; a mountain canyon slope with a north-facing exposure; a mountain canyon floor; and a mountain canyon slope with a south-facing exposure.

Sampling was carried out exclusively by means of unbaited pitfall traps, which were in place for the duration of the study. Number 10 food cans served as traps. These were deep enough to prevent the escape of even the largest scorpion species, and to retain the captured scorpions well below the environmental extremes occurring on the soil surface. Each can was buried so that its open end was flush with the ground surface, and was covered by a suitably sized rock. The trapping method employed has been described in detail by Williams (1968a).

A sampling scheme was designed so the four subareas studied could be compared by equivalent trap catch units. For this purpose, the pooled catch of twenty traps was used as a sample unit. Twenty traps were, therefore, established in each subarea. In addition, the data from all subareas could be pooled together to give one sample unit of 80 traps which would reflect the total scorpion activity of the whole area during any given time interval. Because of the seasonal periodicity of the populations in surface activity, the data for trapping samples were pooled for analysis, by 52-weeks. All data were gathered during 104 consecutive weeks from 29 December 1964 through 25 December 1966.

The assumption was made that relative catch numbers were an index of relative abundance for *Hadrurus arizonensis* (Ewing), *Vejovis confusus* Stahnke and *Vejovis spinigerus* (Wood).

Traps were checked at seven day intervals throughout the year to preserve the equivalence of catch units. The pattern of trap distribution employed was a line-transect along which the traps were placed at varying intervals but never closer than 10 meters apart. Scorpions were removed and preserved (Williams, 1968b) for future reference.

Throughout the study, trap maintenance was carried out as needed. This maintenance included removal of soil and animals from traps, removal of water after rain, keeping the lip of the trap flush with the soil surface, replacement of traps as they became rusty, and keeping trap sides clean and smooth in order to prevent escape.

In addition to the 80 traps sampling the subareas, 100 additional traps were established in other similar areas to test the effect of scorpion removal upon subsequent catches and to test the influence of trap covers on catches (Williams, 1968a).

RESULTS

DESCRIPTION OF STUDY AREA. Phoenix Mountain is a long, northeast to southwest oriented mountain range, isolated from neighboring mountains by expanses of flat desert basin. At the eastern foot of the mountain the elevation is 382 meters above sea level while the highest peak reaches an elevation of 758 meters above sea level. The mountain is rugged, rocky and dissected by many irregular valleys and canyons. The mountain belongs to the Basin and Range Physiographic Province of Arizona and is of heterogeneous geologic structure and origin. Most of the eastern end of the mountain is composed of metasedimentary rock of Precambrian origin represented by gneiss and schist associated with dikes of metamorphosed basalt. The remainder of the surface is dominated by broad felsic dikes of Tertiary origin and subangular, poorly indurated gravel Quaternary origin (Avedisian, 1966). The soils of the mountain slopes are generally shallow while those of the open desert surrounding the mountain are deeper, often stony and with a relatively water-impervious, subsurface mineral layer.

Climatic studies (Kangieser, 1966) provide the following data for the past 28 years. Air temperature extremes during this period ranged from –13° to 46° C with the lowest temperatures in December and January and highest temperatures during June, July and August. Rainfall was very irregular from year to year, but generally was greatest in August, and varied during this month from 0.17 to 14.12 cm with an average of 2.84 cm. May and June were the months of lowest rainfall, with monthly rainfall varying from 0.00 to 2.41 cm.

The daily high temperature coincided with the occurrence of the daily low relative humidity, this point occurring at about 4:00 p.m. (MST) during the summers. The daily low temperature coincided with the occurrence of the daily high relative humidity, this point being reached at about 6:00 a.m. (MST) during the summers.

A number of distinct environmental situations occur because of the physical influence of the mountain. As the mountain is ascended, a heterogeneous array of habitats differentiated by various sun exposures, degrees of slope, water drainages, soil types and plant associations occur. Ecotone effects occur as judged by plant heterogeneity, where two habitat types intergrade. Such ecotones are apparent in the canyon bottoms and where the mountain grades into open desert.

To study how the various habitats existing at South Mountain affect the distribution and abundance of scorpion populations, four distinct habitats were sampled for comparison. These are described below.

Open desert basin.—This area was characterized by a *Larrea-Franseria* community on open, relatively flat desert (Fig. 1). Since the plant community was more diverse and complex than would have been expected, this area perhaps showed some ecotone effect.

The site of this study area was one kilometer west of the town of Guadalupe, along Guadalupe Road. The terrain was basically flat but was occasionally divided by shallow washes. The soils had a texture similar to sandy loam and were well compacted. In most places a hard, subsurface, mineralized layer was present.

The vegetation was dominated by creosote bush (*Larrea tridentata* (D.C.) Coville) and bur-sage (*Franseria deltoidea* Torr.), but, paloverde (*Cercidium microphyllum* (Torr.) Rose and Johnston), ironwood (*Olneya tesota* Gray), white bur-sage (*Franseria dumosa* Gray), Mormon tea (*Ephedra* sp.) and saguaro (*Carnegiea gigantea* (Engelm.) Britt. and Rose) also occurred, although in less abundance.

North-facing slope.—This study area was located 1.5 kilometers west of the open desert basin study area, and was a canyon side with a due north exposure (Fig. 2). The terrain had a slope approximating 25°.

Plants were more abundant and larger in this habitat than in other nearby habitats. The vegetation was bushy, but grasses, mosses, liverworts, and a number of annuals were also common. The most abundant and characteristic plants were: bur-sage, brittle bush (*Encelia farinosa* Gray) and paloverde. The following plants also occurred, but were less abundant: creosote bush, white bur-sage, apricot mallow (*Sphaeral-*

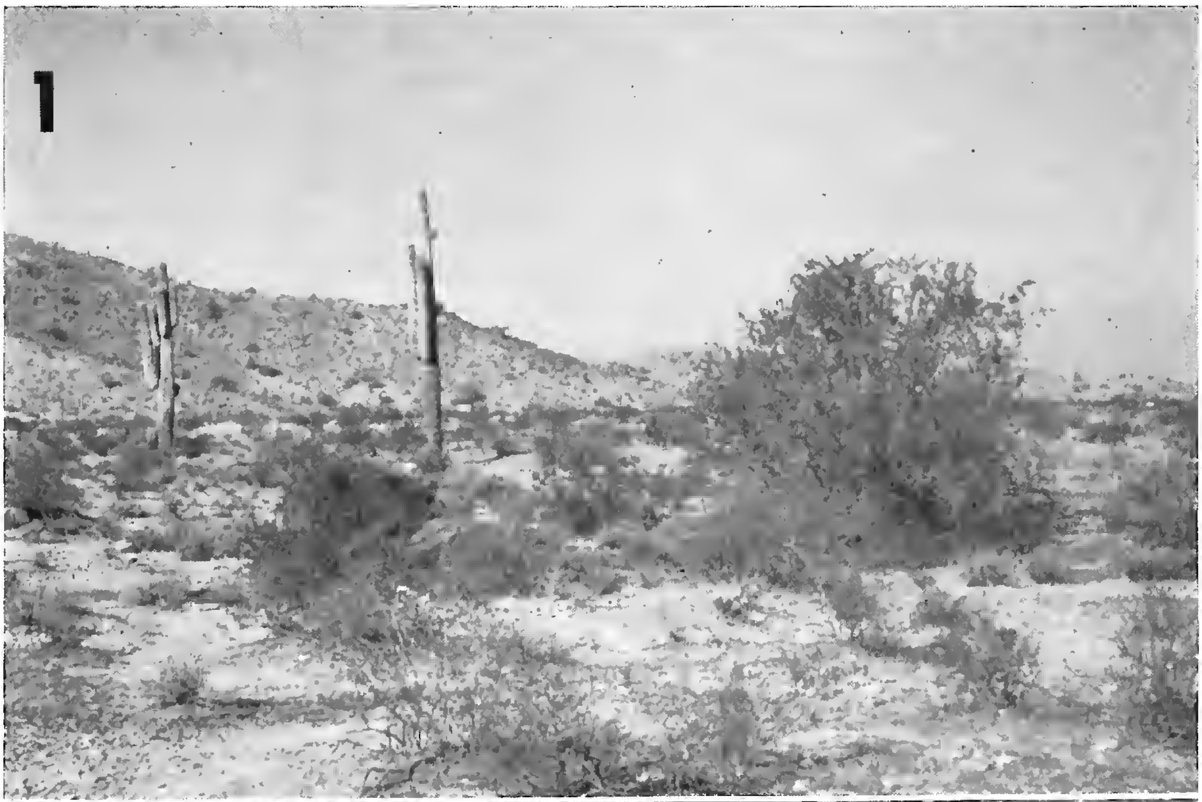

FIG. 1. Open desert basin habitat. In the background, the end of Phoenix South Mountain may be seen. FIG. 2. North-facing slope habitat. This habitat is characterized by a high degree of shielding from sun exposure. Ground temperatures are generally lower and soil moisture higher in this habitat throughout the year in comparison to the other study areas.

cea ambigua Gray), ironwood, Mormon tea, wolf berry (*Lycium* sp.), ocotillo (*Fouquieria splendens* Engelm.), saguaro, staghorn cactus (*Opuntia versicolor* Engelm.), barrel cactus (*Ferocactus wislizeni*

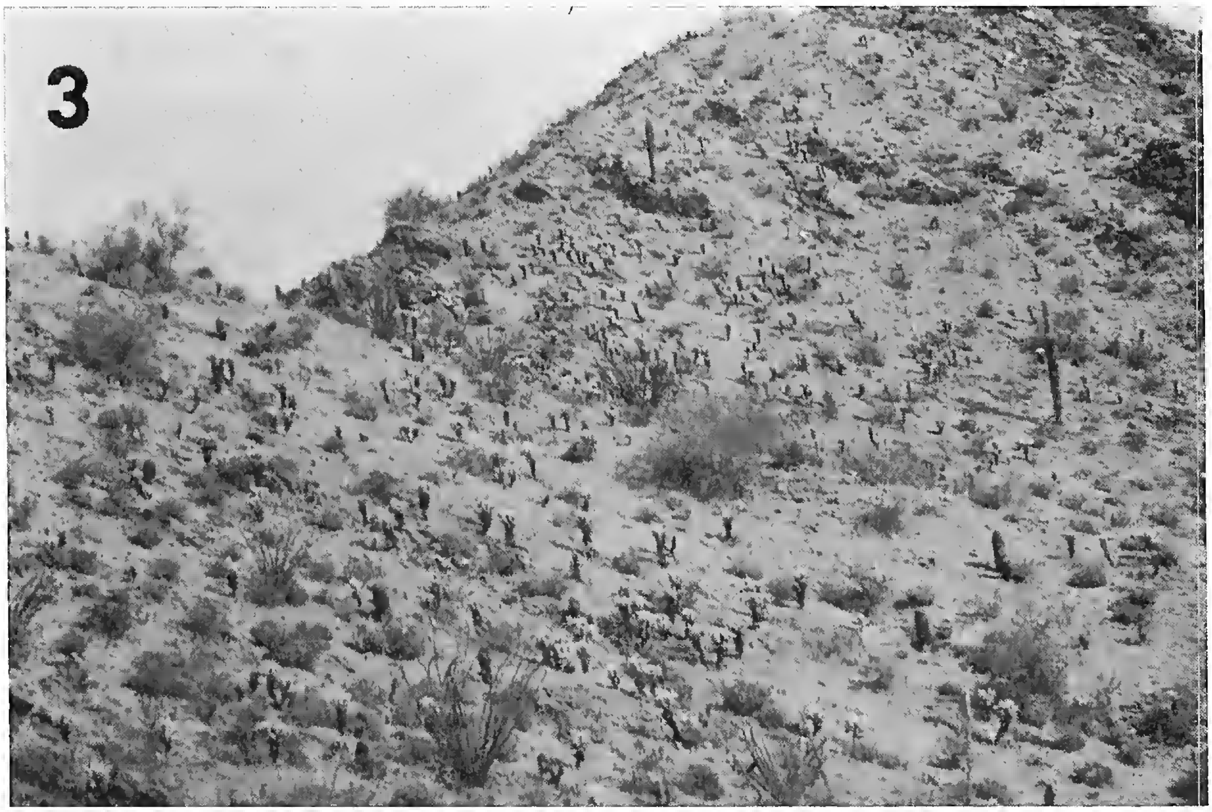

FIG. 3. South-facing slope habitat. This habitat is characterized by an extreme exposure to the sun. Ground temperatures are higher and soil moisture is lower in this habitat than in the others studied throughout the year.

(Engelm.) Britt. and Rose), Christmas cactus (*Opuntia leptocaulis* D.C.), and teddy bear cholla (*Opuntia bigelovii* Engelm.).

The soil, although somewhat sandy, was well packed, considerably finer in texture, and deeper than on the opposing slopes. Large rocky outcrops occurred over the slopes, and between outcrops, the soil was abundantly studded with smaller surface rocks.

South-facing slope.—The south-facing slope studied was the canyon side directly opposite the north-facing slope study area (Fig. 3). This hillside had a slope approximating 25° and was of the same height as the opposite slope. Presumably, this area should have differed from the north-facing slope only in sun exposure and in the environmental effects caused by this intensive exposure.

The whole hillside was very rocky and large outcrops were abundant. Soils were very shallow and coarse, consisting mostly of gravel. This area was sparsely vegetated throughout most of the year, and the weathering effects of the harsh sun were apparent.

The plant community of this habitat was distinctive because of the reduction of both numbers and species of plants. Teddy bear cholla was the dominant species and occurred in stands of varying density. Creosote bush, brittle bush, barrel cactus and ocotillo were moderately

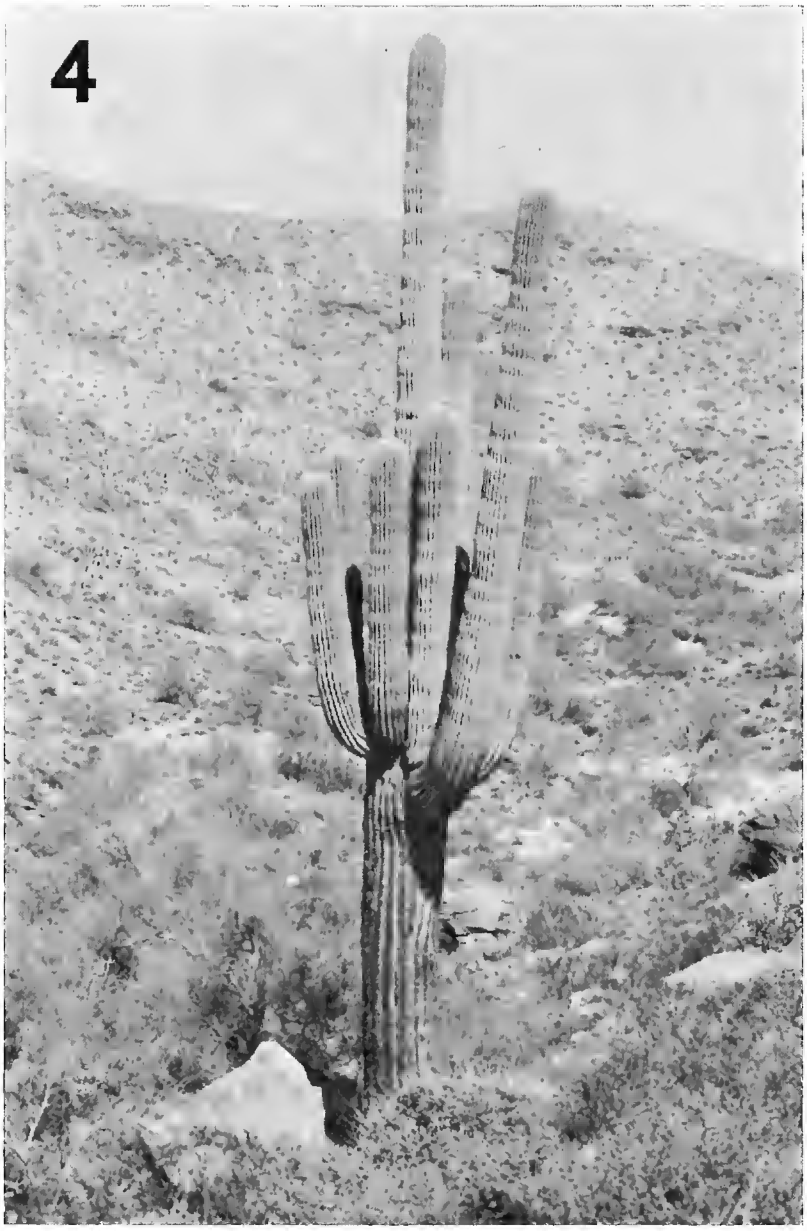

FIG. 4. Canyon bottom habitat. This photograph was taken from the north-facing slope, looking down the canyon bottom. This was the most heterogeneous habitat both in terms of physical and biotic diversity.

abundant, while paloverde, ironwood, wolf berry and saguaro were less abundant.

Canyon bottom.—This was the intermediate area between the north- and south-facing slope study areas, and was the most irregular and physically diverse of all the study areas (Fig. 4). Here were found rocky outcrops, alluvial soils, a deep sandy wash and a seasonal spring. The physical heterogeneity was matched by the heterogeneity of the flora. No one plant species appeared dominant; instead, the flora was a mixture of those plant species found on the adjacent hillsides and open desert floor.

SCORPION POPULATIONS PRESENT AT SOUTH MOUNTAIN. Eight scorpion species from three families occurred at South Mountain. The Buthidae

TABLE 1. Relative numbers of scorpions captured in four habitats at Phoenix South Mountain. Data were based on captures by 80 traps during a two year interval (104 weeks). Each habitat was sampled by 20 traps.

	Catch Numbers								
	H. arizonensis		*V. confusus*		*V. spinigerus*		Habitat Total		
Habitat	1965	1966	1965	1966	1965	1966	1965	1966	Total
desert basin	51	22	50	53	10	11	111	86	197
northern exposure	8	3	0	0	52	61	60	64	124
canyon bottom	23	12	2	1	53	75	78	88	166
southern exposure	25	26	6	0	40	61	71	87	158
species totals	107	63	58	54	155	208	320	325	645

was represented by one species, *Centruroides sculpturatus* Ewing. The Vejovidae was represented by six species: *Hadrurus arizonensis* (Ewing), *Vejovis confusus* Stahnke, *Vejovis stahnkei* Gertsch and Soleglad, *Vejovis spinigerus* (Wood), *Vejovis wupatkiensis* Stahnke, and *Vejovis lapidicola* Stahnke. One small scorpion was found in the stomach of a whip-tail lizard (*Cnemidophorus tigris* Baird and Girard) and was identified as a member of the Chactidae because of the occurrence of six eyes. Due to poor physical conditions, this specimen was identified only to family .

Only three species were captured in sufficient numbers to yield significant ecological information: *V. spinigerus, V. confusus* and *H. arizonensis.* Only the data on these three species were considered in subsequent ecological analyses unless otherwise mentioned. *Centruroides sculpturatus* was found under rock chips and dead vegetation in low numbers, especially on the northern and eastern exposures. Only two specimens were collected by traps during the study. Five *V. stahnkei* were collected by traps in open desert basin areas. One *V. wupatkiensis* was collected in a trap on the southern exposure, and one *V. lapidicola* was collected under a rock chip at the base of an eastern exposure.

During the two-year period, 645 scorpions were captured in the 80 traps (Table 1). No significant difference occurred between the total number of scorpions captured in 1965 (320 scorpions) and those captured in 1966 (325 scorpions) when the yearly totals were compared by Chi Square Analysis ($\chi^2_{(1)} = 0.024$; $P > 0.80$).

RELATIVE NUMBERS OF SCORPIONS IN RELATION TO HABITAT TYPE. Examination of the total catch data indicated that scorpions were more

TABLE 2. Comparisons of the relative numbers of scorpions captured in each of four different habitats. The captures for all areas were placed in an abundance array and adjacent numbers were compared by Chi Square Analysis using Yates' Correction for Continuity. These data were obtained from 80 traps during 1965 and 1966 (104 weeks). Only *H. arizonensis*, *V. confusus* and *V. spinigerus* were considered.

Habitat	Observed Numbers	Expected Numbers	Sample Size	$\chi^2_{(d.f.)}$	P
Desert basin	197	181.5	363	$2.48_{(1)}$	$0.20 > P > 0.10$
Canyon bottom	166	181.5			
Canyon bottom	166	162	324	$0.152_{(1)}$	$0.70 > P > 0.50$
Southern exposure	158	162			
Southern exposure	158	141	282	$3.86_{(1)}$	$P < 0.05$
Northern exposure	124	141			

abundant in some habitats than in others. The total scorpion catches from each habitat, placed in an abundance array, gave the following relationship: 197 (desert basin); 166 (canyon bottom); 158 (southern exposure); and 124 (northern exposure). Analyses of these data gave highly significant Chi Squares ($\chi^2_{(3)} = 16.74$; $P < 0.01$), indicating that scorpions were significantly more abundant in some habitats.

To ascertain which areas supported a more abundant scorpion fauna, habitats which occupied adjacent positions in the abundance array were compared by a series of Chi Square Analyses (Table 2). It then became evident that three habitats, the desert basin, canyon bottom and southern exposure, each supported not significantly different numbers of scorpions and each supported a significantly more abundant scorpion fauna than did the northern exposure habitat.

DIFFERENTIAL RELATIVE ABUNDANCES OF THE SPECIES IN RELATION TO HABITAT. Examination of the catches (Table 1) suggested that the community structure in regard to numerical dominance and relative abundances may have been unique to each habitat. Therefore, the relative abundances of the different scorpion species were analyzed in each habitat separately.

Examination of the pooled, 104 week, scorpion catches clearly indicated that *H. arizonensis*, *V. spinigerus* and *V. confusus* were not equally abundant in any habitat (Table 3). A very obvious, non-random, relative abundance array occurred among the three species in each habitat. *Vejovis confusus* was the numerically dominant species in the habitat characterized by non-rocky, fine textured soils, while *V. spinigerus* was

TABLE 3. Comparison of the relative numbers of *H. arizonensis*, *V. confusus* and *V. spinigerus* captured in each of four desert habitats. Data pooled for 104 consecutive weeks, and analyzed by Chi Square Analysis.

	Observed Numbers	Expected Numbers	Sample Size	Analysis
Open desert				
V. confusus	103	65.7	197	$\chi^2_{(2)} = 52.40$; $P < 0.01$
H. arizonensis	73	65.7		
V. spinigerus	21	65.7		
Northern exposure				
V. spinigerus	113	62	124	$\chi^2_{(1)} = 82.26$; $P < 0.01$
H. arizonensis	11	62		
Canyon bottom				
V. spinigerus	128	55.3	166	$\chi^2_{(2)} = 154.39$; $P < 0.01$
H. arizonensis	35	55.3		
V. confusus	3	55.3		
Southern exposure				
V. spinigerus	101	52.7	158	$\chi^2_{(2)} = 85.70$; $P < 0.01$
H. arizonensis	51	52.7		
V. confusus	6	52.7		

the dominant species in the rocky habitats (northern exposure, canyon bottom, and southern exposure). The large species, *H. arizonensis*, occurred in each habitat, but was never a numerically dominant species.

From the standpoint of relative abundance and numerical dominance of the species, three types of community structures occurred in the four habitats. The open desert was characterized by the numerical dominance of *V. confusus*, the relative lack of the congeneric *V. spinigerus*, and the intermediate abundance of *H. arizonensis*. The northern exposure was unique in that *V. spinigerus* was the numerical dominant, *H. arizonensis* was relatively uncommon and *V. confusus* was absent. The canyon bottom and southern exposure had essentially the same scorpion community structures. Here *V. spinigerus* was always the numerical dominant, *H. arizonensis* was common, and *V. confusus* was relatively rare.

CHANGES IN THE POPULATION SIZE OF THE SPECIES BETWEEN 1965 AND 1966. The population sizes of *V. spinigerus*, *V. confusus*, and *H. arizonensis* remained remarkably stable during the two years of the study. In only two situations did the trap catches indicate a significant increase or

TABLE 4. Comparison of the scorpion catches of 1965 with those of 1966 in each of four habitats at South Mountain. Each habitat was sampled by 20 traps for 52 weeks each year. Yearly catches were compared by Chi Square Analysis using Yates' Correction for continuity.

		Catch Numbers		
Habitat	Year	*V. confusus*	*V. spinigerus*	*V. arizonensis*
Open desert:	1965	50	10	51
	1966	53	11	22
	$\chi^2_{(1)}$	0.03	0.00	10.74
		$0.90 > P > 0.80$	$P = 1$	$P < 0.01$
Northern exposure:	1965	0	52	8
	1966	0	61	3
	$\chi^2_{(1)}$	—	0.57	1.45
		—	$0.50 > P > 0.30$	$0.30 > P > 0.20$
Canyon bottom:	1965	2	53	23
	1966	1	75	12
	$\chi^2_{(1)}$	—	3.44	2.86
		—	$0.10 > P > 0.05$	$0.10 > P > 0.05$
Southern exposure:	1965	6	40	25
	1966	0	61	26
	$\chi^2_{(1)}$	—	3.96	0.00
		—	$0.05 > P > 0.025$	$P = 1$

decrease in species numbers (Table 4). In these cases, the *H. arizonensis* catch decreased from 51 in 1965 to 22 in 1966 ($P < 0.01$) in the open desert habitat, while *V. spinigerus* increased from 40 in 1965 to 61 in 1966 ($P < 0.05$) in the southern exposure habitat. The catches also indicated that *V. confusus* may have been declining in the canyon bottom and southern exposure habitats but catch numbers were not high enough to permit statistical analysis.

DISCUSSION AND CONCLUSIONS

Species diversity.—Eight scorpion species were found at South Mountain. Three species (*Hadrurus arizonensis, Vejovis confusus* and *Vejovis spinigerus*) were very abundant, while the other five (*Vejovis lapidicola, Vejovis stahnkei, Vejovis wupatkiensis, Centruroides sculpturatus* and the unidentified chactid species) were rare. This same relationship between the abundant and rare species was reported in the scorpion fauna of the Nevada Test Site (Gertsch and Allred, 1965).

The South Mountain scorpion fauna (eight species) compared favorably in diversity with the regional scorpion faunas reported in other North American areas. Nine species were reported from the Nevada Test Site (Gertsch and Allred, 1965), five species were reported from Puerto Penasco, Sonora, Mexico (Williams and Hadley, 1967), and five species were reported from Durango, Durango, Mexico (Baerg, 1929). Based on these regional reports, it appears that even diverse scorpion faunas are composed of a relatively few species in North America. The record for scorpion diversity is the nine species reported from the Nevada Test Site.

The regional species diversity of scorpions is considerably less than that reported for other related arachnid groups. For example, 14 species of Araneida were reported from Portal, Arizona (Chew, 1961) while 28 species of Solpugida were reported from the Nevada Test Site (Gertsch and Allred, 1965, citing Muma, 1963). The most likely explanation for the occurrence of scorpion faunas composed of so few species as compared with other related groups was the apparent similarity, within the group, of food sources, habitat requirements, morphology and generalized behavior. No spectacular ecological radiation has occurred in the Scorpionida as compared with the Araneida, Acari and Insecta. The similarities among species of the Scorpionida should tend to cause competitive interactions among these species. Assuming that this were true, the limited number of scorpion species within a regional fauna could be explained by competitive exclusion. The coexistence of scorpion species does indicate, however, that at least a few mechanisms exist which permit escape from competitive exclusion.

The two main mechanisms permitting coexistence were habitat specialization and choice of different sized prey. *Hadrurus arizonensis* avoided competition with the other species by capturing prey too large to be useful to other species. The other species that feed on the same kinds and sizes of prey avoided competition by occupation of different types of habitat. *Vejovis confusus* and *V. spinigerus* clearly utilized the available space at South Mountain in such a way that *V. confusus* dominated the open desert habitats surrounding the mountain while *V. spinigerus* was dominant on the rocky slope and in the canyons of the mountain. The spatial distribution of these two species did overlap to some extent, but they never shared the dominant position in any given habitat. Such spatial overlap of these two congeneric species was perhaps due to some ecotone effect which occurs at the base of desert mountains and their peripheral canyons.

Relative abundance and habitat preference.—Each of the four habitats had a unique and well structured scorpion community, characterized by species composition and relative abundances. Scorpions were not equally abundant in each of these habitats. They were significantly more abundant in the open desert, canyon bottom and southern exposure habitats than in the northern exposure habitat.

Hadrurus arizonensis was moderately abundant in all habitats except on the northern exposure. The abundance was greatest in open desert habitats characterized by the *Larrea-Franseria* plant association. Gertsch and Allred (1965) also found *H. arizonensis* in greatest abundance in this type of habitat at the Nevada Test Site.

Vejovis confusus was most frequently captured in the open desert habitat with *H. arizonensis*, but unlike *H. arizonensis*, it was infrequently found in the rocky habitats more intimately associated with the mountain. The complete absence of *V. confusus* in the northern exposure habitat was striking.

Vejovis spinigerus was equally abundant in all the rocky habitats of the mountain, but was relatively uncommon in the open desert habitat. The few individuals collected in the open desert suggested that these were either migrants or were peripheral representatives of their population.

In 1965, *V. confusus* and *H. arizonensis* shared equally the numerically dominant position in the open desert habitat. This codominance could exist because the two species avoided competitive exclusion by feeding on prey of different kinds and sizes, and thereby avoided direct competition for food. However, the abundance of *H. arizonensis* in the open desert habitat in 1965 may have been unstable since it was significantly decreased in 1966.

Two significant fluctuations in population density occurred during the two years of the study. *Hadrurus arizonensis* significantly decreased in abundance in the open desert habitat and *V. spinigerus* significantly increased in abundance in the southern exposure habitat.

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Observations on the Biology of *Cinygmula reticulata* McDunnough in Oregon[1]

(Ephemeroptera: Heptageniidae)

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Mayflies of the genus *Cinygmula* are widespread and frequently abundant in the lotic waters of the western United States. The immature stages are undescribed at the species level and aside from scattered notes, no details have been published on the biology of any species (Berner, 1959). Information reported here was gathered as a background for studies of benthic communities in lotic waters.

This genus has been included in the works of Traver (1935), Burks (1953), Day (1956), and Jensen (1966). A drawing of *Cinygmula* sp. nymph is provided by Edmunds (1959, p. 909). Three of the 11 North American species were recorded from Oregon by Allen and Edmunds (1956). *Cinygmula par* (Eaton) and *C. tioga* (Mayo) have been collected in the vicinity of Mt. Hood, whereas *C. reticulata* McDunnough is widespread in western Oregon. Allen (1955) collected the latter only west of the Cascade Mountains. Jensen (1966) reported it from east-central Idaho.

TAXONOMIC CONSIDERATIONS

Jensen (1966) used the following combination of characters to distinguish *Cinygmula* nymphs from those of other genera of Heptageniidae: (1) three well developed caudal filaments present; (2) gills on abdominal segments one and seven not enlarged nor extending beneath the abdomen, and similar to those on intermediate segments, only smaller; (3) fibrilliform portion of gills absent or reduced to a few tiny filaments; (4) front of head distinctly emarginate medially.

According to Jensen (1966) *C. reticulata* is included in the *minimus* group which is the most difficult section of the genus, with much variation in size and color.

The mature nymph is 6 to 8 mm in length with caudal filaments 5 to 7 mm long. The fibrilliform portion of the gill of *C. reticulata* is absent. The color of the dorsum varies from light brown to dark brown to red,

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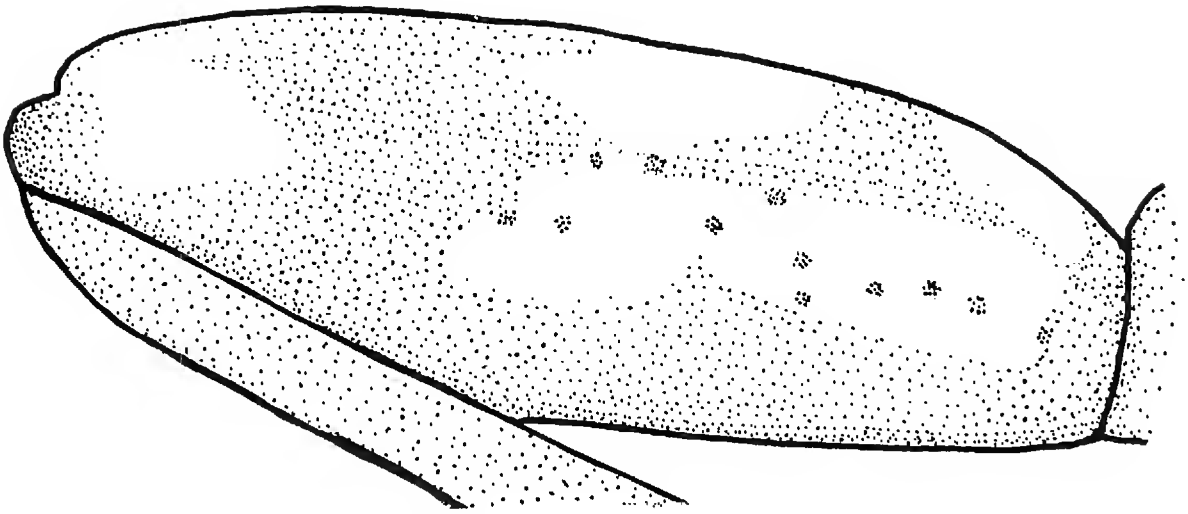

FIG. 1. Femur of *Cinygmula reticulata* illustrating color pattern.

and hence is unreliable as a taxonomic character (see below). Day (1956) used the color pattern on the femur to separate species of *Cinygmula* nymphs. We found that the femur of *C. reticulata* has a basal, central, and sometimes apical white area, with the basal and central areas usually connected by a longitudinal white patch; there are 10 to 15 brown spots in the white area of the basal half of the femur (Fig. 1). Based on the examination of a number of specimens (some of which were not *C. reticulata*) it appears that the brown spots on the femur may be useful for separating the species of nymphs. An unidentified species collected in Montana had nearly 40 of these spots.

Nymphs and adults from the same collection may vary in color (representatives are deposited in the Oregon State University insect collection). The basic color of nymphs ranges from ochreous to grayish-brown and the nymphs occasionally have a distinct dorsal stripe, or they may be marked strongly with red. In reared material, red nymphs retain the red markings from one moult to the next. Within the family Heptageniidae, this occurrence of red nymphs is not restricted to *Cinygmula* as Day (1957) commented on the occurrence of 15 to 18% of the nymphs of *Rhithrogena* with varying degrees of reddish color. Based on laboratory rearing of *C. reticulata,* adults from red nymphs do not differ morphologically from other adults.

In a single series collected in Oregon, adults varied considerably in size, and the wings varied from clear to strongly tinged with yellow. The dark markings forming the wing reticulation may be strong or entirely absent. Since some species in this genus are distinguished only by differences in size or color (Traver, 1935), a revision of the genus would likely yield many synonyms.

Seasonal Size Class Distributions

The life cycle was studied in two streams. Samples were taken from July 1967 to June 1968; monthly in Oak Creek, Benton County, in the Willamette Valley and in alternate months in the Metolius River, Jefferson County, on the eastern side of the Cascade Range. On each sampling date, three samples were taken from each biotope described below. Benthos samples were taken by embedding the end of a length of stovepipe (6 in. dia.) into the substrate of the stream. The larger stones were removed by hand, and then the water was stirred vigorously and the contents were transferred to a pail with a fine mesh (0.2 mm openings) aquarium net.

Oak Creek is a small, densely-shaded woodland stream. The sampling station was five miles northwest of Corvallis in the foothills of the Coast Range at an elevation of 500 feet. Conditions of flow and temperature varied considerably as a result of normal seasonal changes. Stream width in the sample area varied from 3.5 to 16 feet, depending on rainfall, and water temperature varied from 1° C in December and January to 21° C in August. Benthos samples were taken from the following biotopes in Oak Creek: still backwater (protected from main current by stumps and other obstructions) ; glide (water up to 2 feet deep with a smooth flow, impacted silt and rubble substrate) ; and riffle (turbulent flow with much splashing, clean rubble substrate).

Samples from the Metolius River were taken at a site between Camp Sherman and the headwater springs at an elevation of 3,000 feet. In the sample area, volume of flow and water temperatures were fairly constant year round (water temperatures at mid-day were: March, 8° C; May, 10° C; July, 12° C; August, 10° C; September, 10° C; November, 9.5° C; and January, 9° C). The bed of the river is broad (about 100 feet), flat, and shallow, the water seldom being over 2 feet deep. Most of the gravel substrate is less than 2 inches in diameter. Dense beds of *Ranunculus aquatilus* L., islands of sedge, and growths of *Lemna* near the shore, are conspicuous features. Samples were taken from both the gravel and the plant beds.

C. reticulata, in Oak Creek, hatches in the fall, grows slowly during the winter and adults emerge from April to June (Fig. 2). Eggs apparently require several months to hatch. Some small nymphs occurred in the June 1968, sample but from the present data we cannot determine their significance. It is possible that these emerged from eggs deposited in early spring. Sampling was not continued after June so data are not available on the fate of this group. In the previous year, no active stages

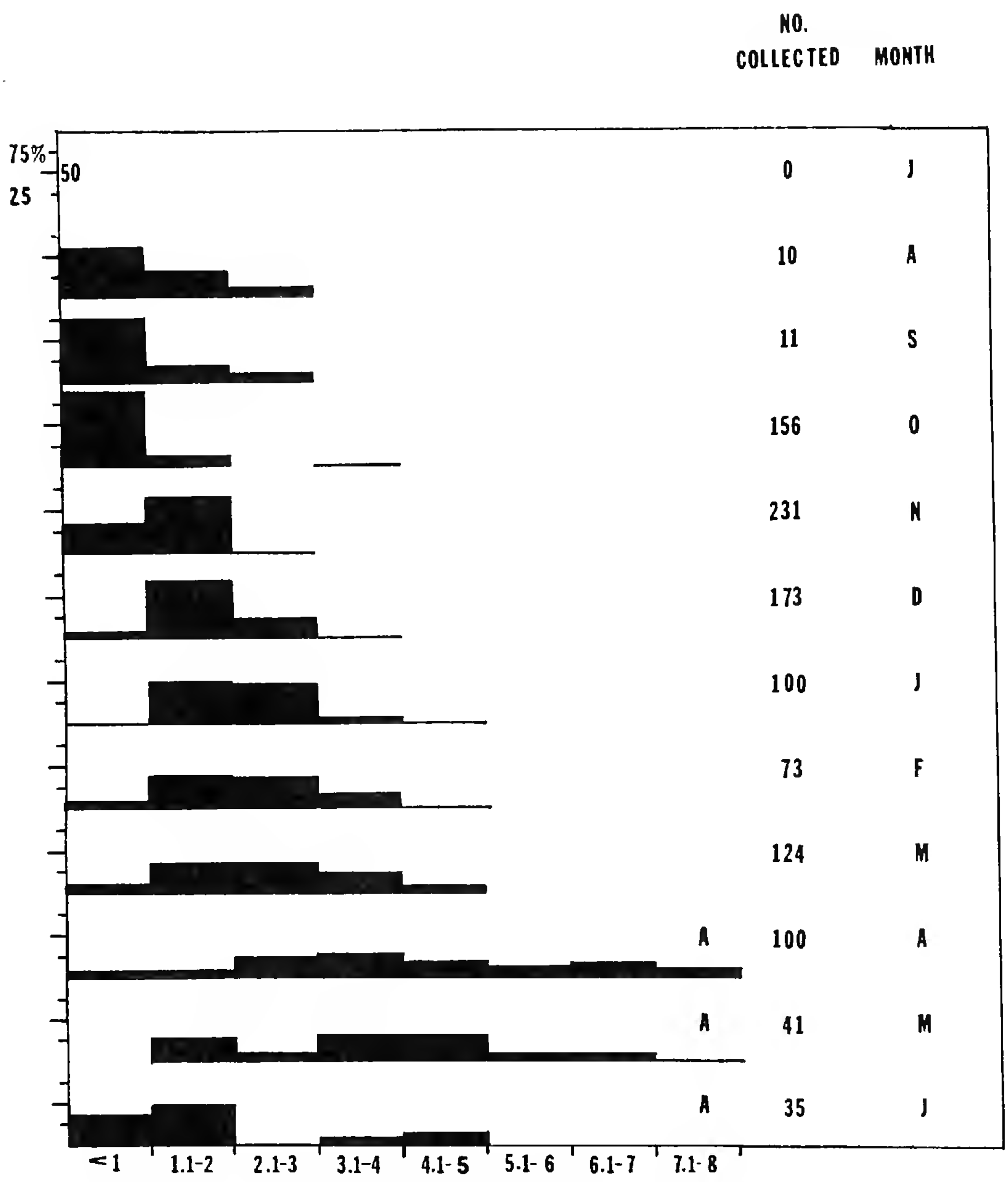

FIG. 2. Size class distribution of *Cinygmula reticulata* in monthly benthos samples, Oak Creek, Benton Co. Ore. A = adults collected. Nymphs absent in July.

of *C. reticulata* were collected during July, and the major hatching period did not start until October.

Figure 3 shows the life cycle of *C. reticulata* in the Metolius River. All size classes were present on nearly all sampling dates. Adults, or nymphs with dark wing pads, were present from April to November indicating that adults emerge during eight or more months of the year. In spite of the long hatching and emergence periods, the overlapping generations can be distinguished by noting the increase in nymphal density in the autumn, and the change in percentage of newly-hatched nymphs (from 4% to 65%) between July and September. The < 2 mm size group in September and the < 3 mm group in November represents the bulk of a new generation hatching in the fall (Fig. 3). The over-

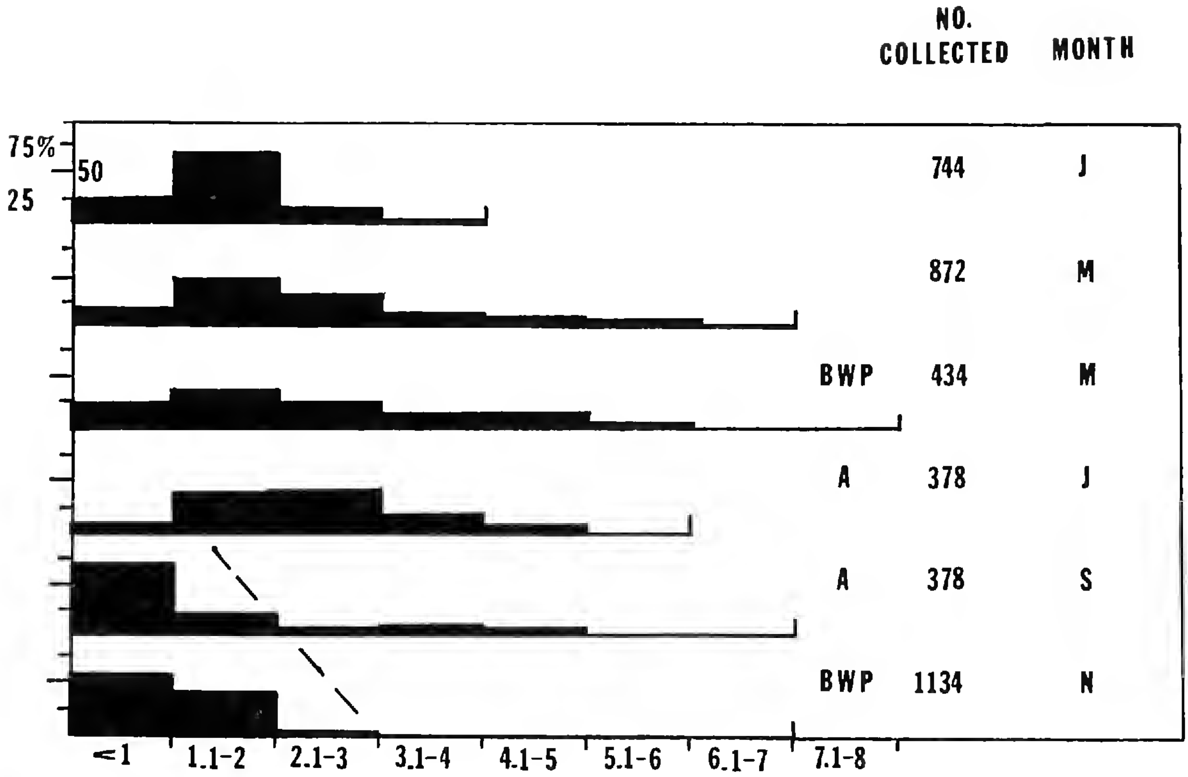

FIG. 3. Size class distribution of *Cinygmula reticulata* nymphs in benthos samples, Metolius River, Jefferson Co. Ore. BWP = mature nymphs with black wing pads. A = adults collected.

lapping generations are separated by a diagonal line, indicating a clear univoltine cycle (by adding those to the left of the diagonal line to the top of the graph).

While the streams differ in many respects, the life cycle of the species is similar in both. The duration and temporal spacing of events differ, probably as a result of differences in air and water temperature. Specimens from the Metolius River tend to be larger and darker in color than those from Oak Creek.

HABITAT PREFERENCES

According to Day (1956), the nymphs of *Cinygmula* spp. are often found in water only 1 to 2 inches deep at the foot of riffles, in crevices, and on the lower surfaces of small stones in small streams in California. Jensen (1966) stated that the nymphs of *C. mimus* (Eaton) are found in small to moderate streams, usually above 5,000 feet, on rocks and among gravel; nymphs of *C. ramaleyi* (Dodds) are found in small to moderate streams above elevations of 4,000 feet; and those of *C. par* occur in small, cold, swiftly flowing streams above elevations of 5,000 feet where they cling to the undersides of rocks in the swiftest portions of the current.

As is apparent from our study, *C. reticulata* occurs at considerably lower altitudes and in larger streams than Jensen reports for the other species. Nymphs of *C. reticulata* live in gravel or rubble substrates, and while they tolerate some silt and organic matter, they are usually absent from muddy areas and plant beds. Nymphs are found in moderate currents, i.e., they are absent from still water, and uncommon in extremely fast riffles. Small nymphs (presumably newly hatched) and mature nymphs (those with dark wing pads) were almost entirely restricted to riffle areas. Of 140 from Oak Creek and 1,269 from the Metolius River, 81% and 99%, respectively, of the small nymphs were from the gravel riffle area. Of the ultimate instar nymphs, 15 of 24 from Oak Creek and 37 of 40 from the Metolius River were from gravel, as opposed to plant bed areas.

We have no detailed data on food habits of the species but nymphs apparently feed both on diatoms and on detritus. Chapman and Demory (1963) carried out gut analysis of a species of *Cinygmula* (as *Cynigmula*) in western Oregon; they found that the nymphs fed heavily on diatoms in spring and early summer but turned to allochthonous detritus from late summer to mid-winter.

Mating and Oviposition

Adults of this species were observed in the field many times. At the Metolius River, swarms comprised of hundreds of adults were observed both in direct sunlight at midday and in the evenings. At Oak Creek, most mating flights were seen on cloudy days or in the shade. The mating flight usually occurred 5 to 8 feet above the surface of the water, and the rising and falling of individuals covered a vertical interval of less than 2 feet.

Thirteen males were collected from a swarm and kept in a cage at outside temperatures. Eight were alive after 24 hours, five after 48 hours, three after 52 hours, and all were dead at 64 hours. Thus, under artificial conditions, males live long enough to swarm more than one day.

A female was observed laying eggs at Oak Creek. She maintained a stationary position by fluttering at the height of one foot over the surface of a riffle. The female extruded a cluster of yellow eggs, dropped to the water and touched the mass to the surface. The eggs scattered in the water and the female flew back to the former position above the riffle. She fluttered there 1 to 2 minutes, more eggs appeared on the underside of the abdomen, and she again dropped to the water. This was repeated four times, after which the insect flew off to the vegetation along the stream bank.

SUMMARY

Cinygmula reticulata McDunnough (Ephemeroptera: Heptageniidae) was studied in Oak Creek (yearly water temperature range 1° to 21° C) and in the spring-fed Metolius River (yearly water temperature range 8° to 13° C) in Western Oregon. In Oak Creek, eggs hatched mainly in October and adults emerged from April to June. In the Metolius River most eggs hatched from September to November and adults emerged from April to November. The species was univoltine in both, and the abbreviated period of adult emergence in Oak Creek was presumably due to high summer temperatures. Nymphs were most numerous in moderate current or silt-free substrates. The most stable character for identification of the nymphs is the color pattern on the femur.

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The Nearctic Doryctinae, IX.
The Genus *Odontobracon* and Notes on Related Genera
(Hymenoptera: Braconidae)

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Within the Doryctinae is a group of genera all of which possess one constant character shared by no other genera, namely the extension of the postnervellus of the hind wing distally toward the wing apex (Fig. 12). They also have a characteristic oval-shaped raised area on abdominal tergum 2 + 3 (Fig. 11), but this is somewhat more variable than the wing venation. The teeth on the dorsum of the hind coxae were previously considered diagnostic, but they do not occur in all of these genera, and are present in other doryctine genera which do not possess the extension of the postnervellus or the characteristic sculpturing of the abdominal terga.

The genera involved are *Odontobracon* Cameron, *Zombrus* Marshall, *Liodoryctes* Szépligeti, *Nervellinus* Roman, *Holcobracon* Cameron, and *Lophogaster* Granger. Various authors in the past have expressed different views concerning these genera, particularly *Zombrus* and *Odontobracon*; some have kept them as separate genera, others have synonymized one with the other. However, it appears that each of the above genera is not only distinct morphologically, but geographically—e.g., *Zombrus* is exclusively Oriental and Ethiopian, *Odontobracon* is exclusively Neotropical and Nearctic, etc.—and I believe it is advisable to retain each as a distinct genus. They can be distinguished by the following key:

1. Hind coxae with two teeth dorsally, one long and one short 2
   Hind coxae with one long tooth or no teeth dorsally 3
2. Notauli present; occipital carina present .... *Zombrus* Marshall
   Notauli absent; occipital carina absent .... *Liodoryctes* Szépligeti
3. Hind coxae with one long tooth dorsally .... *Odontobracon* Cameron
   Hind coxae without teeth dorsally 4
4. Radiellen cell of hind wing divided by a spurious cross vein .... *Nervellinus* Roman
   Radiellen cell without a cross vein 5
5. Cubitella of hind wing arising from junction of postnervellus and basella .... *Holcobracon* Cameron
   Cubitella arising from middle of basella .... *Lophogaster* Granger

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ZOMBRUS Marshall

Zombrus Marshall, 1897, p. 10. Type species: *Zombrus anisopus* Marshall, in Hungarian Natural History Museum, Budapest. Monotypic.

Trimorus Kriechbaumer, 1894, p. 60. Preoccupied by Foerster, 1856. Type species: *Trimorus nigripennis* Kriechbaumer, in Transvaal Museum, Pretoria, South Africa. Monotypic.

Neotrimorus Dalla Torre, 1898, p. 100. New name for *Trimorus* Kriechbaumer.

Acanthobracon Szépligeti, 1902, p. 47 (not *Acanthobracon* Kriechbaumer, 1900). Type species: *Acanthobracon fuscipennis* Szépligeti, in Hungarian Natural History Museum, Budapest. Designated by Viereck, 1914, p. 2.

Trichiobracon Cameron, 1905b, p. 104. Type species: *Trichiobracon pilosus* Cameron, in British Museum. Monotypic.

Trichodoryctes Szépligeti, 1906, p. 599. Type species: *Acanthobracon striolatus* Szépligeti, in Hungarian Natural History Museum, Budapest. Monotypic and original designation.

Oriental, Palearctic, Ethiopian, and Australian Regions. About 40 species have been described in this genus.

LIODORYCTES Szépligeti

Liodoryctes Szépligeti, 1906, p. 599. Type species: *Acanthobracon australiensis* Szépligeti, in Hungarian Natural History Museum, Budapest. Monotypic and original designation.

Neotrimoroides Strand, 1911, p. 104. Type species: *Neotrimoroides dentifer* Strand, in Zoological Museum, Humboldt University, Berlin. Monotypic. NEW SYNONYMY.

Australian Region. Five species have been described.

HOLCOBRACON Cameron

Holcobracon Cameron, 1905a, p. 89. Type species: *Holcobracon fulvus* Cameron, in British Museum (Natural History). Monotypic.

Neotropical and Oriental Regions. Three species have been described.

NERVELLINUS Roman

Nervellinus Roman, 1924, p. 5. Type species: *Nervellinus subdivisus* Roman, in Swedish Natural History Museum, Stockholm. Monotypic.

Neotropical Region. Only one species has been described. The placement of this genus here is based solely on the extension of the postnervellus. The sculpturing of the abdominal tergum 2 + 3 is much different from that in the other genera.

LOPHOGASTER Granger

Lophogaster Granger, 1949, p. 93. Type species: *Lophogaster seyrigi* Granger, in Muséum National d'Histoire Naturelle, Paris. Monotypic.

Madagascar. Only one species has been described.

ODONTOBRACON Cameron

Odontobracon Cameron, 1887, p. 384. Type species: *Odontobracon nigriceps* Cameron, in British Museum (Natural History). Designated by Viereck, 1914, p. 103.

Head cubical; face very coarsely rugose; frons, vertex and temples smooth; frons excavated, divided by longitudinal ridge from median ocellus to between antennae; occipital carina distinct, not meeting hypostomal carina on sides; notauli distinct; sternaulus crenulate, shallow, nearly as long as mesopleuron; second cubital cell of fore wing quadrate, nervulus postfurcal; first segment of mediella of hind wing longer than second, postnervellus angled distally toward wing apex (Fig. 12); abdominal tergum 2 + 3 with large raised basal oval median area delimited by crenulate grooves (Fig. 11).

Nearctic and Neotropical Regions. Nine species have been described, six of which occur in the Nearctic Region.

KEY TO THE NEARCTIC SPECIES OF ODONTOBRACON

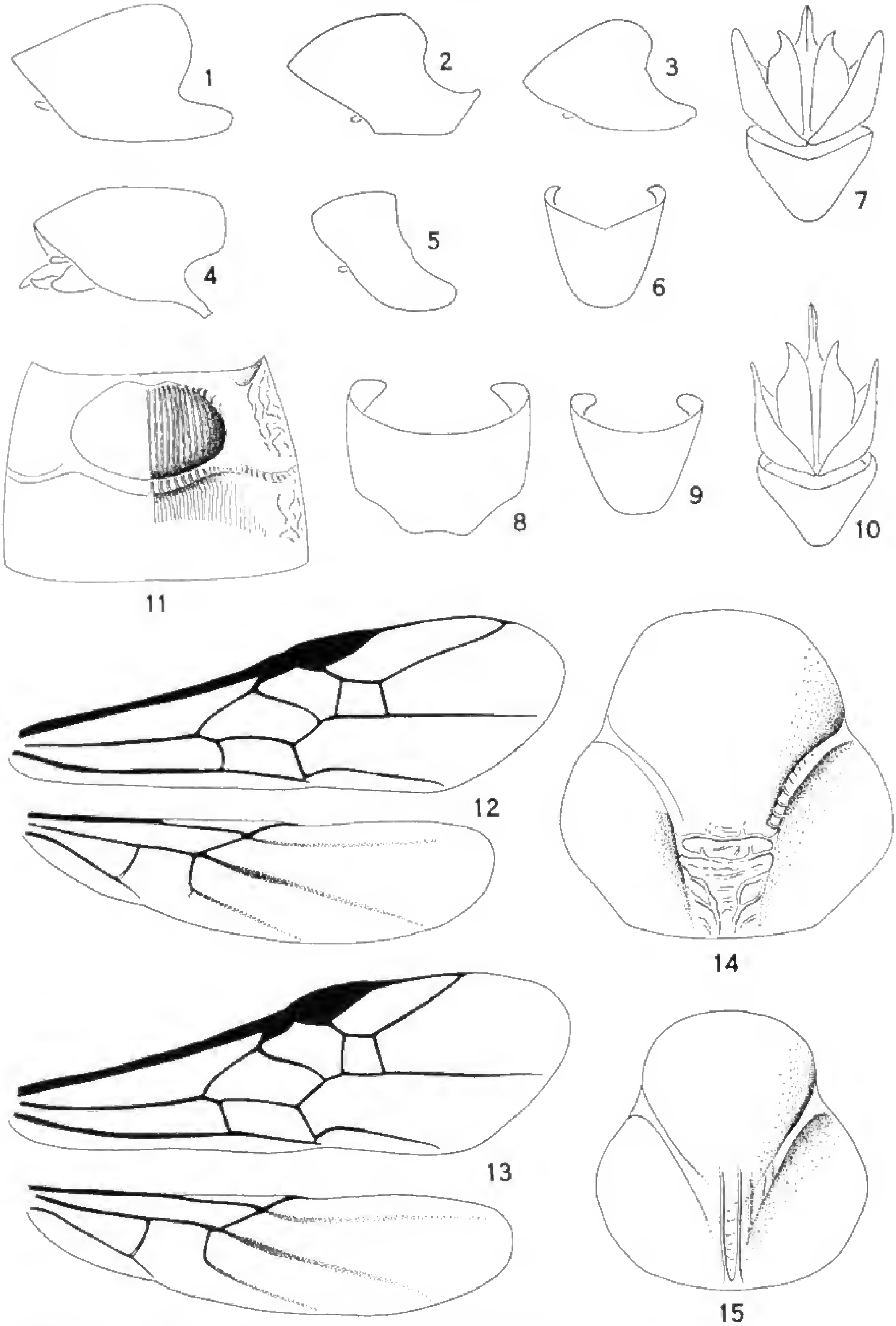
1. Radius of fore wing reaching wing margin well before wing apex, radial cell along wing margin at most as long as stigma (Fig. 13) ...... *cellulus* Marsh, n. sp.
   Radius reaching wing margin nearer apex of wing, radial cell along wing margin longer than stigma. (Fig. 12) 2
2. Malar space with distinct groove extending from base of eye to base of mandible ...... *oemcovorus* Rohwer
   Malar space without such groove 3
3. Notauli meeting posteriorly in wide, rugose, transversely striated or areolated area, usually without two longitudinal converging carinae (Fig. 14) 4
   Notauli meeting posteriorly in narrow longitudinally striate or carinated area, usually with two strong posteriorly converging carinae (Fig. 15) 5
4. Ovipositor longer than abdomen; first abdominal tergum nearly as long as apical width; subalar groove nearly smooth; large species, body length 15 mm or more ...... *grandis* Ashmead
   Ovipositor at most as long as abdomen, usually shorter; first abdominal tergum considerably wider at apex than long; subalar groove distinctly crenulate; smaller species, body length less than 15 mm ...... *nigriceps* Cameron
5. Propodeum aerolate posteriorly, basal carina absent posteriorly; mesonotum usually black ...... *montanus* Cameron
   Propodeum rugose posteriorly, basal carina forked posteriorly; mesonotum red ...... *californicus* Rohwer

ODONTOBRACON CALIFORNICUS Rohwer

(Figs. 4, 9)

Odontobracon californicus Rohwer, 1917, p. 169. Holotype female, in U. S. National Museum.

FEMALE.—Length of body, 6 mm; ovipositor, 2.5 mm. Color orange or red except black head, prothorax, upper part of mesopleuron and legs. Ocellocular distance about four times as long as lateral ocellus; malar space ⅔ eye height, without distinct groove from eye to mandible; frontoclypeal suture and anterior tentorial



FIGS. 1–5, ♂ 9th tergum, side view: 1, *Odontobracon montanus* Cam.; 2, *O. cellulus*, n. sp.; 3, *O. nigriceps* Cam.; 4, *O. californicus* Roh.; 5, *O. oemeovorus* Roh. FIGS. 7 & 10, ♂ genitalia, ventral view, somewhat diagramatic: 7, *O. oemeovorus*; 10, *O. cellulus*. FIGS. 6, 8 & 9, ♂ gonobase, ventral view: 6, *O. nigriceps*; 8, *O. montanus*; 9, *O. californicus*. FIG. 11, abdominal tergum 2 + 3, dorsal view, *O. nigriceps*. FIGS. 12 & 13, fore and hind wings: 12, *O. nigriceps*; 13, *O. cellulus*. FIGS. 14 & 15, mesonotum, dorsal view: 14, *O. nigriceps*; 15, *O. montanus*.

pits not deep; two posteriorly converging longitudinal carinae at junction of notauli before scutellar furrow; subalar groove crenulate; propodeum rugose on posterior surface, basal carina indistinctly forked posteriorly, sides of propodeum weakly punctate on lower half; second segment of radius of fore wing less than twice length of first segment; recurrent vein entering first cubital cell; cubitus between recurrent and first intercubitus about as long as first segment of radius; fore tarsus 1.4 times as long as fore tibia; first abdominal tergum wider at apex than long, tooth at basolateral corner not prominent, basal longitudinal carinae distinct; tergum 2 + 3 weakly striate beyond raised basal oval area; ovipositor slightly shorter than abdomen.

MALE.—Essentially as female; ninth tergum and gonobase (Figs. 4, 9), ninth tergum finely longitudinally striate, setae on distal edge scattered; ninth sternum with few scattered setae medially.

TYPE LOCALITY.—Santa Cruz Mountains, California.

DISTRIBUTION.—Known only from the type locality in California.

This species is easily distinguished by its size, color and thoracic sculpturing.

Odontobracon cellulus Marsh, new species

(Figs. 2, 10, 13)

FEMALE.—Length of body, 10–12 mm; ovipositor, 4–6 mm. Color of head, prothorax, mesonotum and sides of propodeum varying from red to black; mesopleural disc, propodeum dorsally and abdomen always red; legs usually black, rarely femora and coxae red. Ocellocular distance about twice as long as lateral ocellus; malar space ⅔ eye height, without groove from eye to mandible; anterior tentorial pits deep; triangular area where notauli meet before scutellar furrow transversely striate or rugose, rarely with two indistinct converging longitudinal rugae; subalar groove crenulate; propodeum areolated, basal carina present only dorsally; fore tarsus about 1.5 times as long as fore tibia; dorsal spine on hind coxa usually abruptly angled at apex; first segment of radius of fore wing less than twice as long as second segment; radial cell along wing margin at most as long as stigma, usually shorter, radius reaching wing margin well before wing apex (Fig. 13); recurrent vein entering first cubital cell; cubitus between recurrent and first intercubitus about as long as first segment of radius; first abdominal tergum wider at apex than long, tooth at basolateral corner very weak; tergum 2 + 3 usually striate beyond raised oval area, rarely smooth; fourth abdominal tergum sometimes striate at base; ovipositor nearly as long as abdomen.

MALE.—Essentially as female; ninth tergum and genitalia (Figs. 2, 10); sculpturing and setae on apical edge of ninth tergum as in *O. nigriceps*; ninth sternum with few scattered setae medially.

Holotype female, ALAMO CROSSING, YUMA COUNTY ARIZONA, 7 September 1959, Carl E. Benson, collector. U. S. National Museum type number 70853.

Paratypes.—ARIZONA: 1♀, Alamo Crossing, Yuma Co., 22 September 1959, Carl E. Benson; 1♀, Dobbs Spring, reared 21 April 1919, Hopk. no. 10087k, G. Hofer, colr.; 1♀, mouth Bear Cyn., Sta. Catalina Mtns., 3 July 1961, Werner-Nutting; 1♂, Douglas, Cochise Co., 15 August 1958, P. M. Marsh; 1♀, Arizona-Son. Desert Mus., Pima Co., 5–8 August 1962, Nutting-Oman; 1♀, 2♂, Picture Rock Pass, Tucson Mtns., 25 July 1961, Werner-Nutting; 1♀, Portal, Cochise Co., 27 June 1958, W. F. Barr; 2♀, Sabino Canyon, 10 August 1953, 6 August 1959, Butler, Krombein; 2♀, Santa Rita Mtns., 4 September 1914; 1♀, near Sabino Canyon, Pima Co., R. H. Arnett, Jr.; 1♂, 8 mi. N. Vail, Pima Co., 30 August 1962, Werner-Nutting. CALIFORNIA: 1♀, Vallecitos, San Diego Co., 24 September 1936. NEW MEXICO: 1♀, Las Cruces, 26 July 1961. TEXAS: 1♀, 3 mi. E. Presidio, 1 May 1963, H. E. Evans. MEXICO: 1♂, MacDougal Crater, Penacate Mtns., 28 November 1959, G. D. Butler. Paratypes are deposited in the U. S. National Museum, University of Arizona, Canadian National Collection, and the Museum of Comparative Zoology.

This species is very similar to *O. nigriceps,* but the short radial cell of the forewing, the abruptly curved spine on the hind coxae, and the structure of the male genitalia distinguish *O. cellulus.*

ODONTOBRACON GRANDIS Ashmead

Odontobracon grandis Ashmead, 1894, p. 122. Holotype female, in U. S. National Museum.

FEMALE.—Length of body, 16–20 mm; ovipositor, 11–14 mm. Color of head, prothorax, lateral mesonotal lobes, upper part of mesopleuron and legs black; abdomen, rest of thorax and area around mouth opening red. Ocellocular distance about 1.5 times as long as lateral ocellus; malar space about ⅔ eye height, without distinct groove from eye to mandible; frontoclypeal suture and anterior tentorial pits very deep, face very coarsely rugose; notauli obscured posteriorly by strong transverse striations in V-shaped area before scutellar furrow; subalar groove smooth or very weakly crenulate; propodeum areolated dorsally and posteriorly, rugose laterally, basal carina indicated dorsally only; fore tarsus 1.5 times as long as fore tibia; second segment of radius of fore wing twice as long as first segment; recurrent vein interstitial, or nearly so, with first intercubitus; cubitus between recurrent and first intercubitus, if present, much shorter than first segment of radius; first abdominal tergum longer than wide at apex, tooth at basolateral corner very prominent; tergum 2 + 3 strongly striate beyond raised basal oval area; fourth tergum striate at base; ovipositor longer than abdomen.

MALE.—Unknown.

TYPE LOCALITY.—San Jose del Cabo, Baja California.

DISTRIBUTION.—Arizona; Baja California.

This species, one of the largest in the genus, can be separated from *O. nigriceps* by its size, longer ovipositor and first abdominal tergum, and its thoracic sculpturing.

ODONTOBRACON MONTANUS Cameron

(Figs. 1, 8, 15)

Odontobracon montanus Cameron, 1887, p. 384. Holotype female, in British Museum (Natural History).

Odontobracon crassiventris Cameron, 1887, p. 385. Holotype female, in British Museum (Natural History). NEW SYNONYMY.

FEMALE.—Length of body, 7–14 mm; ovipositor, 3–7 mm. Color of head, thorax and legs black; abdomen red; mesonotum occasionally and dorsum of propodeum frequently red; base of middle tibia white. Ocellocular distance 2–2.5 times as long as lateral ocellus; malar space ¾ eye height, without groove from eye to mandible; anterior tentorial pits deep; two parallel longitudinal carinae at junction of notauli before scutellar furrow (Fig. 15); subalar groove weakly crenulate, sometimes smooth; propodeum areolated dorsally and posteriorly, laterally punctate or occasionally smooth, basal carina obscured on posterior face of propodeum; fore tarsus 1.6 times as long as fore tibia; second segment of radius of fore wing about 2.5 times as long as first segment; recurrent vein entering first cubital cell; cubitus between recurrent and first intercubitus about as long as first segment of radius; first abdominal tergum wider at apex than long, tooth at basolateral corner weak; tergum 2 + 3 striate beyond basal raised oval area; fourth tergum striate at base; ovipositor about as long as abdomen.

MALE.—Essentially as female; mesopleuron, propodeum and hind coxae red; third and fourth abdominal terga rugose at base; ninth tergum and gonobase (Figs. 1, 8); sculpturing and setae on distal edge of ninth tergum similar to *O. californicus*; ninth sternum with scattered setae medially.

TYPE LOCALITY.—Irazu, Costa Rica.

DISTRIBUTION.—Alabama, Florida, Georgia, North Carolina, South Carolina, Texas; Costa Rica; British Honduras; Guatemala; Panama.

Specimens of this species have been previously confused with *O. elaphidiovorus* (now a synonym of *O. nigriceps*) but can be distinguished by the different sculpturing where the notauli meet on the mesonotum.

ODONTOBRACON NIGRICEPS Cameron

(Figs. 3, 6, 11, 12, 14)

Odontobracon nigriceps Cameron, 1887, p. 385. Holotype female, in British Museum (Natural History).

Odontobracon elaphidiovorus Rohwer, 1917, p. 168. Holotype female, in U. S. National Museum. NEW SYNONYMY.

FEMALE.—Length of body, 8–13 mm; ovipositor, 3–6 mm. Head black, rarely marked with red; pro- and mesothorax varying from entirely red to black; propodeum and abdomen always red; legs black. Ocellocular distance twice as long as lateral ocellus; malar space about ¾ eye height, without groove from eye to mandible; anterior tentorial pits not deep; notauli obscured posteriorly by V-shaped transversely rugose area before scutellar furrow (Fig. 14); subalar groove strongly crenulate; propodeum areolated, basal carina present only dorsally; fore tarsus 1.25 times as long as fore tibia; dorsal tooth on hind coxa broadly curved, not abruptly angled at apex; second segment of radius of fore wing about twice as long as first segment (Fig. 12); radial cell along wing margin longer than stigma, radius reaching wing margin near wing apex; recurrent vein entering first cubital cell; cubitus between recurrent and first intercubitus about as long as first segment of radius; first abdominal tergum wider at apex than long, tooth at basolateral corner very weak; tergum 2 + 3 usually striate beyond raised oval area, occasionally smooth (Fig. 11); fourth tergum sometimes striate at base; ovipositor at most as long as abdomen, usually shorter.

MALE.—Essentially as female; ninth tergum and gonobase (Figs. 3, 6); sculpturing on dorsum of ninth tergum transverse, fingerprint-like, distal edge with dense fringe of setae; ninth sternum with few scattered setae medially.

TYPE LOCALITY.—St. Gerónimo, Guatemala.

DISTRIBUTION.—Arizona, Arkansas, Connecticut, Florida, Georgia, Illinois, Massachusetts, Mississippi, Nevada, New Jersey, New Mexico, North Carolina, Pennsylvania, Texas, Utah, West Virginia, Wisconsin; Mexico; Guatemala.

HOST.—*Elaphidion villosum* F.

ODONTOBRACON OEMEOVORUS Rohwer

(Figs. 5, 7)

Odontobracon oemeovorus Rohwer, 1917, p. 167. Holotype female, in U. S. National Museum.

FEMALE.—Length of body, 7–9 mm; ovipositor, 2–3 mm. Color of head, thorax and legs black; abdomen red; propodeum occasionally red. Ocellocular distance twice as long as lateral ocellus; malar space about ⅔ eye height, with distinct groove extending from base of eye to base of mandible; anterior tentorial pits and frontoclypeal suture not deeply excavated; two longitudinal carinae on mesonotum converging before scutellar furrow at junction of notauli with rugae or carinae between; subalar groove strongly crenulate; propodeum entirely areolate, somewhat rugose on sides, basal carina present only dorsally; fore tarsus 1.3 times as long as fore tibia; second segment of radius of fore wing slightly less than twice as long as first segment; recurrent vein entering first cubital cell; cubitus between recurrent and first intercubitus about as long as first segment of radius; first abdominal tergum wider at apex than long, tooth at basolateral corner not distinct; abdomen usually smooth beyond raised oval area of tergum 2 + 3; ovipositor shorter than abdomen.

MALE.—Essentially as female; abdominal tergum 2 + 3 striate beyond raised oval area; ninth tergum and gonobase (Figs. 5, 7); sculpturing and distal fringe of setae on ninth tergum as in *nigriceps*; ninth sternum entirely covered with setae.

TYPE LOCALITY.—Appalachicola, Florida.

DISTRIBUTION.—Alabama, Florida, Illinois, Maryland, Michigan, Pennsylvania, Texas.

HOST.—*Oeme rigida* (Say).

The groove on the malar space will immediately distinguish this species.

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Biological Notes on some Nearctic Lepturinae
(Coleoptera: Cerambycidae)

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Collecting cerambycids for larval taxonomic study has produced much new biological information on these insects. Ordinarily, this information would be published with larval descriptions for logical groupings such as genera. However, as the North American Lepturinae are presently under revision by J. A. Chemsak and E. G. Linsley, University of California, Berkeley, it is thought worthwhile to make the following notes available for reference now.

Most of the species noted were collected in Ontario and western Quebec in recent years, but some were collected in the Kananaskis Valley near Seebe, Alberta, in 1968.

W. R. Mason and G. S. Walley, Entomology Research Institute, Ottawa, identified the braconid and ichneumonid parasites, respectively.

Pidonia ruficollis (Say).—In Ontario and Quebec, adults are found in June and early July on flowers of *Rosa, Cornus, Heracleum* and other plants, particularly in partial shade. The host is unknown, but the insect almost always is found in or near aspen stands. Caged females oviposited readily in decaying *Populus* wood.

Grammoptera exigua (Newman).—This species was reared from decaying limbs of *Tilia americana* L. from Rondeau Park, Lake Erie, Ontario. Boring and pupation occurred in the bark. Some parasitism by an unidentified braconid of the genus *Eubadizon* was noted.

Grammoptera subargentata (Kirby).—Adults have been collected from flowers of *Rosa, Cornus* and other shrubs in late June and early July in Quebec, Ontario and western Alberta. Caged females laid eggs on decaying *Populus*, cementing them to bark or wood, or in cracks. Hatching occurred in about 10 days. Sometimes the chorion was partly ingested.

Leptura plebeja (Randall).—This species appears to be rather rare in Ontario and Quebec, but may be found on flowers of *Heracleum* and *Spiraea* from June to August.

Leptura subhamata (Randall).—Adults are fairly common on flowers of *Spiraea, Achillea* and other plants in Ontario and Quebec during July and August. They also are attracted to freshly split pine and birch firewood. Females were observed ovipositing in cracks in 4-year-old, peeled pine logs.

Typocerus sparsus (LeConte).—Adults have been taken on flowers of *Chrysanthemum, Achillea* and *Spiraea* in July in western Quebec and eastern Ontario. Caged females oviposited in decaying pine, forcing the ovipositor into the rotten wood.

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Typocerus velutinus (Olivier).—In southern and central Ontario, adults are common on flowers of *Spiraea* and *Asclepias* from July to September. This species infests decaying wood of various conifers and hardwoods, laying eggs in small checks in the relatively sound wood.

Anoplodera aspera (LeConte).—Adults are fairly common on flowers, especially of *Heracleum,* in western Alberta during late July and early August.

Anoplodera canadensis (Olivier).—Adults are very common on flowers, especially of *Spiraea,* in Ontario and Quebec in July and August. Groups of up to 75 eggs are laid in cracks in logs and stumps that have begun to decay. Hatching occurs in about 20 days, the larvae ingesting the chorion. Larval galleries often are excavated between sapwood and heartwood. Coniferous wood seems to be preferred but ovipositing females also have been found on decaying *Acer* and *Ostrya.*

Anoplodera chrysocoma (Kirby).—This species is very common during June and July in Ontario, Quebec and western Alberta, on flowers of many plants including *Cornus, Viburnum, Sorbus, Heracleum, Rosa, Ledum, Chrysanthemum, Achillea* and *Epilobium.* Near Laniel, Quebec, it was found breeding in decaying stems of fallen black spruce, *Picea mariana* (Mill.) BSP. The larvae mined extensively in the decaying heartwood, packing the gallery with granular and fibrous frass. Pupation occurred at the end of the gallery and the adult bored its way to the outside. Near Sault Ste. Marie, Ontario, larvae were found working in the base of a dead *Populus.* In black spruce, this species was parasitized by the ichneumonid *Coleocentrus quebecensis* Provancher.

Anoplodera instabilis (Haldeman).—Adults were plentiful on flowers of *Achillea* in western Alberta. They also have been taken in window traps at Black Sturgeon Lake in northwestern Ontario.

Anoplodera minnesotana (Casey).—In Ontario and Quebec, adults have been collected from flowers of *Spiraea, Achillea, Viburnum, Sorbus, Heracleum, Rosa, Rubus* and *Cornus.* They also have been reared from decaying *Betula alleghaniensis* Britt. and *Fagus grandifolia* Ehrh. The larvae mine extensively in relatively sound wood at the edge of decay. Pupation occurs near the wood surface, the larva first preparing an exit hole plugged with frass. At least three years seem to be required for development. The same wood is attacked repeatedly.

Anoplodera mutabilis (Newman).—Adults are very common on flowers of *Cornus, Viburnum, Crataegus, Sorbus, Achillea, Spiraea,* etc., during June and July in Ontario and Quebec. They also occur in western Alberta. The pink, scaly eggs are laid under bark and in cracks in decaying hardwoods. The larva mines in the wood, and the adult chews a circular exit hole. This species has been reared from decaying *Alnus, Populus, Betula, Fagus, Quercus, Prunus, Ostrya, Acer* and *Amelanchier.* At Laniel, Quebec, larvae in *Alnus* were parasitized by the ichneumonid *Coleocentrus rufus* Provancher and a braconid, *Eubadizon* sp.

Anoplodera nigrella (Say).—Adults have been reared from standing and fallen dead *Pinus banksiana* Lamb. and *P. strobus* L. Larvae excavated galleries in the decaying heartwood.

Anoplodera proxima (Say).—Adults have been found, often in company with *A. minnesotana,* in Ontario and Quebec on flowers of *Cornus, Achillea, Chrysanthemum* and *Spiraea.*

Anoplodera pubera (Say).—Adults are fairly common in Ontario and Quebec on flowers of *Cornus, Chrysanthemum, Achillea* and *Spiraea* during June and July. One adult emerged from a dead limb of black walnut, *Juglans nigra* L.

Anoplodera sanguinea (LeConte).—This species seems rare in Ontario and Quebec, but a few adults have been captured on flowers of *Viburnum* and *Chrysanthemum leucanthemum* L. In western Alberta, adults are more plentiful on flowers of *Achillea* and *Galium boreale* L. Caged females oviposited readily in the softened sapwood of decaying *Pinus.*

Anoplodera sexmaculata (Linnaeus).—This species is fairly common on flowers of *Rosa, Achillea, Heracleum, Viburnum, Sorbus, Amelanchier* and other species in June and July in western Quebec, Ontario and western Alberta. Caged females laid eggs in profusion on decaying *Pinus,* but also on the cage floor.

Anoplodera tibialis (LeConte).—In Ontario adults are rather rare on *Spiraea* flowers in July. In western Alberta, they were found on flowers of *Heracleum* up to an altitude of 6,500 feet. Caged females laid small groups of eggs in cracks in decaying *Pinus.*

Anoplodera vagens (Olivier).—In central Ontario, adults have been taken occasionally on flowers of *Heracleum* and *Spiraea* in July.

Anoplodera vittata (Swederus).—In Ontario and Quebec, adults have been collected in July from flowers of *Viburnum, Rosa, Ranunculus, Chrysanthemum* and *Spiraea.* One adult was found in a pupal cell in a decaying stump of *Betula alleghaniensis.*

Toxotus obtusus (LeConte).—Adults were fairly common during July and early August on *Achillea, Heracleum, Galium* and other flowers in subalpine meadows near Seebe, Alberta.

Rhagium inquisitor (Linnaeus).—This species flies in May and June in Ontario and Quebec but has not been found on flowers. Adults are readily attracted to turpentine bait (Gardiner, 1957). The females lay eggs in groups of four to 10 under bark scales on stumps and logs of *Pinus* and *Picea.* Hatching takes place in 17 to 20 days. In northern Ontario, development requires two years, the larva feeding entirely in the phloem. The larvae construct a broad oval or circular pupal cell with fibres cut from the wood surface. The second winter is passed in the adult stage in the cell.

Centrodera decolorata (Harris).—The adults are nocturnal and are attracted to light. Larvae have been found in a decaying branch stub on a living *Quercus rubra* L. near Sault Ste. Marie, Ontario.

Anthophilax attenuatus (Haldeman).—In Ontario and Quebec this species has been found breeding in the relatively solid parts of decaying *Betula, Acer, Ostrya, Fagus* and *Populus.* At least two years are spent in the host. The last-instar larvae leave the wood in June and burrow into the grey, leached layer below the humus of the soil, where they pupate in cells in August. A month later they complete development and overwinter as adults, which emerge in late May and June, and feed on the male flowers of *Pinus.* Eggs are laid in fan-shaped clusters of from 20 to over 100 in cracks in solid wood or among fibres of decayed wood. Some mortality in the soil is caused by the entomophagous fungus, *Isaria farinosa* (Dicks.) Fr.

Anthophilax malachiticus (Haldeman).—This species has been found breeding in well decayed, fallen trunks of *Acer saccharum* Marsh. and *Betula papyrifera* Marsh. near Bruce Mines, Ontario. It also has been found in the decaying base of an *Amelanchier* stem 3 cm in diameter. Eggs are placed singly and in groups in cracks of decaying wood.

Sachalinobia rugipennis rugipennis (Newman).—Little is known of this rather rare species. In Ontario it appears to be associated with dead spruce. One adult was found on a dead black spruce and another emerged from a caged black spruce "club top." Others have been captured at turpentine bait.

Pachyta lamed (Linnaeus).—In early August, adults were captured in flight near Seebe, Alberta, in a spruce-pine forest. One caged female laid more than 275 eggs in and under a piece of moist absorbent cotton.

Evodinus monticola (Randall).—Adults fly in late May and throughout June in Ontario and Quebec, visiting flowers of *Trilium, Cornus, Viburnum, Ledum,* etc. Eggs are laid under bark scales of dead *Pinus, Picea* and *Tsuga.* The larvae feed in the phloem for 12 to 14 months, then drop to the soil in which they pupate at the onset of cold weather. It is not known if they pass the second winter as adults or pupae. Occasionally this species is infected with *Isaria farinosa* in the soil. It is also parasitized by the ichneumonid *Rhyssa persuasoria* (L.).

Pseudogaurotina abdominalis (Bland).—This species is very common in western Quebec in June on flowers of *Rosa, Viburnum, Sorbus, Cornus, Heracleum, Ledum* and *Diervilla.* It does not appear to occur in the region around Sault Ste. Marie, Ontario. Attempts to rear it have been unsuccessful, although it has been offered wood of many species and conditions.

Pseudogaurotina cressoni (Bland).—Near Seebe, Alberta, adults were rather rare on *Rosa* flowers in July, at 4,500 feet above sea level. In August, they were more plentiful at 6,500 feet on flowers of *Heracleum.*

Acmaeops bivittatus (Say).—In 1968, a few adults were found on flowers of *Galium* near Seebe, Alberta.

Acmaeops pratensis Laicharting.—Adults are common in June and July in Ontario, Quebec and western Alberta on flowers of *Achillea, Sorbus, Viburnum, Ledum, Erigeron, Heracleum* and *Galium.* In Sweden, it breeds under bark of spruce and pine, pupating in the soil (Palm, 1956).

Acmaeops proteus (Kirby).—This is one of the most common cerambycids in eastern Canada and it was also collected in western Alberta. It breeds in all coniferous trees except cedars, attacking recently killed material. Adults fly from early May through July, feeding on pollen of various flowers, especially *Achillea.* They are attracted readily to turpentine. Eggs are laid under bark scales and lichen; hatching occurs in about 16 days; and the young larvae ingest the chorion before boring into, and feeding on the phloem. At the end of the second summer, some larvae leave the host and construct pupal cells in the soil, pupating the following spring. The remainder spend a third summer in the host, so that part of each population has a 2-year and part a 3-year life cycle. Larvae in the soil are sometimes infected with *Isaria farinosa* (Gardiner & MacLeod, 1959).

Bellamira scalaris (Say).—In Ontario and Quebec adults are fairly common on flowers, especially *Spiraea* and *Rhus typhina* L. in July and August. This species has been found in decaying *Populus* and *Betula alleghaniensis.* Eggs are laid in groups of up to 40 in cracks in the wood. The larvae mine extensively in the decaying material, pupating close to the wood surface. Two ichneumonid parasites attack this species in western Quebec: *Arotes amoenus* Cr. and *Spilopteron formosum formosum* (Cr.).

Desmocerus palliatus (Forster).—Larvae develop in the lower stems and roots of living *Sambucus,* and adults feed on the flowers and foliage of the same shrub throughout the summer. The larvae bore upwards in the stem and pupate up to 30 cm from the ground. The adults emerge by chewing a circular hole, sometimes through an old branch scar. The brown, scaly, longitudinally striated eggs are distinct from all other known lepturine eggs.

Cortodera subpilosa (LeConte).—Adults are plentiful during July in western Alberta on flowers of *Achillea.*

(Acmaeops) rufula (Haldeman).—This species was assigned by Swaine and Hopping (1928) to *Acmaeops,* but it obviously does not belong in that genus. It is rare in collections. Adults appear in June on flowers of *Ledum groenlandicum* Oeder, and in smaller numbers on *Cornus stolonifera* Michx. and *Antennaria canadensis* Greene. Distribution appears to be boreal; it has been taken at Laniel, Quebec, and Sault Ste. Marie and Black Sturgeon Lake, Ontario. Attempts to rear this species have been unsuccessful and the host is unknown. It is invariably associated with black spruce.

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Synopsis of *Anamphidora* Casey With a New Species From Baja California

(Coleoptera: Alleculidae)

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Casey (1924) originally described *Anamphidora* in the Tenebrionidae and included a single species, *A. parvula,* from Mexico. Spilman (1958) discovered the misplacement and transferred the genus to the Alleculidae. Marshall (1967) recorded the genus from Texas and described a new species which he named *A. campbelli.* The present paper summarizes the available information on *Anamphidora,* places it systematically, and describes a third species from Baja California.

The terminology in general accordance with that of Campbell (1966, 1968) is used in the following account. The size of the eyes is expressed as the ocular index, a quantitative character discussed fully by Campbell and Marshall (1964).

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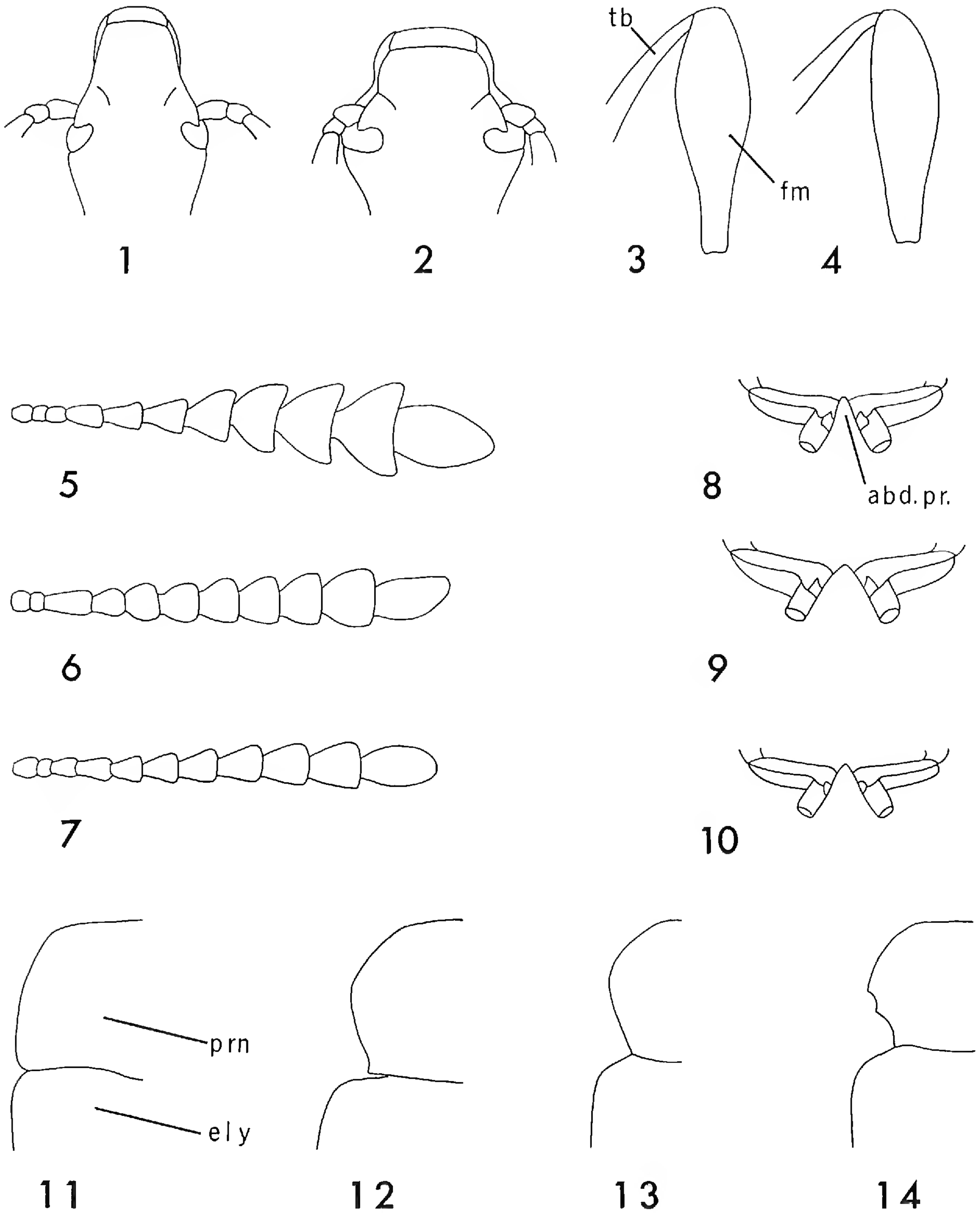


FIGS. 1–14. Key characters for distinguishing Central and North American genera of Lystronichini. FIGS. 1–2. Dorsal view of heads. (1) *Erxias*, (2) typical Lystronichini. FIGS. 3–4. Forelegs, *tb* = tibia, *fm* = femur. (3) *Prostenus*, (4) typical Lystronichini. FIGS. 5–7. Antennae. (5) *Prostenus*, (6) *Xystropus*, (7) *Lystronichus*. FIGS. 8–10. Metacoxae and abdominal processes, *abd. pr.* = abdominal intercoxal processes. (8) typical Alleculini, (9) *Lystronichus*, (10) *Anamphidora*. FIGS. 11–14. Dorsal views of left halves of pronota and elytra, *prn* = pronotum, *ely* = elytra. (11) *Cteisa*, (12) *Xystropus*, (13) *Lystronichus piliferus*, (14) *Lystronichus scapularis*.

SYSTEMATIC PLACEMENT

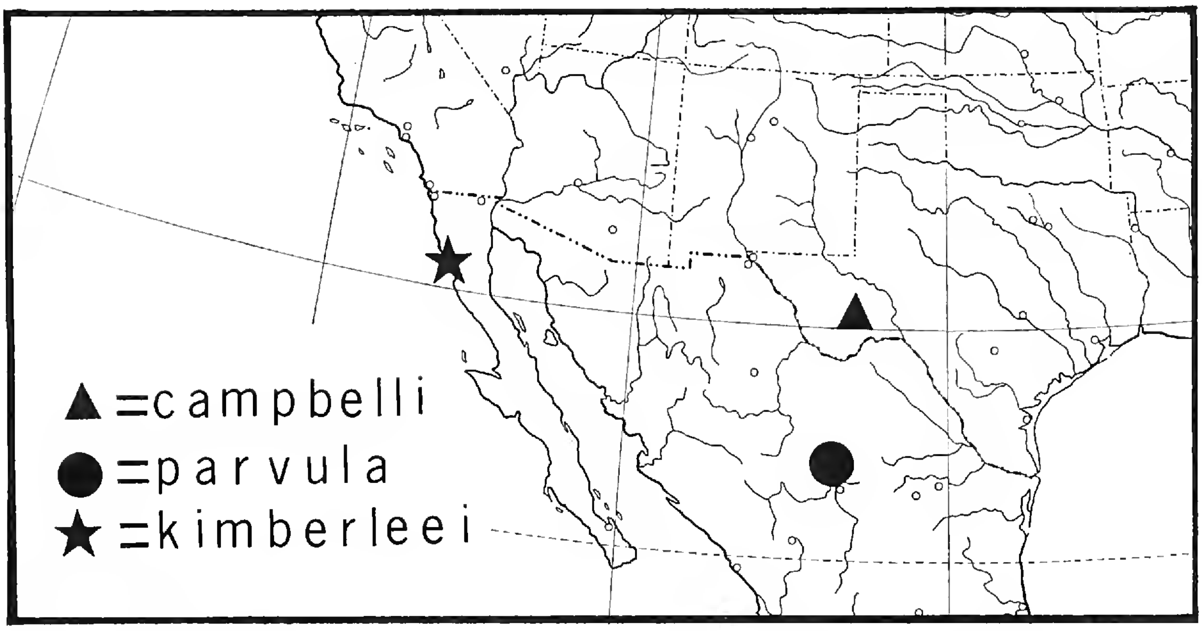
The family Alleculidae is currently represented in the New World by four tribes of the subfamily Alleculinae (Campbell, 1966, pp. 4–5). One of these tribes, Lystronichini Lacordaire, includes seven New World genera characterized by a combination of unlobed tarsi and somewhat wide, apically acute intercoxal processes between the metacoxae. Campbell (1966), never having seen *Anamphidora,* placed this genus in his classification, along with a few others, into a category of genera of unknown tribal affinity. On the basis of the rather wide abdominal process (compare Fig. 10, *Anamphidora,* and Fig. 9, *Lystronichus,* with Fig. 8, typical alleculini), the present author places *Anamphidora* in the Lystronichini. As Campbell (1966) has stated, the morphological studies reported by Crowson (1955) indicate that the Lystronichini may eventually have to be given subfamily status.

Anamphidora somewhat resembles *Phedius* in the tribe Alleculini Seidlitz and would probably be included with it were it not for the complete absence of tarsal lobes in the former. In addition to the superficial similarities both genera are flightless, with the species being either apterous or subapterous.

The following key separates the known Central and North American alleculid genera assignable to the Lystronichini. In couplet 4 a decision will have to be made regarding the presence or absence of functional wings. The apterous or subapterous versus alate condition of most Alleculidae can usually be determined without lifting an elytron, because normally the elytra are sufficiently dehiscent apically so that the wings are visible underneath. If, as in certain rare instances, the elytra of the specimen in question are not dehiscent, then it becomes necessary to lift an elytron to determine the presence or absence of wings.

KEY TO GENERA OF CENTRAL AND NORTH AMERICA LYSTRONICHINI

1.	Head prolonged in front of eyes (Fig. 1)	*Erxias* Champion
	Head not as above (Fig. 2)	2
2.	Femora distally clavate (Fig. 3); antennae with distal joints expanded and greatly flattened (Fig. 5)	*Prostenus* Solier
	Femora not clavate (Fig. 4); antennae not as above	3
3.	Pronotum in dorsal view with caudal margin as wide as cephalic margin of elytra (Fig. 11)	*Cteisa* Solier
	Pronotum with caudal margin distinctly narrower than cephalic margin of elytra (Figs. 12, 13, 14)	4
4.	Wings rudimentary	*Anamphidora* Casey
	Wings developed	5



Map 1. Distribution of known species of *Anamphidora.* Goode Base Map No. 202 reproduced by permission of the Department of Geography, the University of Chicago. Copyright by the University of Chicago.

5. Antennae with distal joints transverse, about as broad as long (Fig. 6) .... *Xystropus* Solier
Antennae with distal joints longer than broad (Fig. 7) .... *Lystronichus* Latrielle

ANAMPHIDORA Casey

Anamphidora Casey, 1924: 330; Spilman, 1958: 288; Campbell, 1966: 5.
Type: *Anamphidora parvula* Casey, monobasic.

DIAGNOSIS.—The combination of the slender, filiform antennae and rudimentary wings serve to separate *Anamphidora* from all other lystronichine genera of Central and North America.

DEFINITION OF GENUS.—Small to moderate in size, subovate, convex in cross-section; integument shining, punctate, glabrous or pubescent. Head exserted, visible from above; distinctly, transversely impressed line on front between bases of antennae; terminal segment of maxillary palpi robust and triangular; antennae slender, filiform, third segment as long as or only slightly longer than fourth, remaining segments slender, elongate, each segment gradually expanded distally; eyes small; prothorax subquadrate; cephalic margin subtruncate; sides feebly rounded throughout, subparallel, only slightly narrower than caudal margin. Subapterous, wings rudimentary. Elytra wider at base than caudal margin of pronotum; elongate, ovate; striae obsolete or impressed; intervals flat or convex. Abdomen with intercoxal process of hind coxae wide, apex somewhat acute, angulate. Legs with tarsal segments not lobed.

DISTRIBUTION.—United States and Mexico (Map 1).

DISCUSSION.—At present no males of *Anamphidora* are known. The known species can be distinguished by the following key.

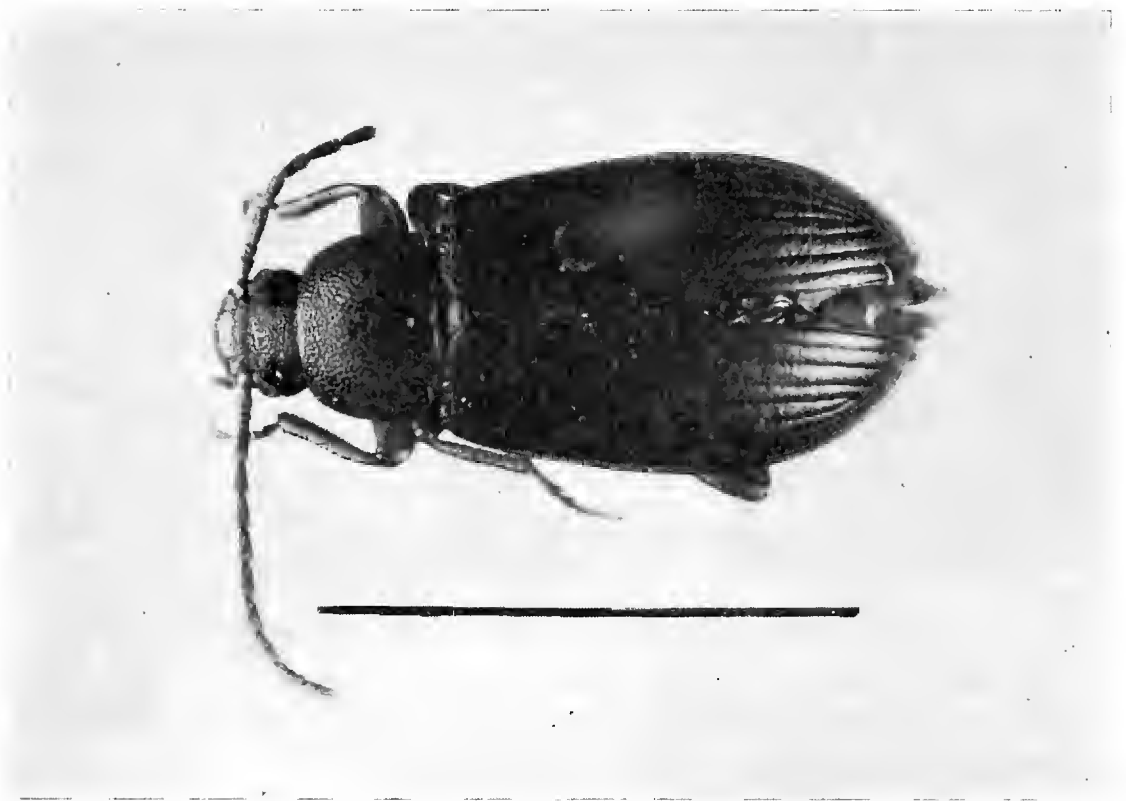


FIG. 15. *Anamphidora campbelli* Marshall. Photograph courtesy of J. Milton Campbell. (line = 5.0 mm.)

KEY TO SPECIES OF ANAMPHIDORA

1. Elytra with striae pronounced (Fig. 15); glabrous above; (Texas) .... *campbelli* Marshall
   Elytra with striae not at all, or only slightly impressed (Figs. 16, 17); long, erect setae above 2
2. Highly polished throughout; setae sparse; (Mexico) .... *parvula* Casey
   Only slightly shining throughout; setae moderately dense; (Baja California) .... *kimberleei* Marshall, n. sp.

ANAMPHIDORA CAMPBELLI Marshall

(Fig. 15)

Anamphidora campbelli Marshall, 1967: 209.

DIAGNOSIS.—This species is known only from western Texas, and is easily distinguished from other species of the genus by the glabrous nature of the dorsal surface and the deeply impressed elytral striae.

Location of type: United States National Museum.

Type locality: Alpine, Texas.

DISCUSSION.—In addition to the type, only one other specimen of *A. campbelli* is known, and it was collected near Ft. Davis, Texas (Map 1). This latter specimen resides in the collection of J. Milton Campbell.

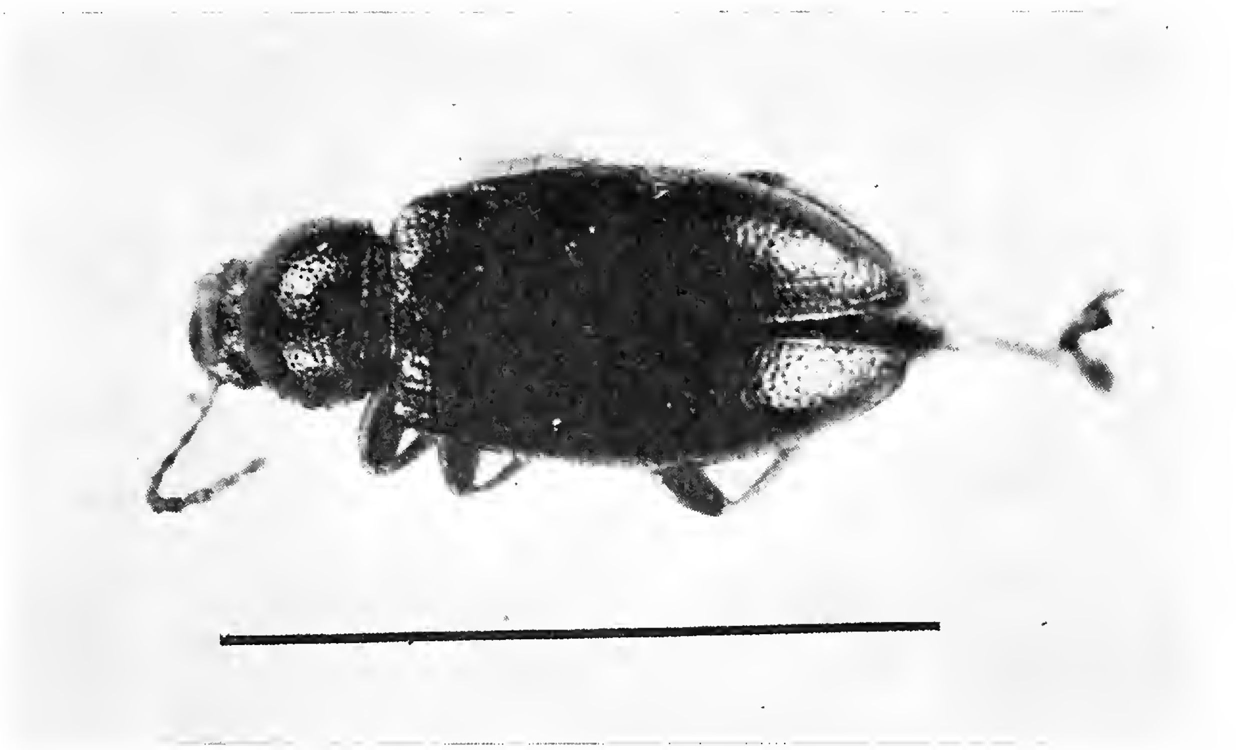


FIG. 16. *Anamphidora parvula* Casey. (line = 5.0 mm.)

ANAMPHIDORA PARVULA Casey
(Fig. 16)

Anamphidora parvula Casey, 1924: 330; Spilman, 1958: 288.

DIAGNOSIS.—This species is known only from Mexico, and can be distinguished from the other members of the genus by the highly polished integument, the sparsely distributed, long erect setae, and the lack of impressed elytral striae.

DESCRIPTION.—*General*: Convex in cross-section; integument piceous, highly polished throughout; body with sparsely distributed, long, erect setae above, appendages sparsely pubescent. *Head*: Elongate, narrowing gradually behind eyes, punctures moderately impressed, loosely distributed; terminal segment of maxillary palpi with angle formed at junction of inner and basal sides approximating 90°, inner side about as long as outer side; antennae almost one-half as long as body, segment three subequal to fourth, four through eleven about two times as long as greatest distal width; eyes small, ocular index = 58.0. *Thorax*: Subquadrate in shape, one-fourth wider than long, sides arcuate; caudal margin broadly and feebly sinuate; basal angles rounded. Pronotum with punctation moderately impressed; punctures sparse, majority separated by much more than their diameters. *Elytra*: Sparsely and confusely punctate; one and one-half times wider at base than caudal margin of pronotum; sides rounded, becoming wider near middle; about twice as long as greatest width; striae on disc unimpressed, sutural striae one and two feebly impressed, intervals flattened, those near suture becoming feebly convex apically. *Abdomen*: polished, piceous throughout. *Length*: 5.3 mm.

Location of type: United States National Museum.

Type locality: Tepehuanes, Durango, Mexico (Map 1).

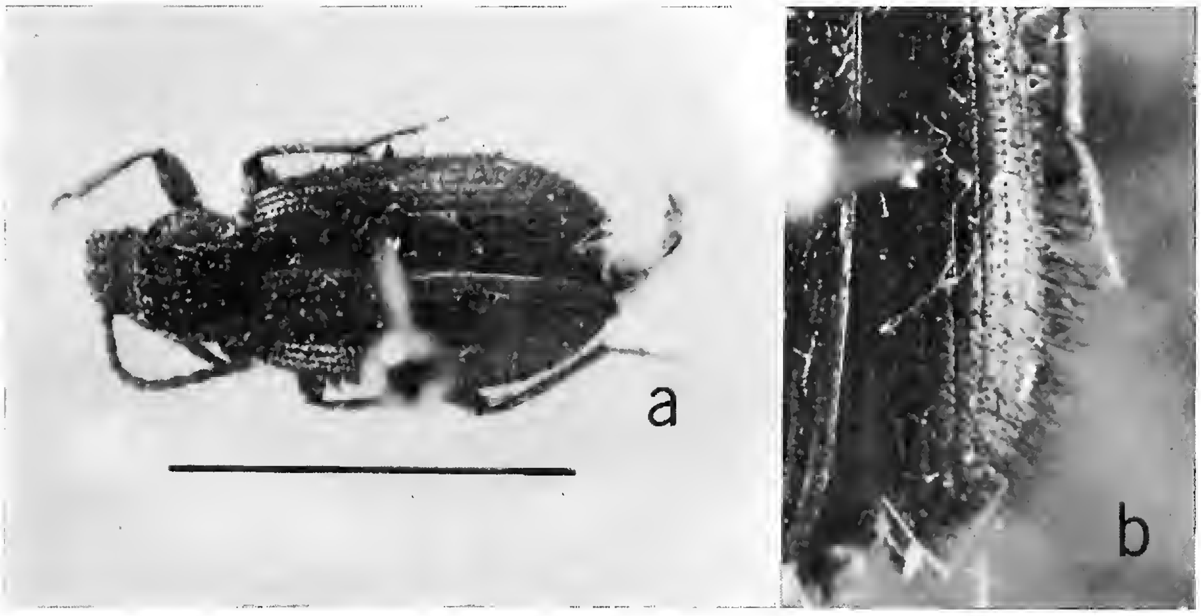


FIG. 17. *Anamphidora kimberleei* Marshall. (a) female holotype; (b) close-up of apical portion of right elytron showing setae. (line = 5.0 mm.)

DISCUSSION.—This species is known only from the female holotype in the Casey collection at the United States National Museum. It was described originally in the Tenebrionidae, and Spilman (1958) properly placed it in the Alleculidae.

Anamphidora kimberleei Marshall, new species

(Fig. 17 a, b)

DIAGNOSIS.—This species is known only from Baja California. The very conspicuous, moderately dense, erect black setae on the dorsal surface distinguish *A. kimberleei* from the other members of the genus.

DESCRIPTION OF FEMALE HOLOTYPE.—*General*: Moderately convex in cross-section; integument brown, only slightly shining throughout; body conspicuously, somewhat coarsely setate above; setae black, erect, each seta about equal to length of third joint of antenna; appendages moderately, finely pubescent. *Head*: Narrowing gradually behind eyes, not constricted; punctures irregularly impressed, rather shallow and sparse laterally and posteriorly, becoming more densely, strongly, and slightly more irregularly punctate on front anteriorly and between eyes; terminal segment of maxillary palpi with angle formed at junction of inner and basal sides about 90°, inner side feebly sinuate, approximately same length as outer side; antennae one-third as long as body, third joint 1.2 times as long as fourth, joints four through eleven about two times as long as greatest distal width; eyes small, ocular index = 54.5. *Thorax*: subquadrate, cephalic margin three-fourths as wide as caudal margin; caudal margin rather narrowly and very feebly sinuate; basal foveae lacking; basal angles almost obtuse, only faintly rounded. Pronotal punctation moderate in density; punctures rather deep and unevenly distributed, becoming more shallowly so toward cephalic margin. *Elytra*: One and two-thirds times wider at base than caudal margin of pronotum; sides rounded, becoming wider posteriorly; about twice as long as greatest width; striae not deeply impressed but plainly marked with serial punctures; punctures bearing setae, separated by distance averaging not quite the diameter of punctures; intervals feebly and irregularly punctate, feebly convex on disc, becoming more so apically, especially toward suture. *Abdomen*: Shining throughout; setae rather sparse, equal in length to those on dorsal surface, appressed, pointing toward apex. *Length*: 8.3 mm.

Holotype female, SAN QUINTIN, BAJA CALIFORNIA, MEXICO, 12 July 1922 (Map 1). To be deposited in the collection of the California Academy of Sciences.

DISCUSSION.—This species is known only from the female specimen described above, and is named for the author's daughter, Kimberlee Marshall.

ACKNOWLEDGMENTS

Several people have assisted the author in this study. T. J. Spilman, United States National Museum, kindly permitted access to the Casey collection and obtained the ocular index of *A. parvula.* Hugh B. Leech, California Academy of Sciences, loaned the specimen described as a new species in the preceding account. J. M. Campbell, Canadian National Collection, furnished the photograph of *A. campbelli.* Jan Boles, The College of Idaho, assisted with the photograph of the new species. P. M. McKnight, Department of Geography, University of Chicago, granted permission to reproduce the North American map used in showing distribution records. Miss Alexis Eichman, The College of Idaho, typed the manuscript.

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The Cerambycidae of the Panamint Mountains, California

(Coleoptera)

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The Panamint Mountains form the western edge of Death Valley National Monument, California. They are an isolated range of desert mountains that vary in elevation from below sea level at their base, in Death Valley proper, to over 11,000 feet on Telescope Peak.

The flora of the upper mountains has been divided into three distinct groups (Ferris, 1962). The *Upper Desert Slope Flora* consists of desert-type shrubs common to higher elevations throughout the Sonoran Desert. In the Panamint Mountains, this floral group is found primarily between 3,500 and 6,000 feet elevation. Above 6,000 feet the influence of the *Pinyon-Juniper Woodland* begins. Single-leaf pinyon pine and Utah juniper are the dominant plants in this region. Near the lower range of the woodland the plants are restricted to the washes and ravines with the juniper being dominant. Above 7,000 feet the pine becomes dominant and both plants are found on all slope aspects. Common tree-like shrubs in this region are the curlleaf mountain mahogany and antelope brush. Above 8,000 feet the *Limber-Bristlecone Pine Woodland* is found. This is perhaps the least collected of the three floral groups.

The mountains above 5,000 feet are for the most part inaccessible except for a few gravel roads. Because of their inaccessibility most collecting has been restricted to the regions bordering these roads. Mahogany Flats (8,000 feet) is the highest point one can reach by road. From this point only a trail traverses the slopes to Telescope Peak. Even with this road and trail, little or no concentrated cerambycid collecting has been attempted and the only record from these mountains was by Dillon and Dillon (1941), when *Monochamus linsleyi* was described from a single specimen.

During the springs of 1965–1968, trips were undertaken to this region to collect wood infested with cerambycid larvae. The wood was returned to San Jose State College and placed in rearing containers (for techniques see Tyson, 1966). Plant species were identified via Munz and Keck (1963) and Ferris (1962). Beetles were identified via Dillon & Dillon (1941), Dillon (1956), and Linsley (1935, 1962a, 1962b, 1963, and 1964).

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The following is an alphabetical list of the cerambycid species reared during the study, and those seen in other collections. With those reared, biological data is given on host, larval habits, and collection localities. Emergence dates are not given since the change in both elevation and climate may have altered the normal life cycles.

The results of this study are not intended to be complete, but to arouse entomological interest in this unique region. It is probable that future collections will produce Cerambycidae not here recorded.

Aneflomorpha lineare (LeConte).—This species was reared from girdled branches of antelope brush (*Purshia tridentata*) collected at Mahogany Flats. The majority of plants in the region were in very poor condition due to the severe girdling by this species. It appears that the larvae work down the branches girdling them several times before pupating. The larvae mine down the center of the branch, but before pupating form a pupal chamber just beneath the thin bark. Although only one adult specimen was reared, many larvae were encountered. Limbs up to 4 cm in diameter were found girdled, but smaller limbs were most commonly utilized.

Arhopalous rusticus hesperus Chemsak and Linsley.—This recently described subspecies was reared from the root-crown of a dead single-leaf pinyon pine (*Pinus monophylla*). The wood was collected near the Charcoal Kilns (7,200 feet) and the adults emerged over a three year period. The larvae work in the sound heartwood and pupate in same.

Callidium antennatum hesperum Casey.—This common and wide spread species was reared in large numbers from single-leaf pinyon pine. Larvae were collected between 7,000 and 8,500 feet, being most common at 8,000 feet. The larvae work beneath the bark of small to medium sized dead limbs, and produce copious amounts of frass, some of which is exited through small holes cut in the bark by the larvae. The mature larvae enter the heartwood and before pupating cut an exit hole through the bark. This form is an early emerger, being caught as adults as early as April at 8,000 feet.

Callidium texanum Schaeffer.—This species was reared from Utah juniper (*Juniperus osteosperma*) wood collected below Mahogany Flats. The larval habits are as those described for *C. antennatum*, but smaller limbs were attacked. Limbs varying from 5 cm to less than 1 cm were found infested. It appears that all western *Callidium* attack only recently killed wood. This species is extremely variable throughout its range and the examples reared were generally smaller in size than the normal range.

Eucrossus villicornis LeConte.—Specimens of this species were reared from single-leaf pinyon pine. The larval habits conform to those described by Tyson (1966) and more recently by Wickman and Seminoff (1968). The immatures are very susceptible to moisture changes, and if the bark is removed from wood with the larvae in their pupal chambers, they usually die from dehydration. However, if the adult stage is reached, many will die within the pupal chamber being unable to exit through the dried frass plug.

Hesperanoplium antennatum (Linsley).—Curlleaf mountain-mahogany (*Cercocarpus ledifolius*) is the primary host of this species. The larvae deeply score the heartwood beneath the bark. The work usually begins at the apical end of a branch and the larvae work toward the base with frass being exited from the gallery along its length. Before pupation each larvae enters the heartwood and constructs a long, frass-free, pupation chamber. This chamber is sealed with a thin calcarious plug, and just behind this plug is another which is thicker and composed of thin strips of wood. Larval work was also observed in the small branches of a low-growing willow (*Salix*) in the same region the mahogany was collected (Mahogany Flats).

Haplidus testaceus LeConte.—Small to medium sized branches of single-leaf pinyon pine were most frequently found infested by this species. The infested wood was collected at the Charcoal Kilns and Mahogany Flats. The larvae work beneath the bark of dry limbs (usually dead for two seasons) and enter the heartwood to pupate. The outer surface of the wood, just beneath the bark, is sealed with a calcarious plug. Limbs infested are usually those that die and remain on the tree. No wood in contact with the soil was found infested.

Neacanthocinus obliquus pacificus Casey.—The host of this species is single-leaf pinyon pine. The larger dead branches or the main trunk of dead trees are most commonly found infested. The wood was collected at the Charcoal Kilns. For larval habits see Tyson (1966).

Monochamus linsleyi Dillon & Dillon.—Until recently the unique type specimen was the only known representative of this species. To date over 40 have been reared from single-leaf pinyon pine. The larval work is characteristic of other members of this genus with the larger limbs and the main trunk being attacked. Infested wood was collected at Mahogany Flats and the Charcoal Kilns. A large number of the immature forms are destroyed by predaceous beetle larvae (Ostomatidae) and woodpeckers.

Oeme costata costata LeConte.—The larval work in single-leaf pinyon pine is very characteristic. The galleries are beneath the bark and are very wide, much wider than the larvae. The sides of the galleries are heavily reticulated and resemble work of the Buprestidae. The larvae enter the heartwood to pupate, and may or may not cut exit holes through the bark.

Osmidus guttatus LeConte.—Several specimens in the Park Service collection at Furnace Creek, California, are labeled Furnace Creek. These specimens were reared from mesquite (*Prosopis juliflora*) by the Park Naturalist. Since mesquite is found in at least one valley of the Panamint Mountains (Wild Rose Canyon) it is possible that *Osmidus* does occur there.

Poliaenus schaefferi Linsley.—The larvae mine the small limbs (1 to 2 cm in diameter) of dead branches of single-leaf pinyon pine. They etch both the bark and the sapwood and enter the heartwood to pupate. The pupal chamber, as with the majority of the members of this genus, is sealed with a tight plug of coarse frass. This record extends the range of this species which was thought to be only found west of the Sierra Nevada Mountains.

Prionus californicus Motschulsky.—One specimen in the Death Valley Park Service collection labeled Wild Rose Canyon.

Semanotus ligneus amplus (Casey).—This species was reared from dead Utah juniper wood collected in the region of the Charcoal Kilns. The larvae etch both the bark and the sapwood and their galleries are tightly filled with coarse frass. The larvae enter the heartwood to pupate and seal the opening with a tight plug of frass.

My thanks to James Cope, Richard Main, and G. G. Bianconi of San Jose State College for valuable assistance on collecting trips, and to the National Park Service for making these collections possible.

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New Mexican Species of *Eburia* Serville and *Eburodacrys* Thomson

(Coleoptera: Cerambycidae)

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The hesperophanine genera *Eburia* Serville and *Eburodacrys* Thomson are represented by numerous species in the Neotropical regions. Recent field expeditions to Mexico have resulted in the collection of a number of undescribed species, primarily with the use of ultraviolet lights.

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The west coast area, especially around Mazatlan, Sinaloa, is quite rich in this group both in species and in numbers of specimens. For the purpose of making their names available for use in other projects, the following three species of *Eburia* and one of *Eburodacrys* are described at this time.

This and related studies have been supported in large part by the National Science Foundation through Grant GB-4944X.

Eburia juanitae Chemsak and Linsley, new species

MALE.—Form elongate, parallel-sided; integument dark reddish-brown, elytra slightly paler; eburneous elytral fasciae usually absent; pubescence fine, grayish, appressed, obscuring surface. Head with front small, with arrow-shaped glabrous spot at middle; median line deep, extending onto neck; vertex very small with median line becoming a glabrous carina; antennal tubercles not prominent; obtuse above; pubescence dense, appressed; antennae extending over two segments beyond elytra, segments three to ten externally produced at apices, scape to basal half of third segment sparsely pubescent, shining, remaining segments densely clothed with very short appressed pubescence, third segment longer than first, fourth subequal to third, fifth longer than fourth, remaining segments gradually increasing in length, eleventh longest, appendiculate. Pronotum about as broad as long, slides obtusely tuberculate; disk with two prominent antemedian glabrous calluses, smaller median callus and two basal ones toward sides; surface irregular, densely clothed with appressed pubescence, longer erect hairs present at sides; prosternum deeply impressed, coarsely deeply punctate over apical half, pubescence dense; procoxal process abruptly declivous toward apex, coxal cavities open behind; meso- and metasternum minutely punctate, densely pubescent, scent glands prominent at apex of metepisternum. Scutellum densely pubescent. Elytra about three times as long as broad; eburneous fasciae usually absent, occasionally with small basal pair and/or small median pair on each side, the outer longer; punctures irregular, becoming obsolete toward apex; pubescence short, dense, appressed, obscuring surface, few longer erect hairs sparsely interspersed; apices bispinose, spines short, subequal in length. Legs slender; posterior femora attaining elytral apices; middle and hind femora acutely spined internally, spines longer than those of elytra. Abdomen minutely densely punctate, densely clothed with short appressed pubescence with a number of long suberect hairs interspersed; apex of last sternite subtruncate. Length, 20–26 mm.

Holotype male (California Academy of Sciences) from 5 MILES N. MAZATLAN, SINALOA, MEXICO, 1 July 1965, at black and white lights (J. A. and M. A. Chemsak, E. G. and J. M. Linsley). Eleven male paratypes same data; one male paratype, 27 June 1965; two male paratypes, 27 July 1964 (J. A. Chemsak and J. Powell); one male paratype from 8 miles S. Elota, Sinaloa, 2 July 1963 (F. D. Parker, L. A. Stange); and one male from 7 miles N. Mazatlan, 7 July 1962 (Sleeper, Anderson, Hardy, Somerby).

Paratypes will be deposited in the California Insect Survey, Berkeley;

California Academy of Sciences; University of California, Davis; Canadian National Collection, Ottawa; United States National Museum; British Museum (Natural History); and the collection of E. Sleeper.

This is one of the most distinctive species of *Eburia.* The usual lack of eburneous fasciae, the short, dense pubescence, and subserrate appearing antennae will readily separate it. One of the specimens in the type series has small basal and median fasciae and several have vague ones at the base only. The dorsal callosities of the pronotum are usually clothed with pubescence.

We take pleasure in dedicating this species to Juanita M. Linsley for her field assistance in various cerambycid projects.

Eburia powelli Chemsak and Linsley, new species

MALE.—Form slender, slightly tapering; integument pale reddish-brown, mandibles, genae, antennal scape partially, front margin of pronotum, pronotal calluses, stripes extending from outside of basal eburneous fasciae, apical halves of femora, apices of tarsal segments, and parts of sternum black; elytra with a usually single pair of slightly curved eburneous fasciae and a pair of contiguous fasciae on each side at middle, the outer slightly longer; pubescence very dense, short, appressed. Head with front deeply impressed, densely pubescent; median line moderately deep, not extending onto neck; vertex small, plane; antennal tubercles prominent, obtuse above; pubescence whitish, dense, appressed; antennae extending over two segments beyond elytral apices, basal segments shining, outer segments moderately densely clothed with very short, appressed pubescence, third segment longer than first, fourth shorter than third, fifth subequal to fourth, remaining segments gradually increasing in length, eleventh narrow, appendiculate. Pronotum slightly broader than long, sides with a short, rather blunt spine; disk densely, coarsely, irregularly punctate, black antemedian tubercles prominent; each side with glabrous callus slightly behind anterior margin; pubescence short, appressed, obscuring surface, sides with several long erect hairs; prosternum deeply impressed, rectangular areas at apical two-thirds coarsely deeply punctate, pubescence dense, appressed; procoxal process abruptly declivous, coxal cavities open behind; meso- and metasternum very finely punctate, densely pubescent, scent glands prominent at apex of metepisternum. Scutellum densely pubescent. Elytra about three times as long as broad; inner basal eburneous fasciae slightly curved, shorter than median ones, outside basal fasciae, if present, small and separated from inner pair; median fasciae contiguous, outer pair slightly longer; basal punctures moderately coarse, black areas behind median fasciae coarsely punctured; each side bicostate from base of median fasciae but not to apex; pubescence fine, appressed, obscuring surface, black spots before and behind median fasciae usually glabrous; apices spined at outer margin, spines short. Legs slender; hind femora extending to apex of elytra; middle and hind femora internally spinose, spines slightly longer than those of elytra. Abdomen densely clothed with recumbent pubescence, surface obscured; apex of last sternite broad, slightly emarginate. Length, 11–18 mm.

FEMALE.—Form similar. Antennae slightly longer than body. Abdomen with apex of last sternite narrower, emarginate. Length, 14–19 mm.

Holotype male, allotype (California Academy of Sciences) from 5 MILES N. MAZATLAN, SINALOA, MEXICO, 27 July 1964, at black and white lights (J. A. Chemsak, J. A. Powell). Paratypes as follows: 9 males, 12 females, same data, 28 July 1964 (Chemsak and Powell); 24 July 1964 (Chemsak, Powell, H. F. Howden); 30 July 1964 (W. C. McGuffin); 5 August 1964 (Chemsak, Powell, Howden); 11 August 1965 (G. H. Nelson). Additional paratypes: 2 males, 7 miles N. Mazatlan, 7 July 1962 (E. Sleeper, R. Anderson, A. Hardy, R. Somerby); 3 males, 3 females, Venedio (= Venedillo), Sinaloa, 27 June 1918, 5 July 1918, 10 July 1918, 27 July 1918 (Van Dyke Collection); 1 male, 40 miles N. Mazatlan, 27 July 1952 (J. D. Lattin); 1 female, 26 miles N. Pericos, Sinaloa, 13 August 1960; 1 female, 34 miles N. Los Mochis, Sinaloa, 27 August 1963 (F. D. Parker, L. A. Stange); 1 female, 6 miles S. Culiacan, Sinaloa, 6 August 1964 (Chemsak and Powell); 1 female, Minas Neuvas, Sonora, 7 August 1952 (C. & P. Vaurie); 1 female, Rio Cuchuhaqui, 7 miles S. Alamos, Sonora, 25 July–7 August 1953 (F. S. Truxal).

Paratypes are deposited in the collections of the California Insect Survey, Berkeley; Canadian National Collection, Ottawa; California Academy of Sciences; American Museum of Natural History; United States National Museum; British Museum (Natural History); Los Angeles County Museum; G. H. Nelson; and E. Sleeper.

This species resembles *E. aegrota* Bates but the two may be separated by the darker color, shorter femoral spines, longer and coarser elytral pubescence and by differences of the eburneous fasciae of *E. powelli.* The inner basal pair of fasciae of *E. aegrota* are reduced or lacking while *E. powelli* has the outer pair usually missing.

This species is named for J. A. Powell in appreciation for his cerambycid collecting efforts.

Eburia sinaloae Chemsak and Linsley, new species

MALE.—Form moderate-sized, subparallel; integument pale reddish-brown, mouthparts, pronotal calluses, apices of antennal segments, areas surrounding eburneous fasciae, parts of coxae, and tips of femora darker; each elytron with a pair of short, separated, eburneous fasciae at base and a median, narrowly separated pair at middle, outer significantly longer than inner; pubescence pale, short, appressed, obscuring surface. Head with front small, median triangular area deeply impressed, median line fairly shallow, extending from vertex to impressed glabrous spot; vertex small, with glabrous shallow carina extending from median spot onto neck; antennal tubercles small, obtuse above; pubescence short, dense, recumbent, mandibles and labrum with long stout setae; antennae extending about five segments beyond body, scape short, stout, segments rather densely clothed with very short recumbent pubescence, segments three to five with dense fringe of suberect hairs along inner margin, third segment about twice as long as first, segments four to seven subequal to third, eight to ten slightly shorter, eleventh very long, appendiculate. Pronotum inflated, much broader than long, sides with small obtuse tubercle; disk with two prominent, glabrous antemedian calluses, two flattened glabrous calluses also present at sides, one behind apical margin and another at lateral tubercle, irregular large callus present at center behind middle and each side with longitudinal swellings extending from base to antemedian calluses; surface coarsely, irregularly punctate; pubescence dense, recumbent, sides with some long erect hairs interspersed; prosternum shallowly impressed, densely, deeply punctate except for basal one-fourth, pubescence dense; procoxal process abruptly declivous, coxal cavities open behind; meso- and metasternum densely, minutely punctate, densely pubescent, metepisternal scent gland prominent. Scutellum moderately densely pubescent. Elytra over twice as long as broad; basal eburneous fasciae short, separated, subequal in length, median pair separated, outer pair much longer; punctures fine, irregular, asperulate with larger asperites bearing erect setae interspersed throughout; pubescence fine, recumbent, partially obscuring surface; apices bispinose, spines short, subequal in length. Legs slender; posterior femora extending beyond apices of elytra; middle femora with a short broad tooth internally, hind femora with subequal short broad teeth at apices. Abdomen densely pubescent; apex of last sternite emarginate. Length, 13–21 mm.

Holotype male, allotype (California Academy of Sciences) from 5 MILES N. MAZATLAN, SINALOA, MEXICO, 5 August 1964, at black and white lights (J. A. Chemsak, J. Powell). Paratypes as follows: 18 males, 24 females, same data, 5 August 1965 (Chemsak and Powell); 27 July 1964 (Chemsak, Powell, H. F. Howden); 28 July 1964 (Chemsak and Powell); 24 July 1964 (Chemsak, Powell, Howden); 27 June 1965 (J. A. and M. A. Chemsak, E. G. and J. M. Linsley); 1 July 1965 (Chemsaks and Linsleys). Additional paratypes: 1 male, 10 miles S. Mazatlan, 3 July 1965 (Chemsaks and Linsleys); 2 males, 1 female, 7 miles N. Mazatlan, 7 July 1962 (E. Sleeper, R. Anderson, A. Hardy, R. Somerby); 2 males, Mazatlan, 27 June 1962 (A. E. Michelbacher); 1 male, Mazatlan, 20 July 1960 (R. B. Loomis, J. Maris).

Paratypes are deposited in the collections of: California Insect Survey, Berkeley; Canadian National Collection, Ottawa; California Academy of Sciences; United States National Museum; British Museum (Natural History); and E. Sleeper.

This species is closely related to *E. brevispinus* Bates but differs by the lack of prominent spines on the middle and hind femora and the much finer pubescence of the elytra. Additionally *E. sinaloae* has very distinct seta-bearing asperate punctures on the elytra.

The type series is rather uniform except for the obvious size differences. The integumental color is paler in some individuals and there is some variation in the size of the eburneous fasciae.

Eburodacrys hesperidis Chemsak and Linsley, new species

MALE.—Form moderate sized, elongate, parallel-sided; integument shining, testaceous, head, pronotum and antennae basally more orangish, tips of mandibles and genae, eyes, three dorsal and two lateral pronotal spots, areas around eburneous fasciae, tips of femora, and some sternites black; each elytron with single short, basal eburneous fascia and narrowly separated median pair, the outer below the inner. Head with front deeply impressed, median line deep, extending only onto vertex; vertex small, coarsely, irregularly, rugosely punctate; antennal tubercles moderate, obtuse above; pubescence sparse, short, depressed with few erect setae on mandibles, labrum and frons; antennae extending about four segments beyond body, basal segments shining, segments from apex of fourth moderately densely clothed with very short pubescence, long erect hairs dense along inner margin of third segment, hairs gradually diminishing in number to seventh segment, third segment with few long hairs at apices, these gradually decreasing in length, third segment much longer than first, fourth shorter than third, fifth slightly longer than fourth, segments six to eight subequal to fifth, nine and ten shorter, eleventh longest, appendiculate. Pronotum as broad as long, sides obtusely tuberculate; disk with two prominent antemedian glabrous calluses and an elongate glabrous median callus extending beyond middle; surface around tubercles coarsely transversely wrinkled; pubescence sparse, mostly long and erect; prosternum moderately impressed, transversely rugose, pubescence sparse, procoxal process abruptly declivous, coxal cavities wide open behind; meso- and metasternum shining, mod- episternal scent gland distinct. Scutellum glabrous. Elytra about 2½ times as erately coarsely punctate at middle, sides minutely punctate, subopaque; met- long as broad; eburneous fasciae usually surrounded by black markings, outer median pair longer than inner, both longer than basal pair; each elytron with four costae, middle pair extending along eburneous fasciae; basal punctures coarse, subconfluent, punctures becoming obsolete toward apex; pubescence sparse, short, with numerous long erect setae interspersed along sutural one-half; apices spinose at outer margins, inner margins dentate, outer spines short. Legs slender; hind femora extending beyond apices of elytra; middle and hind femora internally spinose, spines long and subequal in length. Abdomen sparsely pubescent; apex of last sternite emarginate. Length, 15–20 mm.

FEMALE.—Form similar. Antennae about as long as body. Abdomen with apex of last sternite subtruncate. Length, 17–20 mm.

Holotype male, allotype (California Academy of Sciences) from 5 MILES N. MAZATLAN, SINALOA, MEXICO, 1 July 1965 (J. A. and M. A. Chemsak, E. G. and J. M. Linsley). Five paratypes (3 males, 2 females) same data (one female on 27 June 1965).

Paratypes are deposited in the California Insect Survey, Berkeley and the British Museum (Natural History).

Eburodacrys sticticollis Bates appears to be closely related to this species. *Eburodacrys hesperidis* differs by the smooth median callus of the pronotum, smaller and thinner eburneous fasciae, and by the more densely punctate basal area of the elytra.

The type series is fairly uniform in color and structure except for the small lateral pronotal tubercles of the type. The other six specimens have longer, more acute tubercles.

Death-Feigning among North American Cerambycidae
(Coleoptera)

JOHN A. CHEMSAK AND E. G. LINSLEY
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In reviewing the literature on North American Cerambycidae we have encountered very few accounts of "death-feigning." Townsend (1884) reported that the adult of the diurnal *Mecas inornata* (Say) takes wing and flies away when it observes someone approaching, but drops to the ground and feigns death when unexpectedly disturbed, and Frost (1916) states that *Physocnemum brevilineum* (Say) also drops when disturbed.

The most informative account of "death-feigning"' among North American Cerambycidae of which we are aware is that of Vogt (1949), with reference to the flightless cactus-feeding lamiine *Moneilema ulkei* LeConte. He reported that on numerous occasions this species was found to feign death with the appendages arranged in a curious and characteristic manner as follows: Antennae extended forward, hind legs outstretched and directed partially backwards, middle legs directed straight backward between the hind legs, and the front legs outstretched anteriorly. He further commented that two similarly flightless cactus-feeding lamiines which occur in the same general area of the lower Rio Grande Valley of Texas, *Moneilema armatum* LeConte and *Parmenosoma griseum* Schaeffer "were observed never to latisimulate in such a manner."

In view of Vogt's account, it may be of interest to report the attitude assumed by two species of nocturnal cerambycines, *Eburia ulkei* Horn and *Eburia juanitae* Chemsak & Linsley when disturbed after being attracted to light near Mazatlan, Sinaloa, Mexico. Although both species assume rigid positions when disturbed and will remain rigid when laid on their backs, sides, or ventral surface, in light or in darkness, even when placed in the intense heat range of a gasoline lantern, the two sexes of *Eburia ulkei* were by far the most persistent in maintaining their rigid positions.

THE PAN-PACIFIC ENTOMOLOGIST 46: 305–307. October 1970

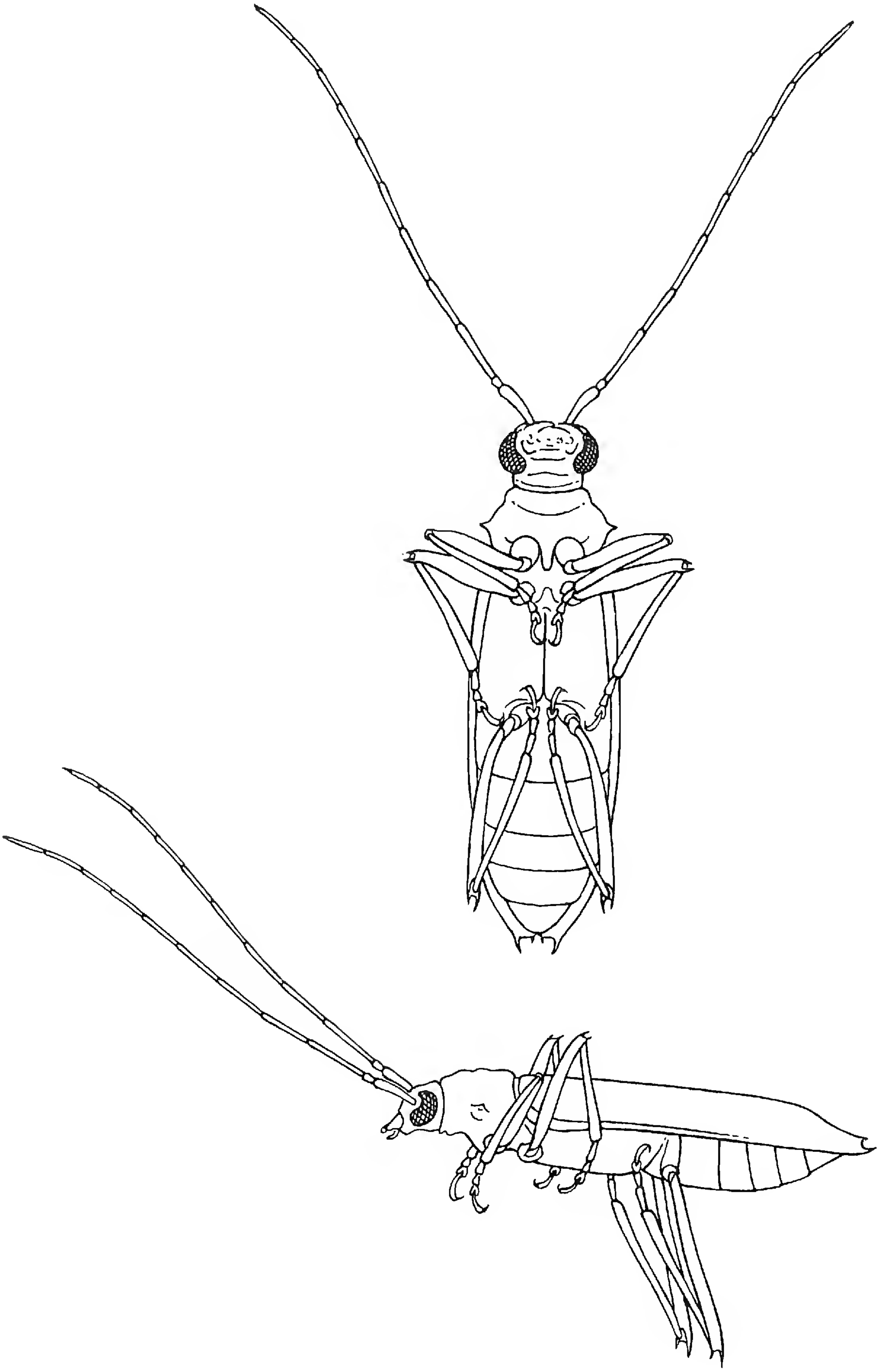

FIG. 1. Ventral and lateral views of female *Eburia ulkei* Horn showing positions of appendages during "death-feigning."

The typical position assumed by *Eburia ulkei* (Fig. 1) involved extending the antennae at an angle so that each was separate, pulling the front legs in close to the body with the femoral spine exposed and lowering the posterior femora exposing the paired apical spines. With the posterior part of the body protected by the terminal spines of the elytra, the anterior portion by lateral thoracic spines, and the antennae separated in a manner that would leave one expendable, if necessary, we conclude that death-feigning by this dark colored cerambycid would not only render it inconspicuous among the debris of the forest floor but would find it utilizing to the fullest its defensive structures. Further, when picked up before feigning death, both males and females emit a loud "squeaking" sound.

In a series of tests, involving numerous males and females, "death-feigning" was maintained for periods twenty minutes to more than two hours in darkness, for shorter periods in the light on the white collecting sheet. While rigid, individuals of both sexes could be picked up by the fourth or fifth segment of one antenna and held horizontally.

Although more than fifty species of cerambycids were attracted to the light, including the closely related *Eburia powelli* Chemsak and Linsley, *E. sinaloae* Chemsak and Linsley, *E. aegrota* Bates, *E. nigrovittata* Bates, *Eburodacrys callixantha* Bates, and *E. hesperidis* Chemsak and Linsley, death-feigning could be induced in none but these two species. Additionally, this behavior has not been observed in other cerambycines, such as *Aneflus, Aneflomorpha, Cacophrissus, Gnaphalodes, Elaphidion, Achryson, Eustromula,* and several Ibidionini.

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FROST, C. A. 1916. Collecting Coleoptera in a Maine sawmill yard. Can. Entomol., 48: 381–390.

TOWNSEND, C. H. T. 1884. Notes on some Coleoptera taken in South Louisiana. Psyche, 4: 219–222.

VOGT, E. B. 1949. Notes on Cerambycidae from the Lower Rio Grande Valley, Texas. Pan-Pac. Entomol., 25: 137–144, 175–184.

Obituary Notice

John Winslow MacSwain, a past President of the Society, died in Berkeley on 9 September 1970. Dr. MacSwain, teacher and biologist, was well known for his systematic studies on bees and first instar larvae of meloid beetles and his studies on the ecology and pollination relationships of bees. He was Professor of Entomology at the University of California, Berkeley, until his retirement in June 1970.

Notice of Dues Change

Due to increased costs of publication of the Pan-Pacific Entomologist, the Executive Board of the Pacific Coast Entomological Society has voted to increase the dues and subscription rates for the journal. Annual dues for regular members will be $7.50, those for student members will be $5.00. Members in each category will receive the journal. Subscriptions to the journal for non-members will be $10.00 per year. These new rates will go into effect beginning with volume 47, number 1, January 1971.

MAILING DATES FOR VOLUME 46

No. 1	19 March 1970
No. 2	29 May 1970
No. 3	10 August 1970
No. 4	12 November 1970

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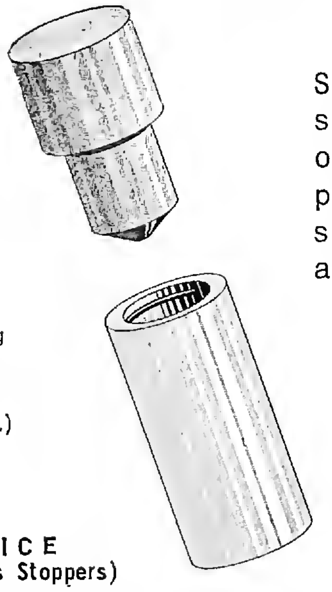

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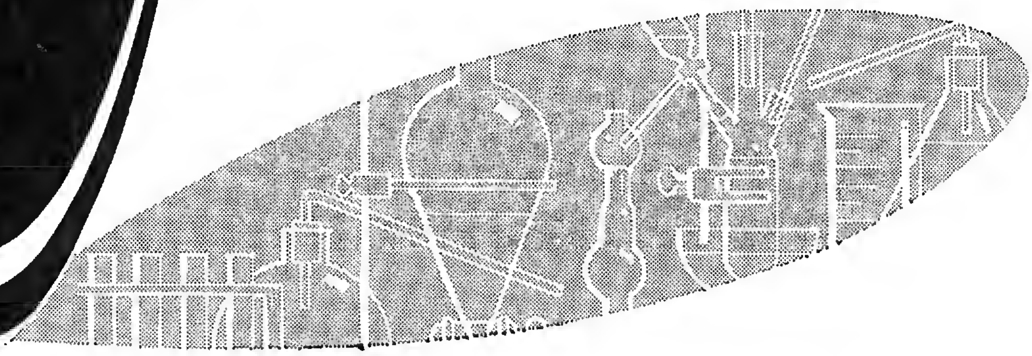

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