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A Review of the Genus *Arhaphe* Herrich-Schäffer
(Hemiptera: Largidae)

Thomas F. Halstead
Arizona Commission of Agriculture and Horticulture, Phoenix 85005

Herrich-Schaffer originally described the genus from "Carolina" in the form of *Arhaphe carolina.* In 1873 Walker described *A. cicindeloides* from Mexico; and in 1911 Barber united *Japetus* Distant with *Araphe* (apparently following Uhler's 1872 misspelling of the generic name) and described *A. mimetica,* thus including *J. sphaerodes* in *Araphe.* In 1924 Barber described *A. breviata* from Kansas and again separated *Japetus* from *Arhaphe,* including *J. sphaerodes* Distant and *J. mimeticus.* In 1956 Bliven added *Jarhaphetus argutus.* This paper again unites the two genera, places *Jarhaphetus* Bliven as a synonym of *Arhaphe,* and describes two new species.

The set of characteristics which sets this genus apart from other Largidae is the combination of the absence of any pronotal or thoracic spination and the possession of a stridulatory apparatus consisting of ridges or corrugations along the edge of the corium with accompanying rasp on hind femora.

Arhaphe Herrich-Schaffer

Arhaphe Herrich-Schaffer, 1850: IX: 175 and 183.
Araphe, Uhler, in Hayden, 1872: 471.
Japetus Distant, 1883: 227; Barber, 1924: 227.
Arrhaphe, Bergroth, 1913: 166.
Jarhaphetus Bliven, 1956: 10. (New Synonymy).

Key to Species of Arhaphe

1. Head and prothorax coarsely punctate 2
   Head impunctate (prothorax impunctate except in *A. capitata*) 4
2. Membrane white with central black spot .... *mexicana* Halstead, n. sp.
   membrane with base white and tip apparently black 3
3. Entire corium brick-red .... *sphaerodes* Distant
   Corium yellow to white with medial black fascia .... *carolina* Herrich-Schaffer
4. Membrane very much reduced, if present at all represented only by narrow band 5
   Membrane entire 6

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5. Row of puncta along claval suture entirely immersed in black band; posterior femora almost reaching abdominal apex .... *cicindeloides* Walker
Row of puncta along claval suture black, each surrounded by white of corium; posterior femora not extending beyond fourth abdominal segment .... *breviata* Barber
6. Head level between and behind eyes .... *mimetica* Barber
Head rising to an elevated knob between and behind eyes .... *capitata* Halstead, n. sp.

ARHAPHE CAROLINA Herrich-Schaffer

Arhaphe carolina Herrich-Schaffer, 1850: IX: 183, tab. 315, fig. 968.
Araphe carolina Barber, 1911: 28.

DIAGNOSIS.—Known from North Carolina south to Florida, thence west through Tennessee to Arizona and Baja California. Cited from "Mexico" by Stal (1870). Easily distinguished from other punctate forms by coloration of corium and by characters in key. Length 7–10 mm.

ARHAPHE CICINDELOIDES Walker

Arhaphe cicindeloides Walker, 1873: VI: 36.
Jarhaphetus argutus Bliven, 1956: 10. (New Synonymy).

DIAGNOSIS.—Known from Arizona and New Mexico, thence south into Mexico at least as far as Sinaloa. Large and black, elongate oval, head and prothorax impunctate, variously pubescent. Corium white with central broad black fascia from side to side. Anterior femora armed with single more or less obvious tooth near apex. Head as broad as or broader than pronotum. Length 9–12 mm. Bliven's description and photograph of *Jarhaphetus argutus* clearly match *A. cicindeloides*. Barber is the only one to mention or use the femoral tooth as a character in separation of the genera, and he must have had individuals of *A. cicindeloides* in which the spines were very small to have missed them. Bliven based his new genus and species on presence of the spine and width of the head, both very variable in this species.

ARHAPHE SPHAERODES (Distant)

Japetus sphaerodes Distant, 1883: 227; Barber, 1924: 227.
Araphe sphaerodes Barber, 1911: 28.

DIAGNOSIS.—The following description of the unique type deposited in the British Museum (Natural History) by Distant was kindly furnished by Mr. W. R. Dolling of that institution: Entirely black except hemelytra. Thorax, abdomen and legs fine silvery recumbent pubescent.

Head, thorax and femora fine sparse erect pubescent. Head shining, coarsely reticulate sculptured. Many interstices of sculpturing bearing single large punctures, each separated from its neighbors by two-thirds to one and one-half times its own width. Hemelytra reaching about 9/16 the distance from pronotal posterior to abdominal apex. Corium entirely and uniformly clear brick-red. Angle of clavus between pronotum and scutellum infuscate, sharply marked off from rest of clavus, clavus concolorous with corium except at its inner edge, where fuscus color runs along innermost line of punctures and fades out just beyond scutellar apex. Basal third of each membrane ivory white; apical two-thirds dark brown. A narrow ivory band borders apical margin; but resulting diamond-shaped spot appears as dark apex, not dark mark in middle, as apical marginal band very narrow. Ratio of antennal segments 45:35:22:50 (basal first, arbitrary units). Basal segment of posterior tarsus accounting for three-fifths of its length. Ratio of head width (across eyes) to anterior thoracic lobe to posterior thoracic lobe 33:23:26½ (different units than above). Rostrum just surpassing anterior coxae. Length 9 mm.

TYPE.—S. Geronimo, Guatemala, Champion.

ARHAPHE MIMETICA (Barber)

Araphe mimetica Barber, 1911: 28.
Japetus mimeticus Barber, 1924: 227. New Synonymy.

DIAGNOSIS.—Known from the Huachuca, Santa Rita and Atascosa Mountains of southern Arizona, but very probably more widespread into south and east. Encountered in oak leaf litter in numbers at Madera Canyon, Arizona, in August. Well differentiated from other species by characters in key. Length 6–8 mm.

ARHAPHE BREVIATA Barber

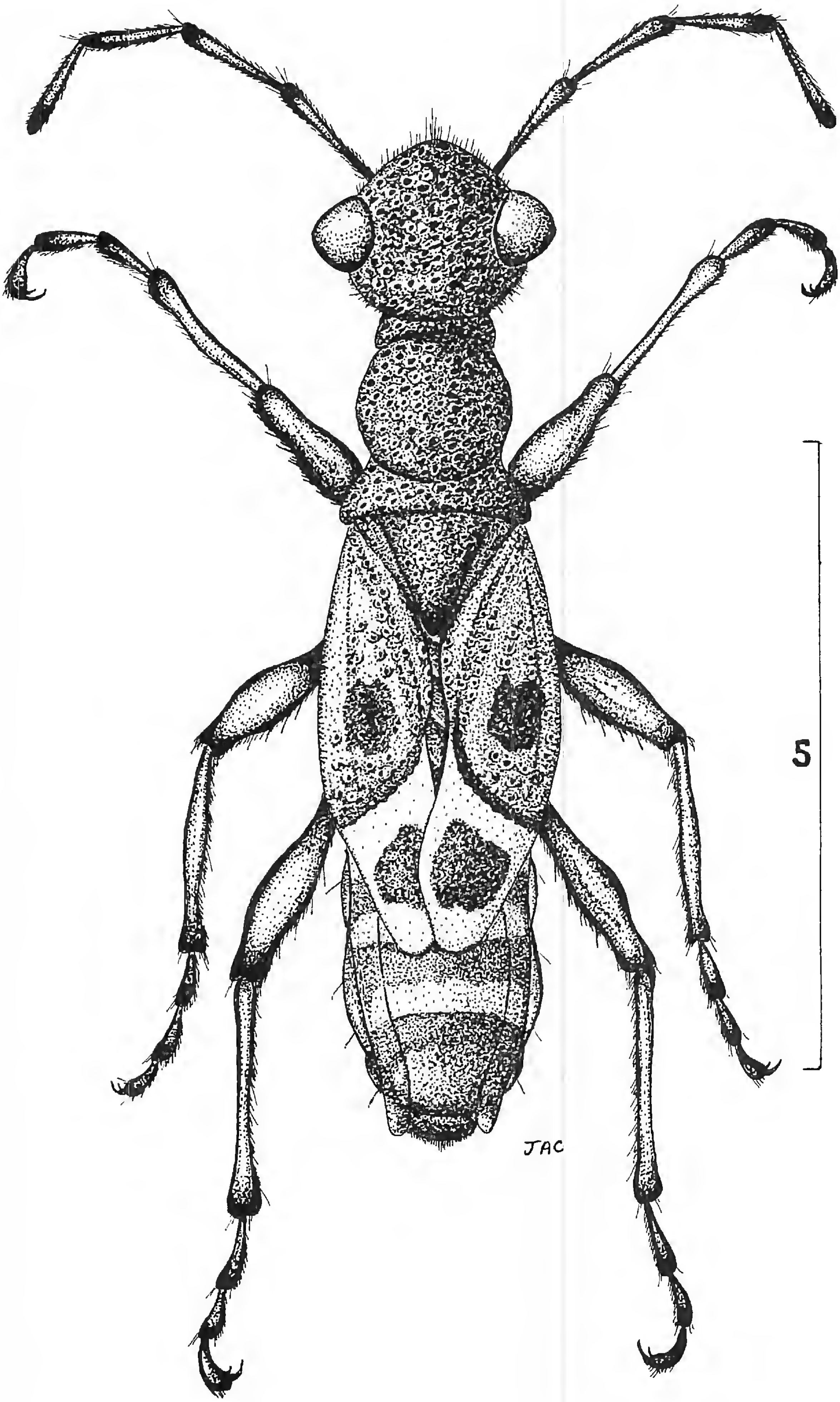
Arhaphe breviata Barber, 1924: 227.

DIAGNOSIS.—Known only from Kansas. Well differentiated from *A. carolina* by absence of head and anterior pronotal punctation and from *A. cicindeloides* by characters in key. Length 7.3–8.25 mm.

Arhaphe mexicana Halstead, new species

(Fig. 1)

DIAGNOSIS.—Known from two male specimens taken near Cuernavaca, Morelos, Mexico. Very distinct from *A. sphaerodes*, the most similar species in genus.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Length of holotype male 8.3 mm (paratype 8.3 mm), width across head (including eyes) 1.9 mm (paratype 1.9 mm), ratio of head to anterior thoracic lobe to posterior thoracic lobe 24:17:21. Width across corium 1.7 mm (paratype 1.7 mm).

MALE.—Linear elongate, black. Head, entire thorax and scutellum coarsely punctate. Corial margins with line of punctures; scattered punctation on remainder. Clavus with marginal lines of puncta; diagonal line of puncta from mid-anterior margin to apex. Anterior femora armed with minute spine near apex. Entire body except corium covered with fine closely appressed silver tomentum, this absent on large circular patches of sides of third through sixth ventral segments and anterior margins of abdominal dorsal segments, appearing as black spots on silver background. Head and thorax sparsely covered with long black hairs. Corium pale orange with black line along apex and circular black spot in middle. Clavus pale orange with black triangle, wider at base and fading out to apex, along its inner margin. Rostrum reaching just beyond anterior coxae. Antennal ratio 27:23:15:31 (basal first, different units than above), reaching somewhat beyond pronotal posterior, first segment somewhat curved.

FEMALE.—Unknown.

Holotype male, 3–6 MI. S. CUERNAVACA, MORELOS, MEXICO. 1 April 1959. 4,000 ft. H. E. Evans (Cornell type number 4609).

PARATYPE MALE.—Cuernavaca, Morelos, Mexico. 17 March 1959. 5,000 ft. H. E. Evans and D. M. Anderson collectors. Deposited in the author's collection.

Arhaphe capitata Halstead, new species

DIAGNOSIS.—Known from two male specimens taken in Morelos, Mexico. Similar in appearance to *A. mimetica* but differing by scattered punctation on pronotal anterior, elevated knob between and behind eyes, and hemelytral membrane surpassing abdominal apex.

Length of holotype male 6.67 mm (paratype 6.9 mm). Width across head (including eyes) 1.9 mm (paratype 1.9 mm). Ratio of head to anterior thoracic lobe to posterior thoracic lobe 22:17:23. Width across corium 1.9 mm.

MALE.—Elongate, black. Head shining black, impunctate, with rather sparse short fine white pubescence on sides and front, with rounded knob between and behind eyes. Collar and prothoracic anterior black, sides sparingly punctate, silvery pubescent. Prothoracic posterior velvety black, coarsely punctate, without pubescence. Scutellum black, silvery pubescent, coarsely punctate. Ventrum black except white posterior margin of metathorax, silvery pubescent, shining. Clavus black, with three lines of punctation running from base to apex along margins and in middle. Femora armed with minute spine. Corium white, with transverse broad black fascia from side to side, row of black puncta along calaval suture,

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FIG. 1. *Arhaphe mexicana* Halstead, n. sp.

otherwise heavily punctate. Membrane white with very large central black or dark brown circular spot; surpassing abdominal apex. Rostrum reaching halfway to mesocoxae. Antennae slender, fourth segment brown; lighter in color than others. Antennal ratio 27:25:17:30 (basal first, different units than above), first segment strongly curved.

FEMALE.—Unknown.

Holotype male, HUAJINTLAN, MORELOS, MEXICO. 14 May 1959. 2,500 ft. H. E. Evans (Cornell type number 4610).

PARATYPE MALE.—Same data, deposited in the author's collection.

DISCUSSION.—In 1911 Barber described *A. mimetica* and placed Distant's *Japetus* as a synonym of *Arhaphe.* In 1924 he re-erected *Japetus*, including *J. sphaerodes* and *J. mimetica.* He separated *Japetus* as follows, "Head more globose, as long as but considerably wider than pronotum; membrane less abbreviated; body and legs without profuse coating of long setae, almost nude; posterior lobe of pronotum not at all or very sparsely tomentose; anterior femora armed with a single small tooth near apex; rostrum short." If an attempt is made to separate specimens on this basis, one immediately runs into many incongruities. *Arhaphe mexicana*, closest relative to *A. sphaerodes*, has a very heavily tomentose posterior pronotal lobe and long setae on the legs and body. *Arhaphe cicindeloides* does have anterior femoral spines, and the head width is variable. The rostrum of the species apparently falling into *Japetus* is shorter, usually only attaining the anterior coxae; but that of *A. capitata* almost reaches the mesocoxae. The head of *A. mexicana* is very flattened, that of *A. mimetica* less so, and that of *A. capitata* even less—approaching *A. cicindeloides* in globosity. In addition, I have a single as yet undescribed Mexican specimen of *Arhaphe* closely resembling *A. cicindeloides*, but possessing hemelytra complete with a fully developed membrane which surpasses the abdominal apex. Attempts to separate specimens by use of a length-to-width ratio result in some males of *A. carolina* being placed with *Japetus.* I have examined slide mounts of the parameres of *A. carolina, A. cicindeloides, A. mimetica, A. mexicana,* and *A. capitata* and can find little of use in specific, let alone generic, differentiation. These very similar parameres do show a uniform variation from those of *Largus* and *Stenomacra* species examined. From the above data it becomes clear that separation cannot reasonably be continued, and members of this homogeneous group must be placed in a single genus.

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I wish to thank Dr. R. C. Froeschner, Mr. H. B. Leech, Dr. L. L. Pechuman, and Dr. F. G. Werner for the loan of specimens; Mr. W. R.

Dolling of the British Museum (Natural History) for examining the type of *A. sphaerodes* and sending me a description of that specimen; Mr. J. A. Childers for the fine illustration; and my wife for typing the manuscript.

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Resurrection of *Sepedon pacifica* Cresson and Redescription of *Sepedon praemiosa* Giglio-Tos with Biological Notes

(Diptera: Sciomyzidae)

T. W. FISHER AND R. E. ORTH[1]

Division of Biological Control, University of California, Riverside, 92502

Giglio-Tos (1893) based the original description of *Sepedon praemiosa* on a single male from Morelia, Mexico, and later (1896) elaborated on the description of the type. Neither verbal treatment is adequate to distinguish *S. praemiosa* from similar species. The type specimen is believed to be in the museum of the University, Turin, Italy. However, unanswered correspondence makes confirmation impossible.

Cresson (1914) described *S. pacifica* from a male collected in Marin Co., coastal central California. We have examined this specimen. Its color is somewhat faded, but the terminalia agrees with our concept of this taxon. Interestingly, Melander (1920) accepted Cresson's designation of *S. pacifica*. Apparently both workers were aware of *S. praemiosa* only from the catalogue by Aldrich (1905), and assumed from the type locality that it was a different species. It is doubtful that either worker had seen the Giglio-Tos type, and they, therefore, considered *S. pacifica* a distinct species. It is fortuitous that all of the localities listed by Cresson and Melander fell within the area of distribution we now ascribe only to *S. pacifica*.

Steyskal (1950) placed *Sepedon relictus* van der Wulp (v. d. Wulp, 1897) and *S. pacifica* Cresson (Cresson, 1914) in synonymy with *S. praemiosa*. Through the courtesy of K. G. V. Smith, British Museum of Natural History, we have examined the van der Wulp type specimen which is a female (not a male as recorded in Biologia Centrali-Americana) and have compared it with a number of females of *S. praemiosa* taken at various localities from Oaxaca, Mexico, to Colorado, U. S. A. and cannot assign it to *S. praemiosa*. We recommend that *S. relictus* van der Wulp be removed from synonymy. The *S. relictus* type fits very well the description of *S. haplobasis* Steyskal (Steyskal, 1960), and we suspect that it is conspecific with that species. However, at this writing (6 October 1971, revision of the original manuscript) specimens of *S. haplobasis* are not at hand for comparison.

Although neither Steyskal nor we have seen the *S. praemiosa* type

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[1] Specialist and Staff Research Associate, respectively, Department of Entomology, Division of Biological Control, University of California, Riverside, California 92502.

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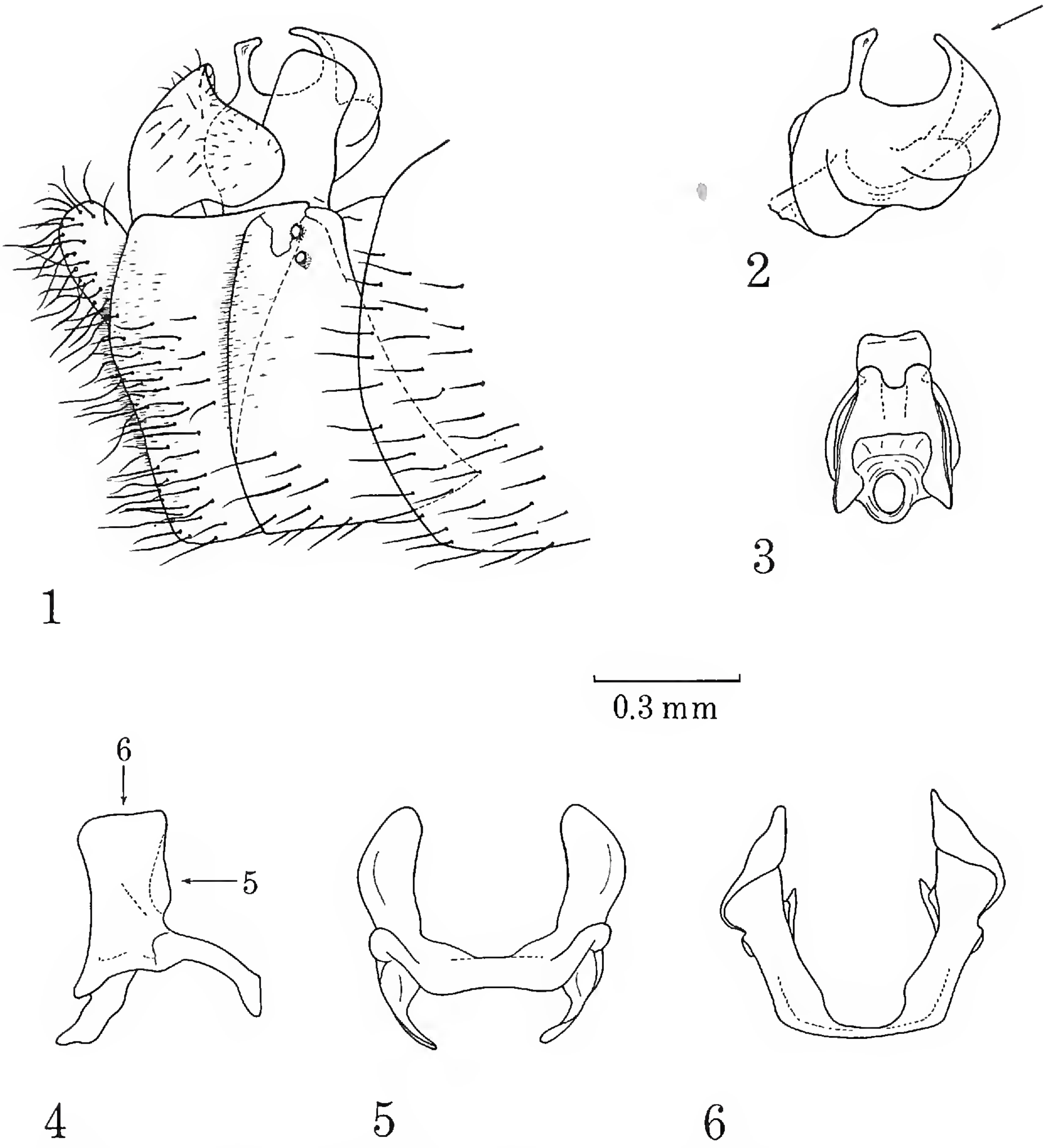
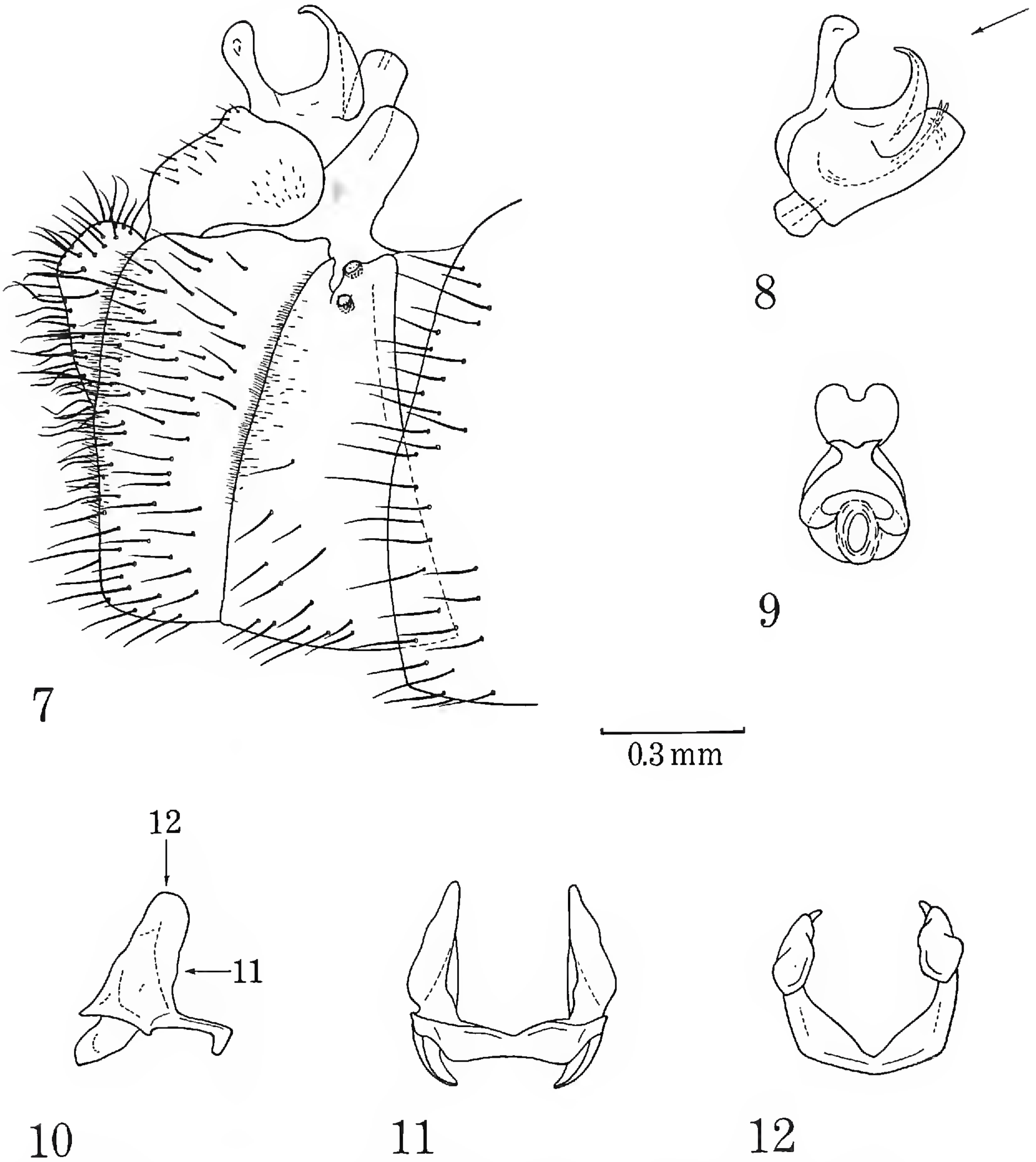


FIGS. 1–6. *Sepedon praemiosa* Giglio-Tos, U.S.A., Colorado, Fremont Co., 20 Aug. 1959 (N. Marston). Wing length of this specimen, 7.0 mm. FIG. 1. Terminalia, sinistral view, inverted. FIG. 2. Aedeagus, sinistral view. FIG. 3. Aedeagus, oblique anterior view from direction of arrow in Fig. 2. FIG. 4. Hypandrium, sinistral view, inverted. FIGS. 5–6. Hypandrium viewed from directions of arrows in Fig. 4.

specimen, examination of a rather large amount of material from western North America, including specimens from Morelia, which we designate as topotypes of *S. praemiosa*, persuade us that the appelation is correct.

We became aware of two forms of *S. praemiosa* in 1966, and since have had at hand over 4,000 specimens which we assign to the taxon *S. pacifica* and 267 specimens to *S. praemiosa*. Both are clearly separated by differences in distribution and in the morphology of primary



FIGS. 7–12. *Sepedon pacifica* Cresson, U.S.A., Colorado, Ft. Collins, 16 April 1958 (N. Marston). Wing length of this specimen 8.3 mm. FIG. 7. Terminalia, sinistral view, inverted. FIG. 8. Aedeagus, sinistral view. FIG. 9. Aedeagus, oblique anterior view from direction of arrow in Fig. 8. FIG. 10. Hypandrium, sinistral view, inverted. FIGS. 11 and 12. Hypandrium viewed from directions of arrows in Fig. 10.

and secondary sexual structures of the males. Although the specimen drawn by Steyskal (1950, fig. 13) and labelled *S. praemiosa* cannot now be located, that illustration agrees well with our concept of *S. pacifica.*

Other than the material collected by us during the survey phase of California Experiment Station Project No. 2037, "Biological Control of Non-marine Mollusks," material was kindly provided by C. O. Berg

(Cornell University), N. Marston (Kansas State University), L. V. Knutson and G. C. Steyskal (Systematic Entomology Laboratory, USDA), P. H. Arnaud (California Academy of Sciences), W. F. Barr (University of Idaho), and entomological collections of Illinois Natural History Survey, Oregon State Department of Agriculture, South Dakota State University, Texas A. & M., University of Minnesota, University of Wisconsin, and the University of California at Berkeley, Davis, and Riverside. Material from S. S. Roback (Academy of Natural Sciences, Philadelphia) included the type of *S. pacifica* Cresson.

Comparison of *S. pacifica* and *S. praemiosa* reveals consistent differences in primary and secondary genitalic structures in the males (Figs. 1–12). With the genitalia extruded—as with fresh material, or with dried material after light boiling in 10% KOH—the lateral and oblique anterior aspects of the aedeagus are diagnostic (Figs. 2, 3, 8, 9).

In general *S. pacifica* appears to be a larger and darker species than *S. praemiosa.* The relative sizes of the sexes are also different. In *S. praemiosa* the males are smaller than the females, but the reverse occurs in *S. pacifica.* However, in proportion to their size, the male genitalic structures of *S. praemiosa* are larger than those of *S. pacifica.* This size relationship is illustrated by comparing the terminalia and especially the hypandria of the two species (Figs. 4, 5, 6, 10, 11, 12—all drawn to the same scale).

NEALLOTYPE, S. PACIFICA.—female, ½ mi. w. Valley Ford, Sonoma County, California, 100 ft., 13 June 1966, AS-485 (T. W. Fisher & R. E. Orth), plus 20 California specimens were deposited in the Academy of Natural Sciences, Philadelphia. In addition 20 California specimens were deposited at the United States National Museum.

TOPOTYPES, S. PRAEMIOSA.—1 ♀, 2 ♂, 8 mi. e. Morelia, Michoacan, Mexico, 1 May 1953 (R. C. Bechtel & E. I. Schlinger). Specimens were collected in sweep nets while sampling the edge of a bean and squash field which was adjoined by a swampy river and marsh. 1 ♀, 1 ♂ plus 10 additional specimens deposited in United States National Museum. 1 ♂ topotype plus 10 specimens to the University of California at Berkeley.

VARIATION.—Unlike most specimens seen, certain specimens from several localized populations of *S. pacifica* in northern California, Oregon, Washington, and Idaho possess prominent black parafrontal spots. [We have also seen this variation in occasional specimens of *S. fuscipennis* from Oregon, Washington, Idaho, and New Mexico.]

The ability to separate *S. praemiosa* from *S. pacifica* on genitalic characteristics has made it possible to reevaluate certain superficial characters to the degree that such characters now assume a diagnostic role of some importance. One such character pertains to the facies. In *S. praemiosa* the color of the facies is much lighter, almost yellowish, when compared to the darker, brownish face of *S. pacifica.* All the *S. pacifica* we have seen have from few to many fine hairs on the medifacies, but approximately 25% of the specimens of *S. praemiosa* we have seen from several localities have no hairs on the medifacies.

Localities where barefaced *S. praemiosa* were collected include: *Mexico.*—Durango (Durango); Michoacan (Morelia). *U.S.A.*—Arizona (Lake Mary nr. Flagstaff); Colorado (Las Animas and Walsenburg); Nebraska (North Platte); New Mexico (Las Cruces, Bob Crosby Draw).

Because of the occurrence of a rather large percentage of barefaced *S. praemiosa,* it now seems advisable to utilize a key character other than "medifacies with fine black (scattered) hairs" to lead to this species, or if key characters currently in use are perpetuated, mention should be made of the rather common occurrence of glabrous medifacies in *S. praemiosa* in the same couplet wherein hairy medifacies are referred to. In similar context, parafrontal spots become of questionable value as primary criteria to separate species of *Sepedon.*

The following key is adapted from Steyskal 1950, with particular emphasis on robust species. The wing length is measured from the basal fracture line. The stated measurements represent the extremes as based on the specimens at hand. The means fall well within the extremes which constitute a very small percentage of total numbers examined. In most species females are larger than males. *S. pacifica* occasionally overlaps the size range of *S. praemiosa,* but since the two do not overlap in distribution to our knowledge, size alone will not be a critical determinative factor. Determination of material from areas of known or potential overlap should be based primarily on proper examination of male genitalia.

In the area covered by our key taxa currently included in the *armipes* group are *S. anchista* Steyskal, *S. armipes* Loew, *S. bifida* Steyskal, *S. capellei* Fisher and Orth, *S. haplobasis* Steyskal, *S. melanderi* Steyskal, and *S. pseudarmipes* Fisher and Orth. *Sepedon haplobasis* Steyskal is reported only from Mexico, D. F.; male hind femur notched, wing length 4.6 to 5.5 mm, females 5.1 to 5.9 mm. The *pusilla* group consists of *S. borealis* Steyskal, *S. lignator* Steyskal, *S. neili* Steyskal, and *S. pusilla* Loew. *Sepedon guatemalana* Steyskal was reported by Neff and Berg (1966, p. 41) from Las Cruces, Chiapas, Mexico, approximately 17° latitude, and thus is the most northern taxon known of the *lindneri* group. A presumed range extension of *S. macropus* Walker is provided by a single female collected by the senior author on the west coast of Mexico, Sonora, 0.5 mi. s. of sign to Potam, 300 feet, 5 October 1967.

Publications which contain illustrations of adult *Sepedon* are those by Steyskal (1950, 1956, 1960), Foote (1961), Yano (1968), and Fisher and Orth (1969). Biologies and distribution maps for 14 taxa of North and Central America are reported by Neff and Berg (1966).

KEY TO THE NEARCTIC AND MEXICAN SPECIES OF SEPEDON LATREILLE

1 Supraspiracular convexity of metathorax with black hairs 2

Supraspiracular convexity of metathorax without black hairs 10

2 Robust species; wing length 5.8 to 8.9 mm; hind femur of males without midventral notch 3

Smaller species; wing length 3.6 to 5.5 mm; hind femur of males with or without midventral notch. North of Tropic of Cancer 8

3 Medifacies with or without fine black hairs; femora orange-yellow to reddish brown with or without bicoloration of black 4

Medifacies, females, without fine black hairs; femora yellowish, not bicolored; wing length 5.5 to 6.4 mm, (smaller females and all males covered by 2′). U.S.A. north of 38° latitude and Canada. [Steyskal, 1950] .... *S. spinipes americana* Steyskal

4 Hind femur slender, much longer than abdomen, length = 69–78% wing length, black apically with or without distinct black annulus. Subtropical to tropical 5

Hind femur thickened, not or but little longer than abdomen, length = 56–59% wing length. Subtropical to temperate 7

5 Middle femur with strong midanterior spinule 6

Middle femur without strong midanterior spinule. Trinidad. [Steyskal, 1950] .... *S. trinidadensis* Steyskal

6 Hind femur with blackish pre-apical annulus. Tropical lowlands of eastern Mexico north to extreme southern Texas, Central America, Columbia. [Walker, 1849, p. 1078] .... *S. macropus* Walker

Hind femur black on apical third. Puerto Rico, Dominica, Haiti. [Melander, 1920] .... *S. caerulea* Melander

7 Face yellowish to amber, with or without scattered fine black hairs on medifacies—may be totally bare; wing length males 5.8–7.2 mm, females 6.3–7.3 mm; hind femur usually less than 4 mm; genitalia as Figs. 1–6. Southwestern Nebraska, western Kansas, Colorado, Arizona, New Mexico, Mexico highlands to Oaxaca; 1,100–8,000 feet. [Giglio-Tos, 1893, 1896] .... *S. praemiosa* Giglio-Tos

Face amber to brownish, medifacies with fine black hairs scattered to moderately dense; wing length males 7.2–8.9 mm, females 7.0–8.0 mm; hind femur usually greater than 4 mm; genitalia as Figs. 7–12. All states west of Rocky Mts. (no records from Arizona); east of Rocky Mts.

north of 40° latitude and east to 96° 28′ longitude; extreme southern portions (50° latitude) of western Canadian Provinces; sea level to 10,150 feet. [Cresson, 1914] .... *S. pacifica* Cresson

8 Male hind femur emarginate ventrally; female hind femur simple; hind tibia distinctly more curved in distal third; abdomen brown with little more than a trace of bluish reflection; oral margin usually raised, rectangular in profile; tp almost straight. Canada, U.S.A., Mexico. [Steyskal, 1950, 1956, 1960; Fisher and Orth, 1969] .... *S. armipes* group

Hind femur of both sexes simple 9

9 Hind tibia more or less evenly arcuate; abdomen frequently almost black with bluish reflections; oral margin usually low, the angle with face acute; wing length males 3.6–4.5 mm, females 3.9–4.9 mm; femora orange-yellow to dark brown; medifacies with fine black hairs. North of 37° latitude. [Steyskal, 1950] .... *S. pusilla* group

Wing length males 5.0 to 5.5 mm, females 5.5 to 6.4 mm; femora yellowish; medifacies without fine black hairs. U.S.A. north of 38° latitude, Canada. [Steyskal, 1950] .... *S. spinipes americana* Steyskal

10 Robust species; wing length 6.3 to 7.6 mm. U.S.A., Canada 11

Smaller species. South America, Central America, Mexico (Chiapas, 2,200 feet). [Steyskal, 1950] .... *S. lindneri* group

11 Second antennal segment compressed, about three times as long as wide (viewed laterally), near base much wider than first segment. Widespread in U.S.A. and Canada, rare in California (Plumas, Sierra counties) and New Mexico (Rio Arriba, Sandoval counties), no Arizona or Nevada records. [Loew, 1859; subspecies Steyskal, 1950] .... *S. fuscipennis* Loew

Second antennal segment almost cylindrical, nearly five times as long as wide, basally not thicker than first segment; oral margin in profile acute. U.S.A. and Canada east of 101° longitude. [Cresson, 1920] .... *S. tenuicornis* Cresson

BIOLOGY, LABORATORY.—In late July 1970 we collected 50 *S. praemiosa* at Lake Mary, near Flagstaff, Arizona, and brought them to Riverside for propagation in the laboratory. Upon our return to Riverside we collected *S. pacifica* locally. The object of these collections was to initiate reciprocal cross mating studies. Many F_1 progeny of *S. praemiosa* were produced, and on 24 August 1970, 60 F_1 puparia were sent to Honolulu, Hawaii, c/o C. J. Davis, Chief Entomologist, for propagation and release against *Lymnaea ollula* Gould. There were enough F_1 adults of *S. pacifica* produced to enable us to set up reciprocal crosses of groups of four females and four males as well as control groups of both species. The results indicated interspecific mating incompatibility, but were inconclusive. The F_1 controls of *S. praemiosa* mated and produced viable eggs but all the larvae died before or during the third instar. The F_1 controls of *S. pacifica* mated but no eggs were laid. In the reciprocally cross mated groups no mating of F_1 adults was observed and no eggs were laid.

Although the reasons for failure of these attempted crosses are obscure, certain comments are considered appropriate. The F_1 larvae were reared on a diet of virtually 100% *Physa virgata* Gould, and a high percentage of both species attained the third instar and then died. Many successfuly pupated, but emerged deformed and soon died. Curiously, our insect pathologist colleagues at Riverside could identify no pathogens in moribund or recently dead material. Possibly, the diet solely of *P. virgata* did not provide all the nutrients required for normal development. Another factor we have recognized in these and other species of sciomyzid flies—as also reported by Neff and Berg (1966)—is that late season (September, October) attempts at laboratory propagation often fail, even with fresh appearing adults. Perhaps a form of ovarian diapause is responsible—a possible survival factor in species suspected of overwintering as adults, and whose immatures could not survive.

We concur with the generalized observations reported by Neff and Berg (1966) for their laboratory rearings, i.e., 3 to 5 days egg incubation period, 12 to 20 days in the three larval stadia, and 5 to 9 days in the pupal stage. In their paper, the biology of *S. praemiosa*, including descriptions of the immature stages, was presented in considerable detail. However, we call attention to the facts that their cultures consisted of material from three localities—(1) Oxaca, Mexico, collected August 1958; (2) Cypress Lake, Saskatchewan, Canada, collected July 1957; and (3) Riverside, California, collected January–February 1961. [Larvae from the Riverside material were taken to Hawaii and Australia by Berg the following August for testing against the freshwater snails *Lymnaea ollula* Gould and *L. tomentosa* Pfeiffer, respectively. Ref. Neff and Berg (1966, p. 48)]. Although no biological or morphological differences between immatures from the three localities were reported, we consider the first to be *S. praemiosa*, and the second and third to be *S. pacifica*.

BIOLOGY, FIELD.—The general statement by Neff and Berg (1966, p. 48) that "the species (*praemiosa*, = *pacifica*) breeds throughout the year in southern California . . ." may hold for coastal or low elevations, but it does not pertain to the higher elevations, such as Big Bear Lake at 6,750 feet in the San Bernardino Mts. or to Lake Hemet, at 4,500 feet in the San Jacinto Mts. We have sampled both localities extensively over a period of years. Our contention is particularly true at Big Bear Lake which sometimes is frozen over, and nearly every year has substantial snow cover during December, January, and February. Water temperatures during these months are in the low 40's °F or upper 30's °F. At comparable and higher elevations in the northern parts of the state where *S. pacifica* occurs winter conditions are more severe. Because of these observations we are reluctant to comment on the exact mode of overwintering in cold areas.

It seems reasonable that the onset of winter would find eggs, larval stadia, and pupae present as well as adults. To begin elucidation of the mechanisms involved, temperature tolerances of all stages require critical study as do other ecological parameters such as day length, light intensity, etc., and the interactions of such stimuli. Perhaps all stages are merely arrested developmentally, perhaps developing a little on warmer winter days. What the larvae would feed on is another question, since at many sites migrating water fowl consume most of the exposed mollusks during the fall and early winter. Surviving aquatic mollusks are buried in the mud, or are on rocks below the mud line, or in lakes they may be in vegetation well below the surface. In such situations they are beyond the reach of bird or fly-maggot predators.

DISTRIBUTION AND RELATIVE ABUNDANCE OF S. PRAEMIOSA, S. PACIFICA, AND S. FUSCIPENNIS.—These three large and superficially similar species are usually encountered in open, unshaded marshes. Most such habitats contain aquatic pulmonate snails of the families Planorbidae, Lymnaeidae, and/or Physidae. In the laboratory the larvae of the three species of marsh flies consume a wide variety of aquatic snail species (Neff and Berg, 1966). Although precise host associations in nature or nutritional requirements remain to be elucidated, the assumption presently is that since the larvae of these species feed as overt predators, their nutritional requirements are not tied to any particular species of mollusk.

We know of no locality (microhabitat) where *S. pacifica* and *S. praemiosa* occur together. A waterway common to both appears to be the South Platte River. *Sepedon pacifica* occurs along its western reaches in northeastern Colorado, and *S. praemiosa* occurs at North Platte in southwestern Nebraska. The intermittent nature of the river during the summer may serve to keep the species separated, but it is possible that seasonally the two species may coexist along this watercourse as well as the North Platte River possibly in the vicinity of the western boundary of Nebraska.

Sepedon fuscipennis is widespread in the U.S.A. and Canada. It is found in association with *S. pacifica* in several localities west of 100° longitude. In the Pacific states the two species occur together in California (south of Crescent Mills, Plumas Co.; west of Sierraville, Sierra

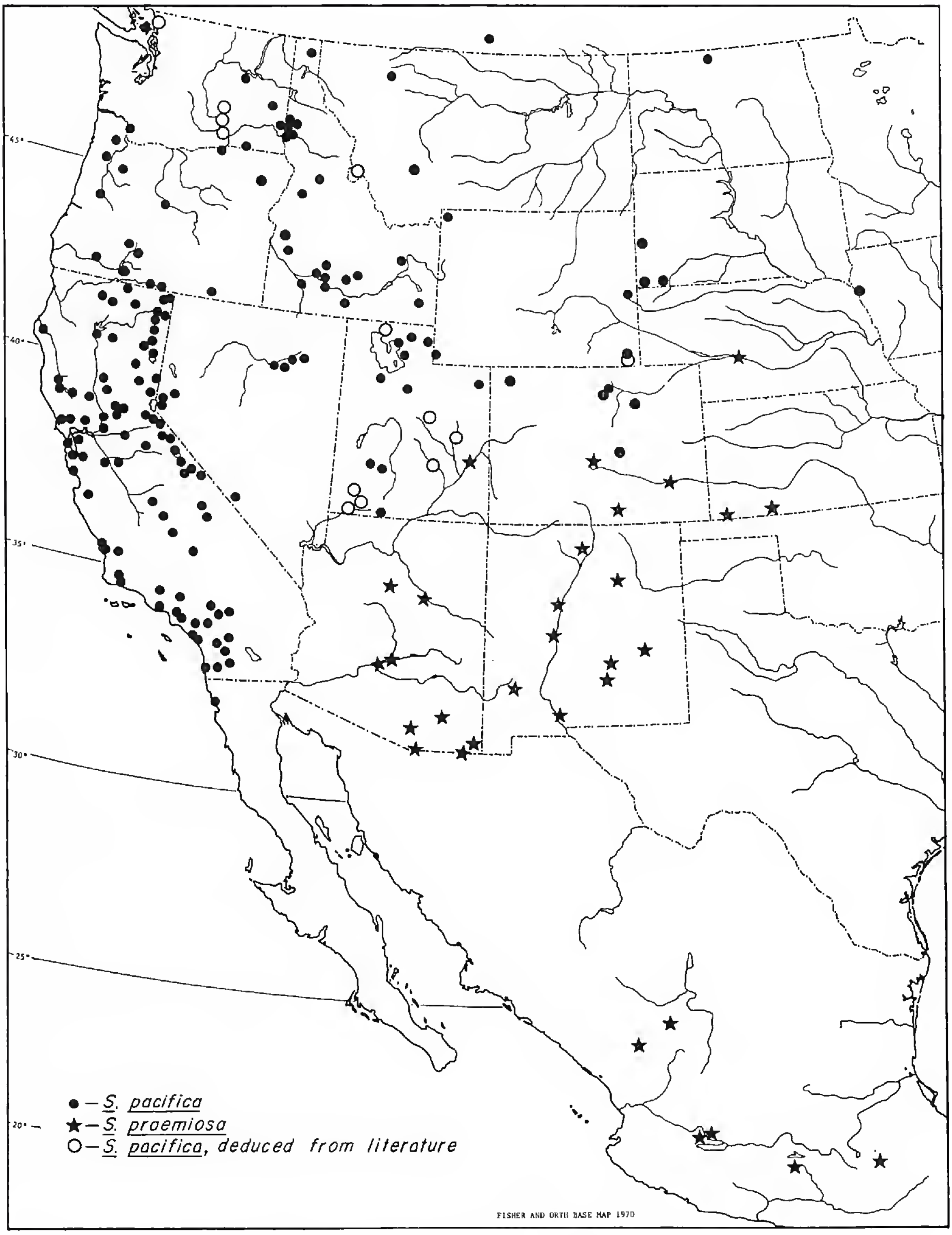


FIG. 13. Distribution of *S. pacifica* and *S. praemiosa.* We have seen specimens from all localities indicated by the blackened circles and stars. Clear circles indicate material not seen but referred to in the literature as *S. praemiosa* or *S. pacifica* and which because of distribution, we assign to *pacifica.*

Co.), Oregon (Eugene, Lane Co.; Klamath Game Refuge, Klamath Co.), and in Washington (south of Kalama, Cowlitz Co.). Foote (1961) reported *S. praemiosa* (= *S. pacifica*) and *S. fuscipennis* from Idaho (Coeur d'Alene and Robinson Lake) and Alberta, Canada (Lethbridge).

The only sites where we are certain *S. praemiosa* and *S. fuscipennis* occur together is a roadside marsh just east of North Platte, Nebraska, and in the Jemez Mts., Sandoval Co., New Mexico. In spite of rather intensive collecting efforts by us and others in the western states and Canada it is curious that *S. fuscipennis* has been reported together with *S. pacifica* or *S. praemiosa* at relatively few sites.

Localities where the three species have been reported singly but where overlap may be anticipated are as follows. We have taken only *S. fuscipennis* at Amargosa and Pike's Stockade in southern Colorado; at Chehalis, Centralia, and Silver Lake in Washington; and at Cave Junction, in Oregon. Foote (1961) reported only *S. fuscipennis* from six localities in Idaho, one in Montana, four in Washington, two in Oregon, two in Alberta, and three in British Columbia. We have taken only *S. praemiosa* at Walsenburg, Colorado, and at Lake Mary (8 miles southeast of Flagstaff), Arizona. Only *S. pacifica* (= *S. praemiosa*, Foote, 1961) was reported by Foote (1961) from 14 sites in Idaho, 28 in Utah, five in Washington, two in Oregon, and one in Alberta.

Material we have seen, and assumptions from literature records (Steyskal, 1950; Neff and Berg, 1966; Foote, 1961) indicate that in the U.S.A. *S. praemiosa* occurs east of the Rocky Mts. at North Platte, Nebraska, (approximately 41° latitude, 120° longitude), in eastern Colorado, southwestern Kansas, and along the Rio Grande watershed in New Mexico. West of the Rocky Mts., *S. praemiosa* occurs in Arizona near Phoenix and Flagstaff and in the southeastern portion of the state. The gorges of the Colorado River and Little Colorado River appear to be the northern limit of its distribution in Arizona, but a male was seen from Moab, Utah. South of the International Border, *S. praemiosa* occurs in the central highlands of Mexico to Oaxaca, 17° latitude. The present occurrence of isolated populations of *S. praemiosa* in well separated drainages suggests that there may have been wet periods in the geological past that would have effected a continuous suitable habitat from Oaxaca to Nebraska, or possibly farther north. Although we have seen no material from Texas or Mexico from the Rio Grande or its tributaries, this watershed probably enabled the species to penetrate as far north as it has.

Sepedon pacifica occurs west of the Rocky Mts. from northern Baja California del Norte, Mexico, 32° latitude, to 50° latitude, becoming rare in northwestern Washington and western British Columbia, Canada. East of the Rocky Mts. it occurs between 40° and 50° latitude. Its easternmost confirmed occurrence is Sioux City, Iowa, 96° 28′ longitude. We saw the material on which the Neff and Berg (1966) record from

North Dakota and records in South Dakota and northeast Colorado were based and assign it all to *S. pacifica.*

The arid southwestern U.S.—Sonoran Desert creates the zoogeographic barrier which effectively separates *S. pacifica* from *S. praemiosa.* A curious fact is that we have never collected either species, nor do we know of any confirmed records, along the Colorado River which bisects this desert, nor in the high or low deserts of southeastern California and the contiguous areas of Nevada and Arizona.

The paucity of *S. praemiosa* and *S. pacifica* in the Colorado River drainage system may be caused by the intermittent turbulence and velocity with the heavy load of silt carried by that river which is a deterrent to snail development. The dams which have been constructed over the past forty years are holding much of the silt that otherwise would flow the length of the river. The result is that relatively calm and clear water habitats are becoming more common. Perhaps in time this alteration of the habitat will be taken advantage of by species of pulmonate gastropods which are suitable, if not necessary, host of *S. pacifica* and *S. praemiosa,* namely planorbid snails, and these sciomyzid flies will thus be able to extend their range.

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Immature Forms, Genitalia, and Notes on the Biology of *Anelaphus albofasciatus* Linnell[1]

(Coleoptera: Cerambycidae)

A. G. Raske

Canadian Forestry Service, Department of Fisheries and Forestry, Edmonton, Alberta[2]

Long-horned beetles of the genus *Anelaphus* generally feed on various hardwood trees (Linsley, 1963). *Anelaphus albofasciatus* (Linnell) is unique within this genus for its habit of feeding on cactus. Adults have previously been collected on *Opuntia bigelovii* Engelmann (Davis, 1928) and on *Echinocactus* sp. (Linsley, 1963). This paper reports my observations of *A. albofasciatus* on *Opuntia whipplei* Engelmann and Bigalow (3 to 6 miles west of Seligman, Yavapai County, Arizona, during mid July and early September 1964 and mid June 1966) and describes characters that separate *Anelaphus* from *Moneilema*, another cerambycid genus which may occur on the same host.

Notes on the Biology

The adult beetles are active in June and July, the larvae are present in July and the pupae appear from late July and throughout the fall. These observations suggest that there is one generation per year on *Opuntia whipplei.*

The adults become active after dusk, and are usually found near the top of the cactus where they feed on the newest growth. They are most often found crawling slowly over the host plants but are also often motionless on the top of a branch with their legs extended and their bodies held high off the substratum; the antennae are held high in the air at a 45° angle. The beetles may remain montionless in this position, which resembles preflight posture, for up to five hours.

Several mating pairs were observed, all at night and on the top of the cacti.

The size and shape of larval mines at early larval instars indicate that eggs are deposited near or on the surface of the host plant. The young larvae apparently mine directly into the pith of the host through an opening of the lace in the cactus skeleton, and proceed either up or

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[1] The work was started at the University of California, Berkeley, and completed at the Canadian Forestry Service, Department of Fisheries and Forestry, Calgary, Alberta.

[2] Present address: Canadian Forestry Service, Department of Fisheries and Forestry, P. O. Box 6028, St. John's, Newfoundland, Canada.

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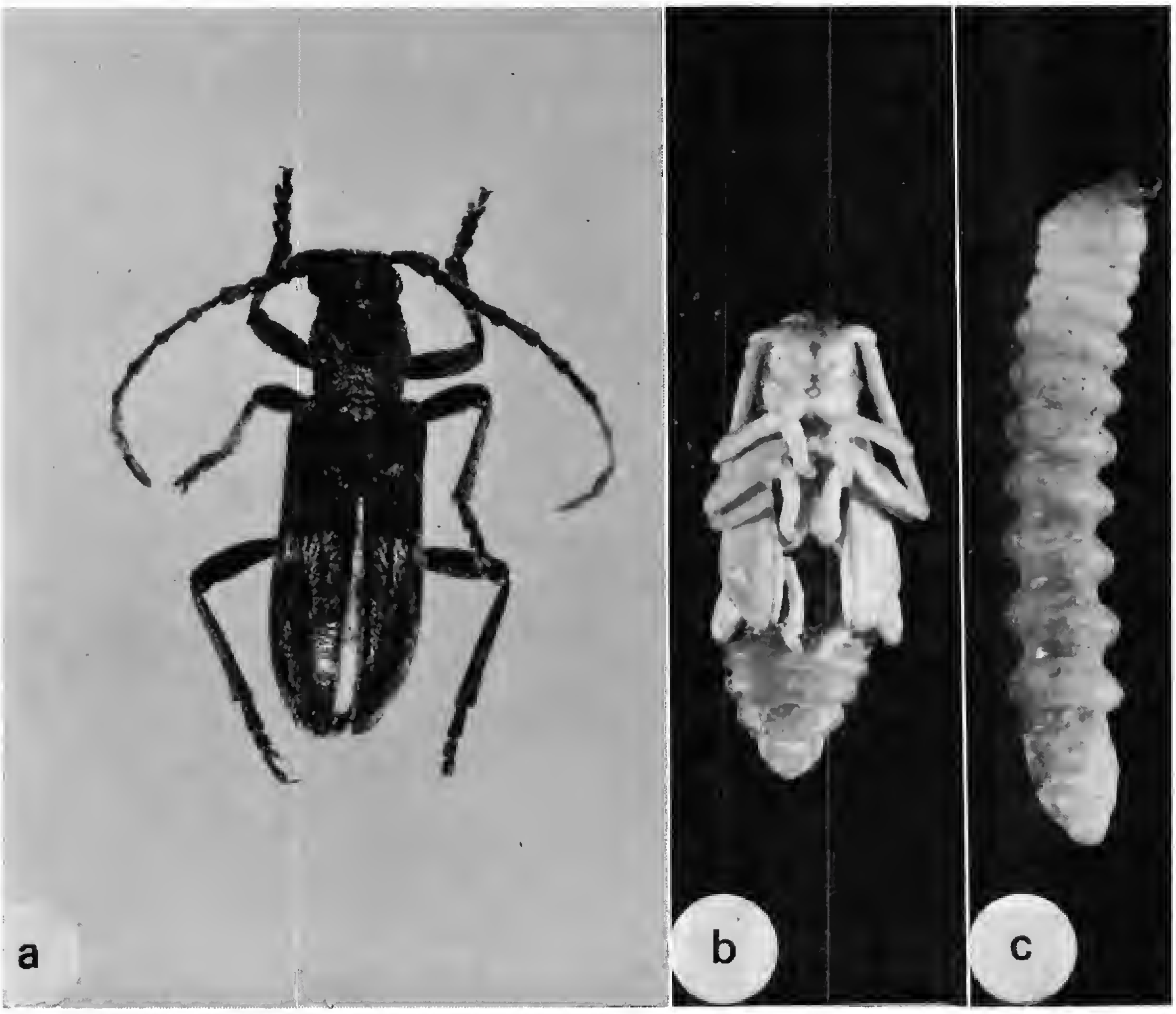


FIG. 1. *Anelaphus albofasciatus* Linnell, a) adult, b) pupa, c) larva (×4) (Photos by P. Debnam, Canadian Forestry Service).

down from this point of entry. In contrast, the larvae of the cerambycid *Moneilema* sp. first mine the exudate produced by the plant and then proceed into the pith (Raske, 1966). The larvae of *A. albofasciatus* constructs a pupal cell from pith and frass, usually at the bottom of the larval mine (Fig. 2).

The cerambycid *Moneilema semipunctatum forte* LeC. (Raske, 1966) attacks *O. whipplei* in the same area. The larvae of the two species can be distinguished by the presence (*Anelaphus*) or absence (*Moneilema*) of prolegs. Generally, *A. albofasciatus* larvae are found in the upper, smaller stems and branches of the plant, while *M. semipunctatum forte* larvae tend to be in the main stem near the ground or in the roots.

Larvae of *A. albofasciatus* were reared successfully in the laboratory on the artificial diet used by Lyon and Flake (1966). From one of the larvae, 41 adults of the internal parasite, *Tetrastichus holbeini* Girault (Hymenoptera: Eulophidae), emerged in early August.

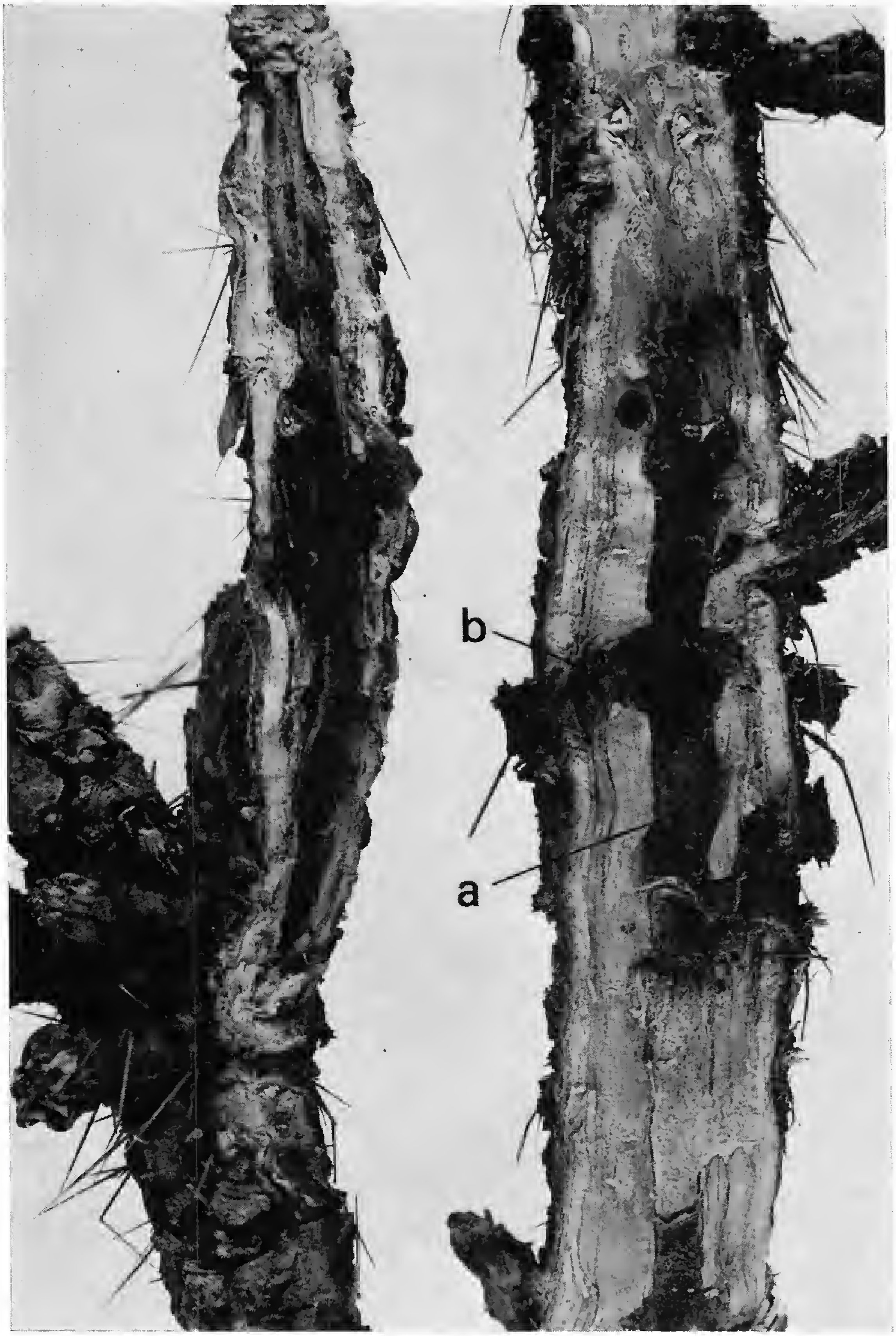
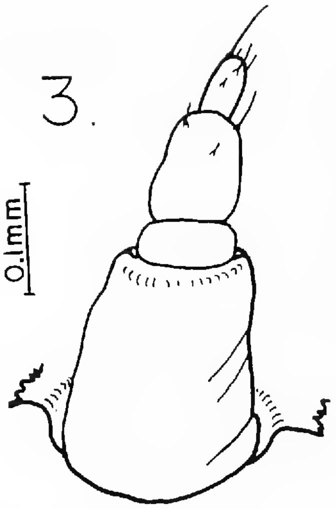
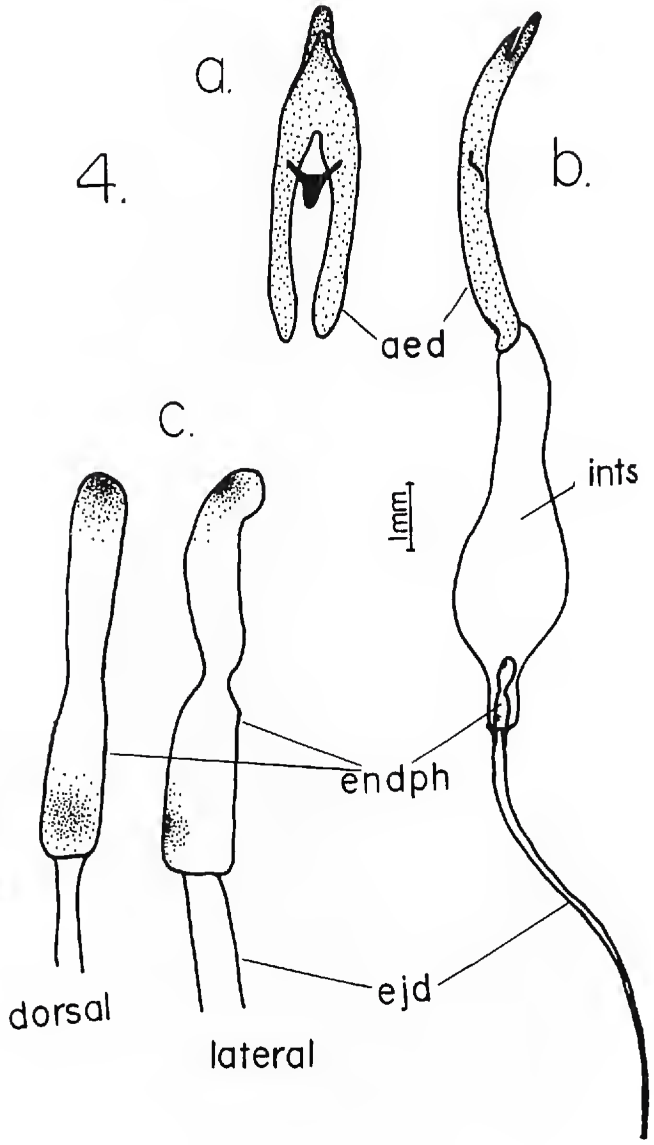


FIG. 2. Larval mine of *A. albofasciatus* in *Opuntia whipplei* with pupal cell (a) and adult exit hole (b). (× 1.3) (Photo by A. A. Blaker, Univ. of California).





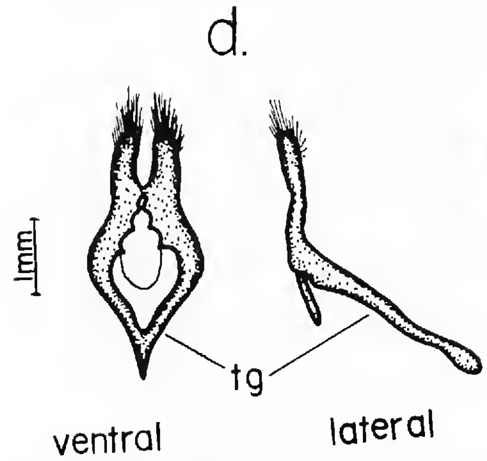


FIG. 3. Antenna of larva of *A. albofasciatus*. FIG. 4. Male genitalia of *A. albofasciatus*, a) aedeagus, b) intromittent structures, c) endophallus (dorsal and lateral), d) tegmen (ventral and lateral). *aed* = aedeagus, *ejd* = ejaculatory duct, *endph* = endophallus, *ints* = internal sac, *tg* = tegmen.

DESCRIPTION OF LIFE STAGES

ADULT.—Linsley (1963) described the external characters of adult *A. albofasciatus* (Fig. 1a), but the internal reproductive structures of taxonomic value were not included. These are illustrated in Figs. 4 and 5.

MATURE LARVA.—Length 18–22 mm. (Fig. 1c). Head transverse, moderately depressed. Genae testaceous behind ocelli for about one-fourth distance between ocelli and base of mandible; sclerotization of mouth frame narrow, setae scattered, most not in testaceous area; antennae three-segmented (Fig. 3); mandible short, stout, cutting edge "gouge-like"; labrum setose, evenly rounded anteriorly, suddenly constricted posteriorly; clypeus transverse, four times as wide as long, anterior margin sclerotized; ligula obtusely conical, tip setose; labial palp two-

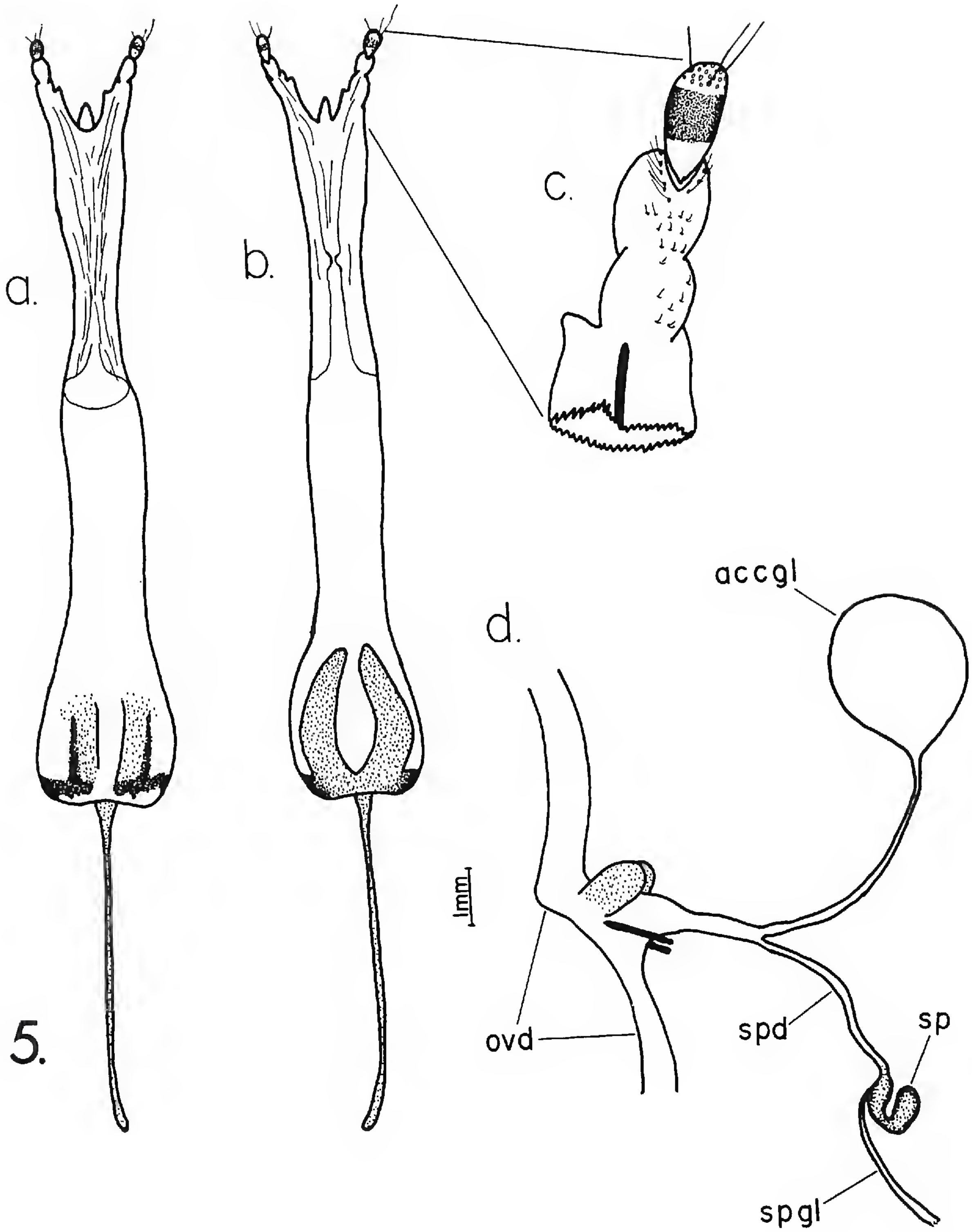


FIG. 5. *Anelaphus albofasciatus*, female genitalia. a) ovipositor (dorsal), b) ovipositor (ventral), c) stylus, d) internal genitalia. *accgl* = accessory gland, *ovd* = oviduct, *sp* = spermatheca, *spd* = spermathecal duct, *spgl* = spermathecal gland.

segmented, lightly sclerotized; maxillary palp three-segmented, lightly sclerotized, process of palpifer prominent, maxillary lobe, cardo, and stipes sclerotized basally, with scattered setae; mentum and submentum membranous; gula with sides widely diverging posteriorly; ocelli two, pigmented, subcontiguous. Pronotum transverse, moderately setose, distinctly raised from pleural regions, dorsal plate divided, with two distinct light testaceous areas, longitudinally striate; eusterna rugose. Abdomen rugose, with ampullae shining, bilobed with transverse and lateral deep grooves, subtuberculate; epipleura inconspicuous; pleural disc a deep pore with radial striations; spiracles broadly oval to suborbicular; peritreme not raised above general level of cuticle.

PUPA (female ?)—Length 13–15 mm. (Fig. 1b). Head with labrum subequal to clypeus in length, clypeus with deep longitudinal groove; antennae reaching to third abdominal segment. Pro-, meso- and metanotum with few inconspicuous setae. Abdominal terga with heavily sclerotized incurved spines, fewest and smallest on first abdominal segment, increasing in size and number on posterior segments; most spines with subapical setae; posterior margin of eighth tergite with row of large spines; sterna glabrous, tenth sternum deeply, irregularly furrowed, with pronounced median blister-like structure, bearing two small setae posteriorly.

ACKNOWLEDGMENTS

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Cytology of Some California Grasshoppers.

1. Taxonomic Considerations

(Orthoptera:Acridoidea)

GILBERT L. SCHROETER AND GODFREY M. HEWITT
Department of Biology, Texas A&M University, College Station 77843, and School of Biological Sciences, University of East Anglia, Norfolk, England

The purpose of this paper is to call attention to the extent of chromosomal variation, both structural and numerical, in several species of grasshoppers and its bearing on orthopteran taxonomy.

Many grasshoppers have evolved novel genetic systems which are not only of intrinsic interest to evolutionary biologists but in many cases can be taxonomically useful (White, 1951, 1954). During the course of studying the effects of chromosome rearrangements on genetic recombination in various species (Hewitt, 1967; Hewitt and Schroeter, 1968), numerous other species were collected in California which had not been previously studied cytologically. The taxonomic status of some of these has remained in doubt due to the fact that morphological features considered alone have not proved reliable enough in establishing phylogenetic relationships. Six species are reported on here which make clear that a chromosomal analysis could, indeed should, be used in any serious taxonomic treatment.

MATERIALS AND METHODS.—The species discussed, sites and dates of collection, and number of individuals examined cytologically are given in Table 1.

Testes from adult male grasshoppers were removed following a mid-dorsal incision and immediately placed in a fixative of 3:1 absolute ethyl alcohol: glacial acetic acid. Ovarioles of females were removed by vivisection under insect saline and then cultured for 30 minutes in 0.05% colchicine in insect saline to arrest and accumulate mitotic metaphases before being similarly fixed. A detailed description of the reproductive anatomy of grasshoppers is to be found on pages 138–150 in Uvarov (1966).

In our experience young male imagines are a good source of meiotic material but meiotic divisions can usually be found even in the testes of males collected late in the season. Only young female imagines have proved to be satisfactory for the study of ovariole wall mitosis.

Following fixation the material was stored in the fixative or 70% ethanol in a refrigerator and subsequently squashed in acetic-orcein.

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TABLE 1. Data on the six species examined cytologically in the present study.

Species	Collection site	Date collected	Number examined cytologically
Tanaoceridae			
Tanaocerus koebelei Bruner	15 mi. W. Panamint Springs, Inyo Co.	7 May 1966	9 ♀♀
Acrididae			
Romaleinae			
Dracotettix monstrosus Bruner	Pope Valley, Napa Co.	15 June 1966	1 ♂
Cyrtacanthacridinae			
Oedaleonotus borckii (Stal)	Jackson, Amador Co.	3 July 1966	8 ♂♂
	Telephone Campground, Glenn Co.	13 Aug. 1966	12 "
Oedaleonotus enigma (Scudder)	15 mi. S. Mendota, Fresno Co.	28 May 1966	26 "
	1.0 mi. E. Oilfields, Fresno Co.	28 May 1966	27 "
	16 mi. S.W. Five Points, Fresno Co.	28 May 1966	99 "
	" " " " " " "	5 Aug. 1968	216 "
	2 mi. E. Oilfields, Fresno Co.	28 May 1966	86 "
	" " " " " "	20 May 1967	29 "
	" " " " " "	8 June 1967	106 "
	" " " " " "	2 July 1967	63 "
	" " " " " "	28 July 1967	25 "
	" " " " " "	3 Aug. 1968	43 "
	13 mi. N. Coalinga, Fresno Co.	28 May 1966	111 "
	" " " " " "	9 June 1967	98 "
	" " " " " "	2 July 1967	88 "
	" " " " " "	28 July 1967	15 "
	8 mi. E. Coalinga, Fresno Co.	28 May 1966	46 "
Oedaleonotus orientis Hebard	About 3 mi. E. Sonora Pass Summit, Mono Co.	1 July 1966	2 "
Oedaleonotus phryneicus Hebard	Los Osos, San Luis Obispo Co.	18 Aug. 1966	3 "
	" " " " " "	31 July 1967	93 "

For details concerning stain preparation and the squash technique the reader is referred to pages 199–205 in Lewis and John (1964).

CYTOLOGICAL OBSERVATIONS AND DISCUSSION

Tanaocerus koebelei Bruner.—The family Tanaoceridae contains but three species, two of which are found in California. The relationship of these desert longhorns to the rest of the Acridoidea remains obscure. In examining the proventricular region of the tanaocerids and comparing it with other grasshoppers, Grant and Rentz (1967) concluded that the tanaocerids are quite different from both the acridids and eumastacids. On the other hand, Dirsh (1956, 1961) considers the Tanaoceridae to be more allied to the eumastacids and includes them in the Eumastacoid section of his taxonomic scheme which is based upon comparative studies of the phallic complex. It should be pointed out that only the epiphallus of *Tanaocerus koebelei* was studied, a structure considered by Dirsh (1956) to be a taxonomic character reliable enough for differentiating families or even groups of families in some cases.

Figure 1 shows an ovariole colchicine-arrested (c-mitotic) metaphase with 22 acrocentric chromosomes. In the past the term "acrocentric" has been used to describe chromosomes with visible short arms and also those in which short arms were not able to be resolved with the light microscope but presumed to be present. This is discussed by John and Hewitt (1968) and White (1969). To avoid confusion, the term acrocentric will be used in this paper in its broad sense, realizing that rod-shaped chromosomes in many instances may possess truly terminal centromeres (i.e., are telocentric). Until a male individual of *Tanaocerus* is studied, a decision concerning the sex-determining mechanism cannot be made. However, if it is the same as in most other grasshoppers, it is an XO♂/XX♀ system, with the X in this case also being acrocentric.

Hundreds of acridid species have been studied and most have a karyotype consisting of 2n♂ = 23 (2n♀ = 24) acrocentric chromosomes (White, 1969). Although fusions between chromosomes have occurred in many species, thus reducing the chromosome number, this does not explain the peculiar karyotype of *Tanaocerus koebelei* in which all the chromosomes are acrocentric. A reduction in number from 22 to 20 by "centric fusion" would be expected to result in a pair of chromosomes with median or sub-median centromeres.

On the other hand, the chromosome complement of *Tanaocerus koebelei* graded in size is very similar to what could be argued as the


1
2
3
4
X'Y'

basic karyotype in the Eumastacidae. It closely resembles that of the Pseudoschmidtiinae and Mastacideinae subfamilies, the cytogenetics of which have been described by White (1970a). As his study makes clear, however, the eumastacids are chromosomally quite varied and a morphologically diverse group.

Certainly more information about the cytogenetics of these groups needs to be obtained before any conclusion concerning their phylogenetic interrelationships can be made.

Dracotettix monstrosus Bruner.—White (1954) has drawn attention to the discussion as to whether the Old World subfamily Pamphaginae is represented in the New World by such genera as *Phrynotettix* and *Dracotettix*, or whether these belong in the subfamily Romaleinae. He points out that the Old World Pamphaginae have 21 (20 + X) chromosomes in males while the Romaleinae possess 23 (22 + X). Since *Phrynotettix* males also have 22 + X chromosomes (McClung, 1914) its inclusion in the latter subfamily seems warranted. Consequently we have determined the basic karyotype of *Dracotettix monstrosus* and found a male to have 22 + X acrocentric chromosomes (Fig. 2). This clearly indicates that its inclusion in the Romaleinae is warranted and both cases together argue against the presence of the Pamphaginae in the New World.

Oedaleonotus borckii (Stal).—A total of 20 individuals from two populations on either side of the Central Valley of California has been examined and both samples appear to be cytologically uniform with males having 22 + X acrocentric chromosomes (Fig. 3).

Oedaleonotus enigma (Scudder).—Over 1,000 males of this species have been collected in the lower San Joaquin Valley near Coalinga. This particular species exhibits considerable chromosome variation and differs strikingly from other members of the genus so far studied in its sex-determining mechanism (Hewitt and Schroeter, 1968). In contrast to the XO♂/XX♀ sex-chromosome systems common to most

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FIG. 1. Mitotic complement of *Tanaocerus koebelei*. 2n♀ = 22. Note the terminal or near-terminal position of the centromeres. × 1125. FIG. 2. First meiotic metaphase of *Dracotettix monstrosus*. 2n♂ = 23. Eleven bivalents and a single unpaired sex chromosome (arrow). × 925. FIG. 3. First meiotic metaphase of *Oedaleonotus borckii*. 2n♂ = 23. All chromosomes possess terminal or near terminal centromeres, including the X chromosome. × 1250. FIG. 4. First meiotic metaphase of *Oedaleonotus enigma* with the 'basic' karyotype of 2n♂ = 22. Note the neo-XY sex bivalent (X'Y'). All chromosomes are acro-(telo-?) centric except the neo-X. × 850. (Line scale = 10μ.)

grasshoppers, *O. enigma* possesses a neo-XY (X′Y′) ♂/Neo-XX (X′X′) ♀ mechanism which has evolved from the former by the fusion of the heterochromatic X with an autosome to form the Neo-X, the homologous autosome becoming the Neo-Y. Instead of possessing an unpaired X-chromosome, males of this species are characterized by having a heteromorphic sex bivalent at the first meiotic metaphase composed of a metacentric Neo-X and an acrocentric Neo-Y (Fig. 4). The few females which have been examined possessed two Neo-X's. Thus, instead of males having 23 (22 autosomes + X), both males and females of this species have 22, 20 autosomes plus the two sex chromosomes.

While 2n = 22 is considered to be the basic chromosome number for this species, male individuals have been found in all populations so far sampled with 20 and 21 chromosomes. This variation in chromosome number is due to the fact that *O. enigma* is polymorphic for a centric fusion involving two non-homologous acrocentric chromosomes, numbers 4 and 5. A fusion between these two chromosomes has occurred at or near their centromeric regions resulting in one large metacentric chromosome. An individual may (i) possess the basic karyotype of 20 acrocentric autosomes, (ii) be heterozygous for the fused and unfused chromosomes or, (iii) be homozygous for the two fused metacentric chromosomes. Those individuals which are heterozygous for the fusion possess nine chromosome pairs and a V-shaped chain-of-three at M1 of meiosis (Fig. 5), while those homozygous for the fusion have 10 pairs, one of which is a large ring bivalent made up of the two fused metacentrics (Fig. 6).

The frequencies of the two types of chromosomes involved in this fusion polymorphism vary from population to population, but no population so far sampled has become fixed for either of the two types, i.e., no monomorphic population has been found. There are, however, differences in frequencies between populations for the fused and unfused chromosomes (Schroeter and Hewitt, in preparation).

Although the Neo-XY sex-determining mechanism and the fusion polymorphism are the most conspicuous cytological features of *O. enigma*, there are several other chromosomal alterations for which the species is also polymorphic.

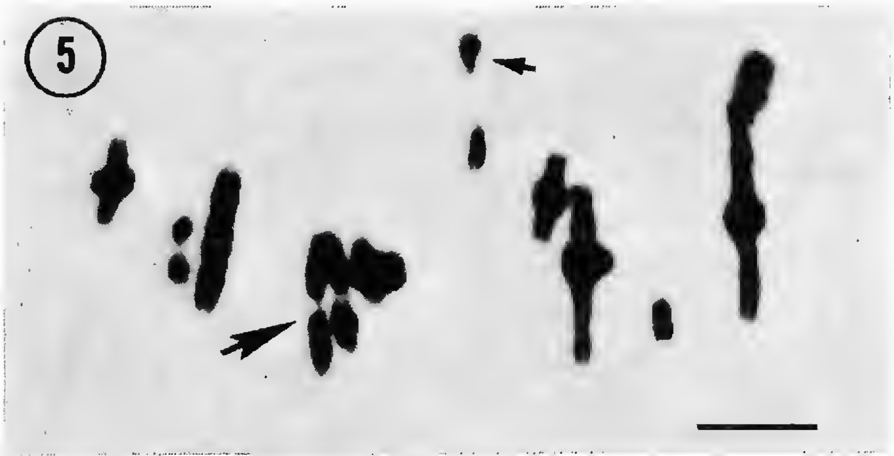
The first of these is a centromere 'shift' in the third smallest chromosome (no. 8). Whereas all the chromosomes of the basic karyotype are acrocentric, a transposition of the centromere has occurred in the number 8 chromosome presumably by means of a pericentric inversion, resulting in a chromosome with the centromere in a sub-median position. Again, in all samples studied, three types of individuals have been observed: (i) those homozygous for the two acrocentric no. 8 chromosomes; (ii) heterozygous for the acrocentric and submetacentric forming a heteromorphic bivalent (Fig. 5) and, (iii) homozygous for the two submetacentrics.

In some individuals one member of the smallest chromosome pair, no. 10, has an additional heterochromatic segment attached to it, resulting in a conspicuous unequal bivalent at M1 of meiosis (Fig. 6). While this enlarged chromosome has been found in all but one of the populations sampled to date, its frequency is usually so low that only a very few individuals have been found to be homozygous for it.

The last chromosomal variable to be mentioned is that some individuals in some populations possess heterochromatic supernumerary or B-chromosomes which do not pair with any member of the standard chromosome complement. The occurrence of these B-chromosomes is even lower than that of the segment attached to chromosome 10, its frequency not exceeding 2.5% in any of the populations so far sampled. The meiotic behavior of these and the other variable components of the chromosome complement of *O. enigma* and their possible role in the population dynamics of the species have been discussed in a previous paper (Hewitt and Schroeter, 1968). However, it is worth emphasizing that these B's are both metacentric and rare, and consequently, unlikely candidates for the extra sex chromosome arm described in three individuals of this species (Hewitt and Schroeter, 1968) as has been suggested by White (1970b).

Oedaleonotus orientis Hebard.—Only two individuals of this species have been collected, but both exhibited a striking chromosomal feature which may prove to be of considerable taxonomic importance. This is the ditactic bivalent (Fig. 7). This peculiar type of bivalent has been thought to be due to chiasma formation between the short arms of two acrocentric chromosomes, but John and Hewitt (1966, 1968) have interpreted ditactic bivalents to result from chiasma formation within truly terminal centromeres. Whatever interpretation may ultimately be applied, in this instance the ditactic bivalent is a feature that was consistently observed in all M1 cells of both individuals and has not been observed in any of the allied species so far analyzed. As in *O. borckii*, males of this species possess 23 acrocentric chromosomes.

Oedaleonotus phryneicus Hebard.—Only a single population of this species has been sampled to date with a total of 96 males having been examined cytologically. The chromosome complement, typical of most acridids, consists of 22 autosomes and one unpaired sex-chromosome in males, all being rod-shaped with terminal centromeres. There is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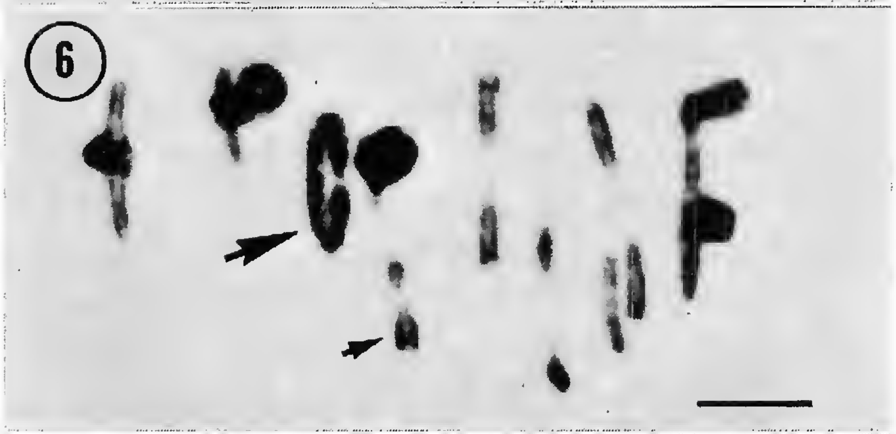
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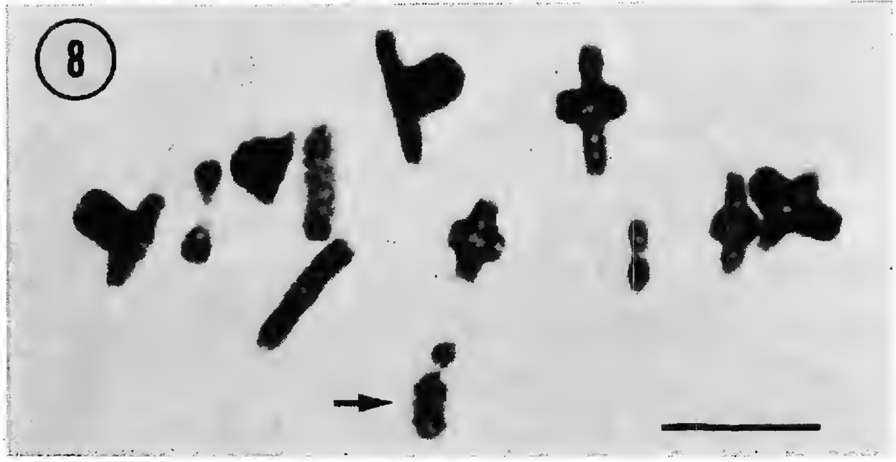
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one feature which this species shares with *O. enigma*, i.e., a supernumerary chromosome segment attached to a member of the smallest autosomal pair. About 12% of the individuals observed were found to be heterozygous for this segment, resulting in an unequal bivalent as seen in Fig. 8. Each of two individuals also possessed an unpaired heterochromatic supernumerary chromosome.

Four of the seven presently recognized species of *Oedaleonotus* having been studied cytologically, the fact emerges that these four differ in some unique way from each other. *O. enigma* contrasts strikingly with the others by possessing a Neo-XY sex-determining mechanism and being polymorphic for an autosomal centric fusion. *O. orientis* is the only species so far studied in which a ditactic bivalent is formed at M1 of meiosis. *O. phryneicus* differs from *O. enigma* in its sex-determining mechanism (XO♂/XX♀) but is similar to the latter in that it also is polymorphic for a supernumerary chromosome segment and supernumerary chromosomes. *O. borckii* differs from the other three in its being monomorphic, there being no apparent chromosome polymorphism nor any type of peculiar bivalent formation or sex-determining mechanism. Thus the *Oedaleonotus* complex would seem to be a most suitable and extremely rewarding area for cytogenetic and evolutionary investigations.

Based on the studies made, it is clear that cytological techniques can be used to great advantage in a serious taxonomic treatment of this genus. Indeed, we would consider any such study to be lacking if the chromosome complement was not taken into account. Strohecker, *et al.* (1968) state that "satisfactory treatment of the forms of this genus will require comprehensive study not feasible at present. Specimens from widely separated localities appear to represent quite distinct species but many intermediate forms occur and we have not been able to find sets of characters consistent enough to be regarded as of specific worth." It may well be that the chromosome complement will prove to be a worthy character.

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FIG. 5. Metaphase I of *Oedaleonotus enigma* which is heterozygous for the 4–5 fusion forming a chain-of-three (large arrow) and a centric shift in chromosome no. 8 (small arrow). × 1050. FIG. 6. Metaphase I of *Oedaleonotus enigma* which is homozygous for the 4–5 fusion (large arrow) and heterozygous for the supernumerary segment on chromosome no. 10 (small arrow). × 1000. FIG. 7. Metaphase I of *Oedaleonotus orientis*. 2n♂ = 23. Note the ditactic bivalent (arrow). × 1700. FIG. 8. Metaphase I of *Oedaleonotus phryneicus*. 2n♂ = 23. Note the unequal bivalent (arrow). × 1350. (Line scale = 10μ.)

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New North American Heterotropinae

(Diptera: Bombyliidae)

JACK C. HALL
Division of Biological Control, University of California, Riverside, 92502

The subfamily Heterotropinae is for the most part made up of an anomalous group of microbombyliids, rarely exceeding 5 mm in length. The anomaly is attested to by the fact that *Prorates* Melander was described as an empidid, *Caenotus* Cole as a therevid and *Apystomyia* Melander runs to the Scenopinidae in most keys to families.

Melander (1950) gave an account of the Heterotropinae together with a rearrangement of Curran's (1935) key to genera. Since 1950 none of the species belonging to the various genera comprising the Heterotropinae have been reported upon. The following account not only describes a new genus and several new species but greatly extends the range of distribution of the genus *Prorates*, hitherto known only from New Mexico and southern California.

The Heterotropinae may be separated from other Bombyliidae by the following combination of characters: Occiput flattened, not or only slightly foveate behind ocellar tubercle; eyes bisected into two sizes of facets, small below, large above, but without dividing line; inner margin of eyes usually indented opposite antennal bases; eyes of male usually holoptic, female dichoptic, wing with two submarginal cells; four posterior cells with first always open; anal cell closed before the margin and petiolate or closed at wing margin; anal lobe greatly developed; legs without conspicuous bristles; body not densely hairy.

KEY TO HETEROTROPINE GENERA

1\. Second posterior cell petiolate at base 2

Second posterior cell sessile, medial crossvein between fourth and fifth veins arises from discal cell 3

2\. Third vein forks closer to r-m crossvein than to tip of wing *Prorates* Melander

Fork of third vein closer to tip of wing than to r-m crossvein .... *Apystomyia* Melander

3\. Arista terminal, normal, of one or two segments 4

Third antennal segment terminates in microscopic tuft of hair .... *Caenotoides* Hall. n. gen.

4\. Proboscis projects well beyond oral margin .... *Heterotropus* Loew

Proboscis at most only slightly projecting beyond oral margin .. *Caenotus* Cole

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APYSTOMYIA Melander

(Fig. 1)

Apystomyia Melander, 1950: 146.

Melander based this genus on a number of specimens collected along streams in the mountains of southern California. *Apystomyia* was placed by Melander (1950) in the Heterotropinae "because it does not conform with any other subfamily . . . ." An examination of part of the type series confirms its placement but if and when additional species are discovered the genus should be reevaluated.

Known only from the genotype species—*A. elinguis* Melander.

The genus may be recognized not only by the characters given in the key to genera but also by the delicate neuration in the wing, the small second basal cell and consequently large discal cell. The head and thorax are polished black and the abdomen subopaque; the hair on the head and thorax is black and quite coarse, that on the abdomen is white. The knob is entirely black and the proboscis is short and non-projecting.

HETEROTROPUS Loew

(Fig. 2)

Heterotropus Loew, 1873: 182.

This genus contains a large number of Palearctic species. It is represented in the Nearctic region by a single species, *H. senex* Melander. Melander's specimen was collected in Arizona at flowers of *Baileya multiradiata.*

Heterotropus senex has the second posterior cell sessile and the anal cell closed at the wing margin; proboscis long; body black with yellow markings and white hair. The halters are whitish.

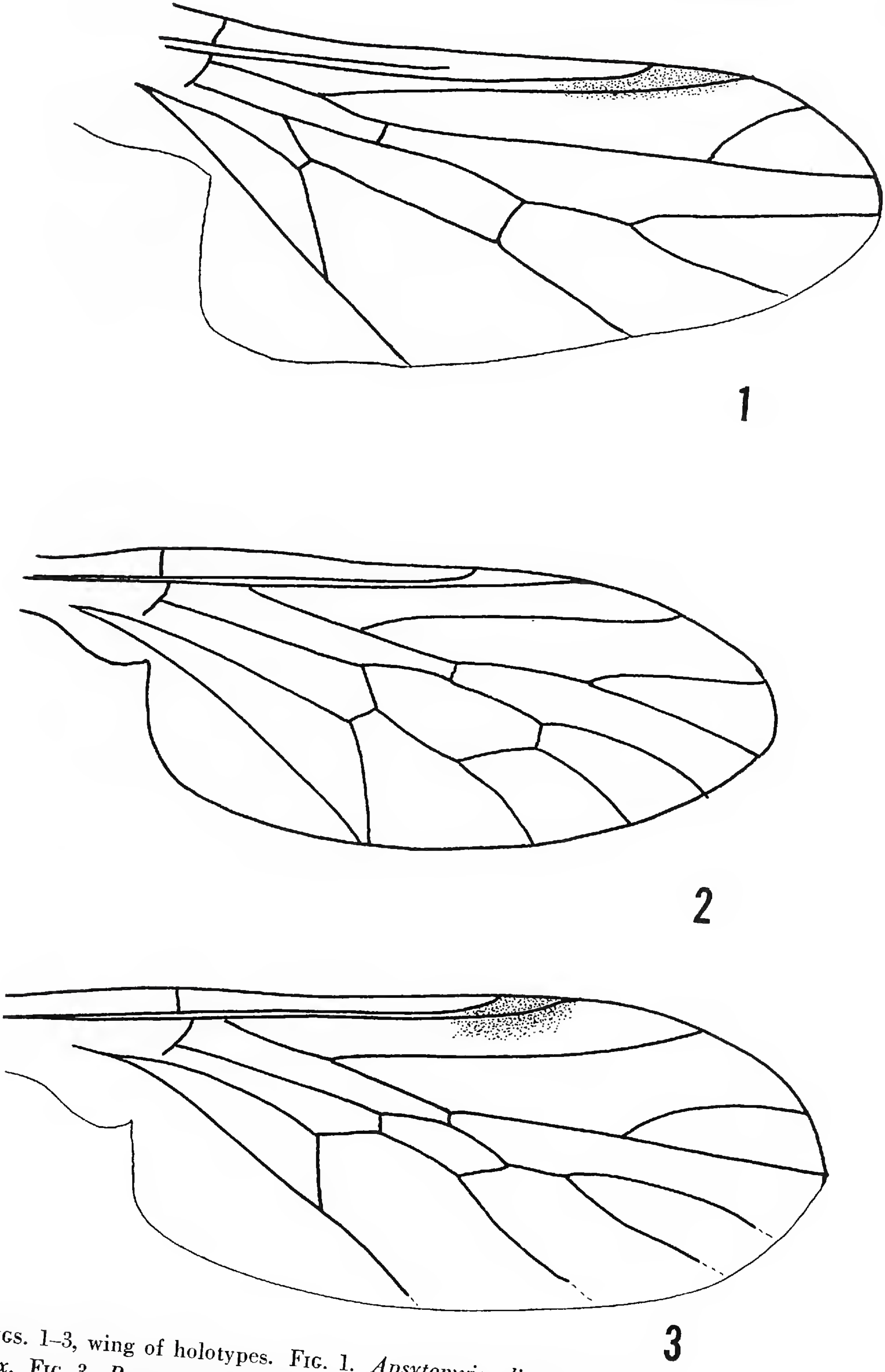
Type locality, Headquarters Organ Pipe National Monument, Arizona. The fly was collected on 16 April.

PRORATES Melander

(Fig. 3)

Prorates Melander, 1906: 372 (as an empidid), 1927: 377; 1950: 145.
Alloxytropus Bezzi, 1926: 186.

Originally described as an empidid but later transferred to the Bombyliidae because of the short costal vein. For many years the genus was known from a single species, *P. claripennis* Melander. Efflatoun (1945) under the name *Alloxytropus* Bezzi, recorded two species from Egypt. Melander (1950) synonymized this latter genus



FIGS. 1–3, wing of holotypes. FIG. 1. *Apsytomyia elinguis*. FIG. 2. *Heterotropus senex*. FIG. 3. *Prorates frommeri*.

with *Prorates*. Five additional species are described below bringing the total known species to eight.

Prorates may be diagnosed as follows: Proboscis projecting usually as far as or farther than the tip of the antennae, except in *P. boydi* Hall described below. Antennae with three segments, (not two as originally stated) first two very small, third elongate conical and covered with minute pubescence. Scutellum with two apical marginal bristles. Costal vein extends to or only slightly beyond the third longitudinal vein; wing usually with darkened stigma below apex of first vein; branch of fourth vein closer to r-m crossvein than to tip of wing; second posterior cell petiolate at base; discal cell smaller than second basal cell. Vestiture of short, fine, scattered hair, longer on underside of head and at base of abdomen.

Genotype species—*P. claripennis* Melander.

KEY TO SPECIES OF PRORATES

1. Proboscis projecting well beyond oral margin 2
   Proboscis short, at most labellae extend beyond oral margin; body and legs black with white hair; knob of halter pale .... *boydi* Hall, n. sp.
2. Hair on mesonotum white or yellow, may reflect brownish in some lights 3
   Hair or mesonotum and scutellum black; scutellar bristles of male black, of female testaceous; abdominal hair white .... *nigrescens* Hall, n. sp.
3. Proboscis projecting beyond oral margin for a distance equal to or less than height of eye 4
   Proboscis projects twice eye height beyond oral margin; palpi long, extending as far as first antennal segment; legs fuscous; hair on abdomen yellow .... *arctos* Hall, n. sp.
4. Legs fuscous, testaceous or dark brown, never mostly pale 5
   Legs and thoracic pleural area pale, sternopleura and femora may be dusky; basal antennal segments pale yellow; abdominal hair yellow .... *frommeri* Hall, n. sp.
5. Abdominal hair golden yellow; proboscis usually extending beyond tip of antennae; legs or at least the tibiae usually yellowish brown; wing veins light brown .... *melanderi* Hall, n. sp.
   Hair on abdomen pale yellow to white; proboscis extends as far as tip of antennae or only slightly beyond; legs brownish yellow, tibiae of female lighter; wing veins dark brown .... *claripennis* Melander

Prorates boydi Hall, new species

Immediately separable from the congeners by the short, non-protruding proboscis and the entirely black body with pale hair.

MALE.—Black, knees and tibiae brownish. Eyes contiguous down front for distance greater than length of ocellar tubercle. Ocellar tubercle and small triangular front bare. Antennae black, third segment may appear lighter in some lights; basal segments short, without apparent vestiture; third segment, in lateral view conical, broadest at base then tapering to narrow apex, at least twice as long as wide, microscopically pubescent; arista terminal, as broad as apex of third segment. Face retreating, bare above, scattered short white hair below. Proboscis short, not projecting beyond oral margin. Palpi nearly as long as proboscis, one segmented. Occiput white pilose, hair not dense, nearly bare above.

Mesonotum dull, when viewed from in front brownish pollinose becoming whitish laterally; hair short, scattered, yellowish, longer and tending towards white near scutellum; bristles wanting (may be broken off). Pleura white pollinose, bare except for few thin whitish hairs on mesopleuron. Legs with short pale yellow hair, that on tibiae setaceous; bristles other than apical tibial bristles wanting; hind tarsus longer than hind tibia. Pulvilli as long as claws. Halter stem brownish, knob white. Squama white with fringe of white hair. Scutellum dull with long, erect, white hair, bristles wanting.

Wing hyaline, stigmal area faintly yellowish; anterior veins brown, rest pale. Costa terminates at fourth vein; second posterior cell short petiolate, and petiole shorter than r-m crossvein; r-m crossvein at middle of discal cell; discal and second basal cells of nearly equal length; petiole on anal cell longer than posterior crossvein; anal lobe large; alula moderately well developed.

Abdomen with short, erect, scattered white hair; posterior margin of second segment narrowly pale. Venter with posterior margins of second and third segments narrowly pale; short white hair overall. Genital capsule brownish, round, lateral plates moderately truncate at apex.

FEMALE.—Unknown.

Holotype and two paratypes from P. L. BOYD DESERT RESEARCH CENTER, (DEEP CANYON), 3 MI. S. PALM DESERT, RIVERSIDE COUNTY, CALIFORNIA, 20 June 1969 (S. Frommer and B. Worley), malaise trap at marker 57. One paratype male from Fish Springs, Imperial County, California, 13 September 1965 (R. C. Dickson), from a yellow sticky-board trap. Type deposited in U. S. National Museum.

PRORATES CLARIPENNIS Melander

Melander, 1906: 373.

Differs from the congeners by the black legs and black halters. The basal antennal segments are also black. *Prorates claripennis* is very similar to *P. melanderi* Hall. From this latter species *claripennis* may be separated by the shorter proboscis, which does not extend beyond the tip of the antennae and by the pale yellow to white, not golden, abdominal hair.

Melander's original description is short and as such incomplete. A full redescription of both sexes follows:

MALE.—Black, knees and fore coxae a little lighter. Halter stem and knob black. Eyes in contact down front for distance equal to length of ocellar tubercle; inner margin of eyes at most only slightly indented opposite antennal bases. Small triangular front bare. Basal antennal segments short, equal in length, each segment with two or three short yellowish hairs; third segment in lateral view elongate conical, flattened, one and one-half times longer than two basal segments combined, microscopically pubescent; arista terminal, minute, not distinctly separated from third segment. Face receding, bare above, pale yellow to white hair below. Proboscis projecting, short, not reaching beyond apex of antennae; hair on labellae pale. Palpi testaceous, approximately one-third length of proboscis, hair short, pale. Occiput vaguely cinereous pollinose with short, scattered white hair.

Mesonotum vaguely cinereous pollinose with two median darker vittae; hair short, yellow; bristles yellowish. Pleura cinereous pollinose, essentially bare. Hair on legs pale yellow; hind tibia and tarsus of equal length. Pulvilli as long as claws. Squama pale, whitish with fringe of long pale hair. Scutellum cinereous pollinose, hair short, fine, scattered, pale; two apical bristles dark brown.

Wing hyaline, stigma dark brown, veins dark, only vaguely reaching posterior margin. Costa terminates at fourth vein; petiole at base of second posterior cell shorter than r-m crossvein; discal and second basal cells of nearly equal length; petiole on anal cell one and one-half times longer than posterior crossvein; alula moderately well developed.

Hair on abdomen pale yellow to white; posterior margin of third segment narrowly white in ground color. Venter with white hair. Genital capsule with yellowish hair, elongate and narrowly rounded apically.

FEMALE.—Very much like male except legs lighter colored. Knob of halter brownish yellow. Eyes at narrowest point separated by nearly one and one-half times width of ocellar tubercle. Eyes definitely emarginate opposite bases of antennae. Posterior margins of third and fourth segments narrowly pale; lateral margin from base to sixth segment pale; basal sternites with posterior margins narrowly pale. Otherwise as described for male.

Other than the holotype and allotype, both from New Mexico, I have seen no other specimens. Both are in the U. S. National Museum.

Prorates arctos Hall, new species

The long proboscis, dark color, well pronounced wing venation and the northern distribution will serve to distinguish this species.

FEMALE.—Black, tips of tibiae, knees and knob of halter pale; legs fuscous; head and thorax somewhat grayish pollinose. Eyes at narrowest point separated by more than width of ocellar tubercle. Front bare, slightly concave in front of ocellar tubercle. Eyes emarginate opposite bases of antennae. Basal antennal segments equal in length, each with a few short pale hairs; third segment slightly longer than two basal segments combined, elongate oval, microscopically pubescent; arista small, terminal. Face bare above, scattered pale hair below. Proboscis projecting nearly twice eye height beyond oral margin. Palpi testaceous, tips darker, with pale hair. Hair on occiput pale, short, scattered.

Mesonotum with two dark median vittae; hair short, yellowish; bristles brown. Pleura bare. Coxae and hind femur with short pale hair; hind tibia and tarsus of nearly equal length; pulvilli as long as claws. Squama white with fringe of long white hair. Scutellum with yellow hair (bristles apparently broken off).

Wing veins dark; stigma well pronounced. Wing hyaline; petiole at base of second posterior cell extremely short; second basal cell slightly longer than discal cell; petiole on anal cell much longer than posterior crossvein; alula well developed.

Abdomen rather evenly blackish brown; hair golden yellow; venter with lateral margins of segments one to four pale; hair pale yellow.

MALE.—Unknown.

Holotype female from 10 MI. S. SHOSHONI, FREMONT COUNTY, WYOMING, 3 July 1965 (F. R. Holland) as prey of the robberfly *Heteropogon wilcoxi* James. Deposited in the U. S. National Museum.

This fly represents the most nothern record for the genus *Prorates* which was hitherto known only from New Mexico and southern California. It seems probable that specimens should be found throughout the Great Basin.

Porrates melanderi Hall, new species

This species consists primarily of the series of specimens which Melander collected in Borrego, California and which he considered to be the same as *P. claripennis* from New Mexico. I have three additional specimens from Borrego.

The resemblance to *P. claripennis* is remarkably close. *Prorates melanderi* may be distinguished from *P. claripennis* by the golden yellow hair on the abdomen, the lighter colored legs and the slightly longer proboscis.

MALE.—Brownish black; basal antennal segments light brown; legs testaceous; knob of halter dark. Eyes in contact in middle of front for a distance shorter than ocellar tubercle. Inner margin of eyes incised opposite bases of antennae. Small triangular front bare, cinereous pollinose. First two antennal segments equal in length, first segment with a few short, fine, pale yellow hairs at apex; third segment twice as long as two basal segments combined, in lateral view elongate conical, microscopically pubescent; arista minute, terminal. Face bare, few scattered pale hairs below oral opening. Proboscis projecting shorter than height of eye beyond oral margin but reaching beyond tip of antennae. Palpi yellowish, at least half as long as proboscis, with short pale yellow hair. Occiput cinereous pollinose with short pale hair, that on ocellar tubercle yellowish.

Mesonotum cinereous with two darker median vittae; hair short, yellow; lateral bristles yellow. Pleura cinereous especially below, bare except for few pale hairs on mesopleura. Coxae and legs with short pale yellow to white hair, that on femora very short and setiform; hind coxa darker than fore and mid-coxae; hind tibia longer than hind tarsus. Pulvilli as long as claws. Squama white with fringe of long pale hair. Scuttellum blackish brown, somewhat cinereous pollinose; two marginal bristles testaceous; hair white.

Wing hyaline, veins pale brownish; petiole of second posterior cell longer than r-m crossvein; discal cell small, nearly one-half length of first basal cell; petiole on anal cell longer than posterior crossvein; alula developed, rounded.

Abdomen dark brown with golden-yellow hair, may be lighter towards base of abdomen; posterior margins of second and third segments narrowly white; lateral margin of first three segments white; posterior margins of second and third sternites narrowly whitish. Genital capsule brown with yellow hair, triangular in lateral view with apex bluntly rounded.

FEMALE.—Grayish-black; basal antennal segments darker than in male; knob of halter pale yellowish. Eyes separated at narrowest point by at least width of ocellar tubercle; lateral margin of abdominal segments one to five white. Otherwise as described for the male.

Holotype male and allotype from PALM CANYON, BORREGO, IMPERIAL COUNTY, CALIFORNIA, 3 May 1945 (A. L. Melander). In U. S. National Museum.

Nine paratopotypes and three paratypes, Borrego, Imperial County, California, 3 May 1956 (P. H. Timberlake) in the authors collection.

Prorates nigrescens Hall, new species

This species is readily differentiated from the others by the black hair on the mesonotum and the black scutellar bristles as well as by the darker knob of the halter.

MALE.—Blackish brown; palpi and legs brownish yellow; posterior margins of first four abdominal segments narrowly white. Eyes contiguous down most of front. Ocellar tubercle and small triangular front bare. First two antennal segments short, small, of nearly equal length, both microscopically white pollinose; third segment in lateral view conical, a little more than twice as long as wide, microscopically pubescent; arista apical, minute. Face receding, cinereous pollinose below. Proboscis projecting, reaching beyond tip of antennae. Palpi nearly one-third length of proboscis. Underside of head and lower half of occiput with whitish hair.

Mesonotum when viewed from in front shows three grayish brown median vittae which do not reach scutellum; mesonotal hair short, scattered, erect, black, longer towards scutellum; one prealar and one postalar bristle, both pale in color. Pleura whitish pollinose, bare with few short, fine, pale hairs on mesopleuron. Legs apilose and asetose, covered with minute hair-like setulae; posterior tarsus a little longer than posterior tibia; pulvilli nearly as long as claws. Stem of halter pale, knob black or dusky. Squama dusky with fringe of long pale hair. Scutellum with short black hair with two median, strong, black, marginal bristles.

Wing hyaline, stigma dark brown, anterior veins brown, rest pale; petiole on second posterior cell longer than r-m crossvein; vein M_3+Cu_1 reaches hind margin of wing; petiole of anal cell longer than posterior crossvein; discal cell a little shorter than second basal cell; anal lobe large; alula moderately developed.

Abdomen sparsely white haired. Genital capsule with yellowish hair, in lateral view elongate, narrowed apically.

FEMALE.—Eyes at vertex separated by one and one-half times width of ocellar tubercle. Head cinereous pollinose. Front bare with a narrow longitudinal median depression. Lower half of pleura and all of legs yellowish; spines on ovipositor pale yellow. Otherwise as described for the male.

Holotype male and allotype from RIVERSIDE, BOX SPRINGS MTS., RIVERSIDE COUNTY, CALIFORNIA, 4 July 1969 (J. C. Hall, M. E. Irwin) malaise trap. Both in U. S. National Museum.

One paratopotype and one paratype, topotypic except collected 3 October 1967, in the author's collection.

Prorates frommeri Hall, new species

This species differs from the congeners by the pale yellow basal antennal segments, pale hair on the mesonotum and by the pale legs.

MALE.—Brownish, legs, basal antennal segments, thorax somewhat, venter of abdomen and genitalia pale yellow. Eyes contiguous down most of front; ocellar tubercle and small triangular front bare. Basal antennal segments small, at most with few short hairs; third segment long conical, nearly four times longer than wide, microscopically pubescent; arista terminal, minute. Proboscis projecting beyond oral margin for distance nearly equal to height of eye. Palpi short, pale with pale hair. Face bare. Underside of head and lower half of occiput with white hair.

Mesonotum, when viewed from in front, with three lighter colored median, longitudinal vittae which become coalesced in front of scutellum, lateral margin brownish yellow; hair short, fine, erect, yellow; bristles yellow. Pleura bare small patch of fine hair on mesopleuron. Long hair on legs wanting, femora and tibiae with small setaceous hair; bristles wanting. Pulvilli as long as claws. Halter stem and knob yellowish white. Squama white with fringe of white hair. Scutellum brownish, hair short, scattered, yellow, two convergent marginal bristles testaceous.

Wing hyaline, stigmal area at most only faintly colored; anterior veins brown, rest pale; second posterior cell long petiolate, petiole as long as posterior crossvein; second basal cell much longer than discal cell; petiole on anal cell much longer than length of posterior crossvein; no veins reach posterior margin of wing; alula moderately well developed.

Abdominal dorsum with short, scattered yellow hair; posterior margins of nearly all segments narrowly pale in ground color. Venter with yellow hair. Genital capsule brownish, in lateral view elongate triangular, lower apical corner slightly elongated.

FEMALE.—Head cinereous pollinose; eyes widely separated. Body and legs entirely pale yellowish or straw colored. Otherwise as described for male.

Holotype male and allotype, from P. L. BOYD DESERT RESEARCH CENTER, (DEEP CANYON) 3 MI. S. PALM DESERT, RIVERSIDE COUNTY, CALIFORNIA, 1 October 1969 (S. Frommer), malaise trap at marker #57. In U. S. National Museum.

Two hundred twenty-one paratopotypes collected from 1 June 1969 to 4 October 1969, in a malaise trap.

There is a rather wide range of color expressed from nearly entirely brown (except the legs) to entirely straw colored. The majority of the specimens are of this latter color, although the males generally tend to be darker. I can find no structural differences between the color variants of this species.

CAENOTUS Cole

(Figs. 4, 8)

Caenotus Cole, 1923: 14; Melander, 1950: 148.

Caenotus was originally described as a therevid. Cole based his decision on the placement of the genus in the Therevidae primarily because of the five posterior cells found in the wing of the genotype species, *C. inornatus* Cole. An examination of part of the type series of *C. inoratus* shows that although there are five posterior cells in each wing the longitudinal veins forming the extra cell arise from the discal cell. In the Therevidae the posterior vein forming the fifth posterior cell arises from the small crossvein at the base of the discal cell. The other three species of *Caenotus*: *C. canus* Melander, *C. minutus* Cole and *C. hospes* Melander, all have only four posterior cells.

Melander (1927) transferred *Caenotus* to the Bombyliidae. In 1950 he recharacterized the genus and gave a key to the species together with the descriptions of two new species. I can add nothing more to Melander's remarks.

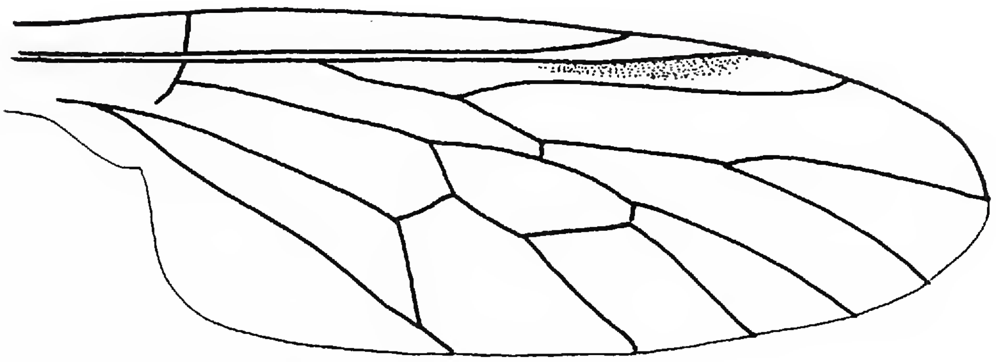
Caenotoides Hall, new genus

(Figs. 5, 6, 7)

The new species described below were discovered during the course of study for this report. The one striking difference noted about the specimens was that the third antennal segment terminated in a microscopic tuft of hair. The only other genus of bombyliid sharing this characteristic is *Anthrax*, a group to which these specimens obviously do not belong.

Caenotoides is similar in habitus to *Caenotus* but differs by the shorter and less abundant pile on the body, the shorter one-segmented palpi, the tuft of hair at the tip of the third antennal segment which is not separated by a distinct suture and by the costa terminating at the third longitudinal vein or only slightly beyond.

Small flies, up to 4 mm in length. Eyes of male contiguous, widely separated on female; lower half of eye of male more finely faceted than upper half, facets of female uniform in size. Ocellar tubercle large, ocelli form equilateral triangle. Antennae approximate at base, first two segments nearly equally short, both broadened apically; basal half of third segment short, broad, apical half styliform, about as long as basal portion, terminating in tuft of minute hair.



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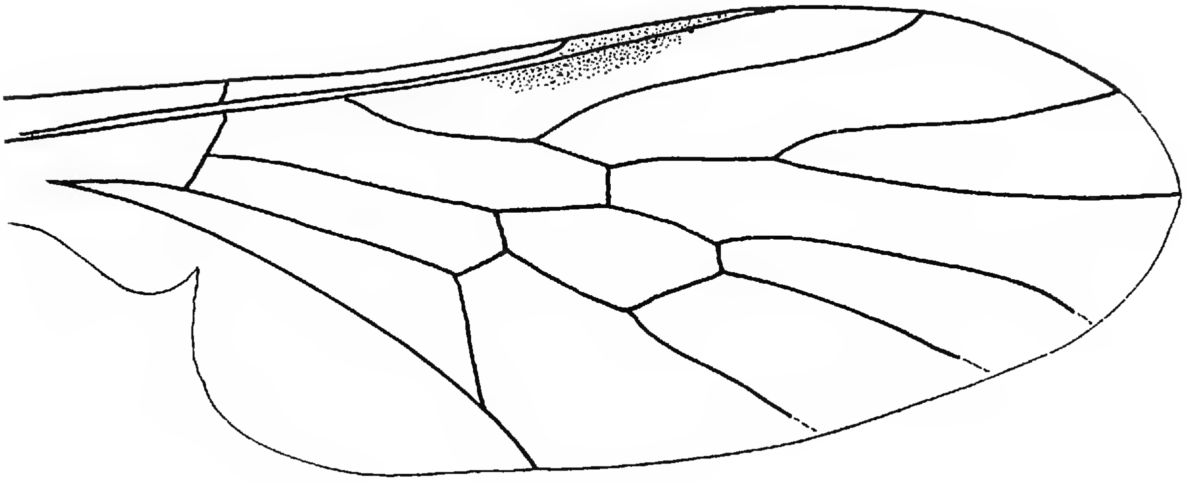

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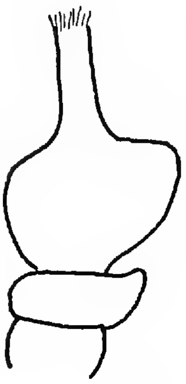

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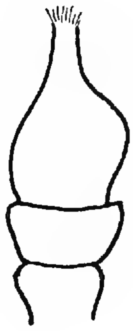

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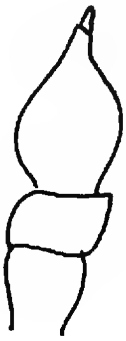

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FIGS. 4 & 5, wing of holotypes. FIG. 4. *Caenotus hospes*. FIG. 5. *Caenotoides californica*. FIGS. 6–8, lateral view of antenna. FIG. 6. *Caenotoides californica*. FIG. 7. *Caenotoides idahoensis*. FIG. 8. *Caenotus hospes*.

Oral opening reaches base of antennae. Proboscis short, about half as long as oral opening; palpi very small, one-segmented. Face rounded, not protruding, receding below. Occiput flat. Head slightly wider than width of thorax. Mesonotum rounded, without apparent bristles, hair short and sparse. Legs with short setula-like hair; pulvilli present, much shorter than claws. Scutellum rounded without marginal bristles. Wing hyaline, at most stigmal area slightly colored; two submarginal cells; four posterior cells, all open in wing margin; costa terminates at tip of third vein or only slightly beyond; apical portion of vein R_5 from branch of R_4 to tip of wing longer than basal portion from branch of R_4 to r-m crossvein; medial crossvein at base of third posterior cell arises from discal cell; discal cell much smaller than either basal cell; anal cell closed before wing margin and petiolate; anal lobe large; alula small. Abdomen of male with seven visible segments, female with eight. Genital capsule large, rounded, medially divided.

Genotype.—*Caenotoides californica* Hall, described below.

KEY TO CAENOTOIDES SPECIES

1. Third antennal segment gradually attenuated to styliform apical one-half, legs not black 2
   Base of third antennal segment broad then suddenly constricted to apical styliform portion; legs black, tibiae testaceous .... *californica* Hall, n. sp.
2. Legs flavo-testaceous; abdomen pale yellowish with basal black stripe on second segment .... *mexicana* Hall, n. sp.
   Legs dark brown; abdomen white or whitish, base of second segment black .... *idahoensis* Hall, n. sp.

Caenotoides californica Hall, new species

(Figs. 5, 6)

MALE.—Black, subshining, abdomen other than base of second segment, venter and genitalia, white. Legs black, tibiae testaceous; halter stem brown, knob white. Vertex vaguely whitish pollinose. Hair on ocellar tubercle short, erect, white. Small triangular front bare, whitish pollinose. Basal antennal segments equal in length, second segment much broader apically than the first, both with few minute pale hairs; base of third segment, in lateral view, not as broad as second segment but broadly flattened, suddenly and sharply constricted to apical styliform half which terminates in a tuft of microscopic hair or setae (Fig. 6). Face whitish pollinose laterally near antennae, white hair at sides below. Oral opening wide, reaching base of antennae or nearly so. Proboscis short, black. Palpi extremely small, black. Lower half of occiput with long pale hair, upper half nearly bare except for a few short hairs next to eye margin.

Mesonotum, when viewed from in front, with three vague brownish median vittae which do not reach scutellum; pile pale, short, scattered. Pleura bare with few short fine hairs on meso- and stenopleurae. Hair on legs setiform, not long or dense; apical tibial bristles small, fine. Squama white with fringe of white hair. Scutellum brownish pollinose, hair white, scattered, fine, those hairs along posterior margin a little stronger but not bristle-like.

Wing hyaline, veins brown; costa terminates slightly beyond apex of third longitudinal vein, ambient vein not evident; third posterior cell of nearly equal width throughout; petiole on anal cell equal to length of posterior crossvein.

Abdomen elongate, cylindrical with short, fine, scattered pale hair. Venter with much shorter pale hair. Genital capsule rounded, shiny, lateral pieces with short white hair, apex rounded.

FEMALE.—Front whitish yellow pollinose, small, narrow, median black stripe just below median ocellus. Mesonotum brownish yellow pollinose without apparent vittae; humeral and postalar calli a little lighter in color than notum; hair on mesonotum pale yellow. Pleura black, upper part of sternopleuron and small spot on posterior portion of mesopleuron yellowish. Abdominal dorsum with small blackish spots on sides of second to fifth segments, sixth and following segments entirely black as is middle of venter. Each side of ovipositor with five stout, blunt spines. Female otherwise as described for male.

Holotype male and allotype from 3 MI. N. OF NORTH PALM SPRINGS, RIVERSIDE COUNTY, CALIFORNIA, 25 February 1968 (M. E. Irwin). Both in U. S. National Museum.

These specimens were take in copulo and are mounted on one pin, the male being uppermost.

These flies were collected in a sand dune association. They were flying close to the ground among the sparse grass and when captured they were very reluctant to rise into the net. Only one other male was collected at the same time. There were probably more specimens but because of their small size and camouflaged appearance they were overlooked. Repeated attempts to collect more specimens have brought negative results.

Caenotoides idahoensis Hall, new species

(Fig. 7)

Very similar to *C. californica.* Differs primarily in the shape of the third antennal segment and the blunt apices of the lateral pieces enclosing the genitalia.

MALE.—Basal portion of third antennal segment gradually constricted to apical styliform one-third. Mesonotum entirely black. Wing veins yellow. Black mark at base of second abdominal segment not dark, rather obscure. Extreme lateral margins of abdominal segments four to seven yellowish. Legs dark brown. Otherwise identical to description of *C. californica.*

Holotype male from BRUNEAU, OWYHEE COUNTY, IDAHO, 23 June 1938 (H. M. Harris). In U. S. National Museum.

Caenotoides mexicana Hall, new species

Quite similar to the congeners. Differs mainly by the flavotestaceous legs and the absence of the black stripe across the base of the second abdominal segment.

MALE.—Palpi pale yellow. Abdomen yellowish not white; mesonotum vaguely brownish yellow pollinose without vittae. Antennae like that in *C. idahoensis* except styliform portion equal in length to broadened basal portion. Body with white hair except that on scutellum yellow. Dark stripe across base of second abdominal segment wanting. Venter dark in middle of fourth segment only. Specimen otherwise as described for *C. californica.*

Holotype male from 23 MI. E. SAN LUIS, BAJA CALIFORNIA, MEXICO, 24 April 1962 (M. E. Irwin). In U. S. National Museum. Type was collected in a sand dune association.

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The Genus *Sintoria* Hull

(Diptera: Asilidae)

J. WILCOX
Anaheim, California 92806

The genus *Sintoria* Hull (1962) was proposed for *S. emeralda* Hull from Mexico. Material collected in recent years has extended the range of the genus to Baja California and north to Utah. Six species are described as new and a key to the species is given.

Sintoria is closely related to *Cyrtopogon* Loew. In both genera the mystax is composed of hairs, there is a comb of about five curved bristles at the apex of the tibiae, and they lack strong dorsocentral and scutellar bristles. In *Sintoria* the facial gibbosity arises abruptly below the antennae to a height subequal to the length of the first antennal segment from which it recedes gradually to the oral margin; in *Cyrtopogon* the gibbosity is usually evenly rounded with the greatest height at the middle. There are weak occipital bristles in *Sintoria* while in *Cyrtopogon* they are usually long dense hairs. In *Sintoria* the scutellum is more or less flattened and the disc largely bare of pollen and with short discal and long marginal hairs; in the groups of *Cyrtopogon* with flattened scutellum, the disc is pollinose and the hairs long erect on the disc and posterior margin. In *Sintoria* the head, thorax and coxae are largely pollinose; spots on the mesonotum, the abdomen largely and the legs are bare of pollen, and these areas are shining black with metallic reflections of blue, green or purple; no *Cyrtopogon* have been noted with these metallic colors.

Sintoria is mainly a fall genus, occurring from August to November. *Cyrtopogon* occurs mainly in the spring and summer and until recently had not been collected in Mexico. Its range in North America in the west, is from New Mexico to Baja California Norte and north to Alaska; in the east it occurs from Florida to Nova Scotia and occurs in all the Canadian Provinces; it is not found in Texas and is absent or rare in the Great Plain States.

I am indebted to the following persons for the loan of specimens: J. G. Rozen, American Museum of Natural History, AMNH; Mont A. Cazier, Arizona State University, ASU; Paul H. Arnaud, Jr., California Academy of Sciences, CAS; J. A. Powell, California Insect Survey, University of California, Berkeley, CIS; E. L. Sleeper, California State College, Long Beach, CSCLB; Eric Fisher, Long Beach, Calif., EF; Charles H. Martin, Tucson, Arizona, CHM; P. H. Timberlake, University

THE PAN-PACIFIC ENTOMOLOGIST 48: 51–58. January 1972

of California, Riverside, UCR; W. W. Wirth, Entomology Research Division, Agr. Res. Serv., U. S. D. A., USNM, W. J. Hanson, Utah State University, USU.

Measurements were made with an ocular micrometer: of the face and wings at 40 times, and of the antennae at 75 times.

KEY TO SPECIES

1. Mesonotum behind suture largely bare of pollen; wings lightly infuscated 2
   Mesonotum behind suture largely pollinose, small intermediate spot and postalar calli bare; wings hyaline 3
2. Hairs of face light yellow; hairs of mesonotum yellowish; abdomen bluish green, posterior corners of male tergites 1–5 and female 1–6, yellowish pollinose; length 8–9 mm. (Mexico) ..... *emeralda* Hull
   Mystax largely black; anterior mesonotal hairs on central stripe largely black; abdomen blue black, small posterior corners of tergites 2–5, gray pollinose; length 7–9 mm. (Baja California Sur) ..... *lagunae* Wilcox, n. sp.
3. Central mesonotal crest of hairs largely black and nearly as long as antennal segments 1–3; mystax largely and hairs of frons and ocellar tubercle, black; length 9 mm. (Mexico) ..... *rossi* Wilcox, n. sp.
   Central mesonotal hairs white or yellowish and subequal in length to antennal segments 1–2; mystax, hairs of frons and ocellar tubercle, white or yellowish 4
4. Pollen on sides of abdominal tergites 2–6 extending inward on anterior margins 5
   Pollen on sides of abdominal tergites if extending inward, on posterior margins 6
5. Anterior pollinose fascia on male abdominal tergites 2–6 broadly separated, entire on female 2–5; central stripe of mesonotum bare of pollen anterior to suture and in male confluent with intermediate spots, posterior intermediate spots narrowly separated from postalar calli; length 8 mm. (Arizona, Utah) ..... *cazieri* Wilcox, n. sp.
   Anterior pollinose fascia on male abdominal tergites 3–5 entire; central stripe of mesonotum pollinose, intermediate spots small and widely separated from each other and from postalar calli; length 7 mm. (Texas) ..... *pappi* Wilcox, n. sp.
6. Scutellum all pollinose; broad sides of abdominal tergites 1–6 gray pollinose, broadly extending inward for short distance on posterior corners of 2–6; length 10 mm. (California) ..... *mojavae* Wilcox, n. sp.
   Disc of scutellum largely bare of pollen, narrow posterior margin and basal central spot on disc, gray pollinose; sides of abdominal tergite 1 and posterior corners of 2–6, gray pollinose, the pollen extending narrowly forward to anterior margins on most specimens; length 7–8 mm. (Arizona) ..... *cyanea* Wilcox, n. sp.

Sintoria cazieri Wilcox, new species

MALE.—Length 8 mm. Head black, densely white pollinose. Hairs and bristles white; 8 erect bristles on ocellar tubercle. Face at antennae 21/30 width of one eye. Antennae black; hairs white; two yellowish bristles below on segment 2; segment 3 of nearly uniform width, narrowed on apical fourth; segments 10:11: 33:16 in length.

Mesonotum black, gray pollinose, central stripe anteriorly brown, area between humeri and central stripe golden. Anterior intermediate bare spots broadly connected across dorsum and narrowed laterally; posterior spots connected narrowly with bare postalar calli. Hairs white, short sparse, not much longer than antennal segment 1, longer in posterior dorsocentral rows and long erect on humeri. Two presutural bristles yellowish, supraalars and postalars white, hair-like. Pleura and coxae densely gray pollinose, hairs white. Disc of scutellum bare, posterior margin and narrow base gray pollinose, 6 long white marginal hairs.

Abdomen black with greenish reflections; sides of tergites 1–7 densely gray pollinose, pollen extends inwards narrowly on anterior margins of 1 and 3–5, interrupted at middle by about half width of segments. Hairs short sparse white, longer laterally; lateral bristles on tergite 1 white. Sternites 1–7 densely gray pollinose, hairs white. Genitalia black, hairs white.

Legs black, reflections blue, on hind femora greenish. Hairs white; bristles yellowish white; pulvilli and empodia whitish; claws black, base narrowly reddish.

Halteres yellowish brown, lower stem brown. Wings hyaline, veins brown, anterior crossvein at 42/66 length of discal cell, third vein branched beyond end of discal cell, anal cell open, posterior cell 4 narrowed at wing margin.

FEMALE.—Length 8 mm. Bristles on ocellar tubercle and hairs below on antennae, yellowish. Anterior intermediate bare spots not connected dorsally, and posterior spots separated from bare postalar calli. Anterior pollinose bands on abdominal tergites 2–5 entire, narrowly separated on 6; segments 7–8 bare; apical spines brown. Anterior crossvein at 40/67 length of discal cell, minute stump vein on one side, posterior cell 4 not narrowed at margin.

Holotype male, HOLDEN, UTAH, 18 September 1959, CIS. Allotype female, Beryl, Iron County, Utah, 27 September 1953 (M. Cazier) AMNH.

PARATYPES.—1 female, Five Points, Utah, 5 September 1931 (G. F. Knowlton, M. J. Jones) beets; antennal segment 3 missing, JW; 2 females, House Rock, Arizona, 14 September 1946 (F. H. Parker) A. L. Melander Collection, USNM.

Named in honor of Mont A. Cazier, Arizona State University, Tempe, a most persistent and productive collector who has supplied me with innumerable Asilidae in the last ten years.

Sintoria cyanea Wilcox, new species

MALE.—Length 8 mm. Head black, densely grayish white pollinose, frons with slight golden tinge. Hairs white, in mystax longer on oral margin; 4–5 yellowish lateral hairs on frons; about 6 erect yellowish bristles on ocellar tubercle; occipitals white. Face at antennae 21/33 width of one eye. Antennae black, segment 1 grayish and remainder brownish pollinose; sparse hairs below on segments 1–2 white, above brownish; two brownish bristles below on segment 1 and one on segment 2; segment 3 slightly coarctate, tapering on apical fourth; segments 14:13:39:17 in length.

Mesonotum black, densely grayish brown pollinose; central stripe subshining; small intermediate spots before and behind suture and postalar calli, shining black. Hairs erect yellowish, as long as antennal segments 1–2. Bristles yellowish, 2 presutural, 2 supraalar, 3 postalar. Pleura and coxae grayish pollinose, hairs white. Scutellum shining black, narrow posterior margin and basal semicircular spot, grayish brown pollinose; hairs yellowish white, on disc as long as mesonotal hairs, posterior margin with fringe of about 20 longer erect hairs.

Abdomen shining blue-black, sides of tergites 1–6 gray pollinose widening slightly on the posterior corners of 2–5. Hairs white, long laterally, short sparse dorsally. Sternites 1–7 gray pollinose with long white hairs. Genitalia black, long hairs white.

Legs blue black; hairs white; bristles white becoming yellowish brown on tarsi; claws black; pulvilli and empodia light brown.

Halteres yellowish, base brown. Wings hyaline, veins brown, anterior crossvein at 36/70 length of discal cell, third vein branched opposite end of discal cell.

FEMALE.—Length 7 mm. Apical spines of abdomen black. Third vein branched beyond end of discal cell.

Holotype male, SABINO CANYON, SANTA CATALINA MTS., ARIZONA, 25 October 1962 (J. Wilcox) CAS. Allotype female, same locality, 20 October 1962, CAS.

PARATYPES.—Arizona: 9 males, 19 females, same locality, 19 to 25 October 1962, 22 October 1965 (Itol J. and J. Wilcox) JW; 3 males, 3 females, same data, 11 October 1964 (Eric Fisher) EF; 1 female, 1.5 mi. N. E. Carrizo, Navajo Co., 28 September 1962 (P. H. Timberlake) UCR; 1 female, Huachuca Mts., 13 October 1931 (E. D. Ball) USNM; 2 males, 2 females, 3 mi. E. Pantano, 20 October 1962, 22 October 1965 (J. Wilcox) JW; 1 male, 1 female, 7 mi. W. Peach Springs, Mohave Co., 28 September 1964 (P. H. Timberlake) UCR; 14 males, 21 females, 2 mi. N. E. Portal, 10 October 1964 (Eric Fisher, R. R. Snelling) late afternoon and evening, some by sweeping Tar Bush, and 3 at light, EF; 1 male, 2 mi. N. E. Portal, 22 October 1960 (M. A. Cazier) ASU; 1 male, 3 females, 2 mi. N. E. Portal, 23 October 1962 (J. Wilcox) JW; 1 male, 2 females, Tucson, September 1939 (R. H. Crandall) AMNH; 1 male, Tucson, 31 September 1958 (R. S. Beal) ASU; 1 male, Tucson, 9 July 1920, JW.

The specimens collected at the mouth of Sabino Canyon, elevation about 3,000 feet, were mostly on the dead stems down in or among the seed clusters and flowers of Burro Brush. Near Portal, they were found on the stems and leaves of Tar Bush. On hot days, they were not found until 3:30 or 3:45 p.m., but on a cloudy day they appeared at 11:30 a.m., but soon disappeared when it became cooler. Another time a few were collected resting on the green foliage of mesquite about four feet high at 11:00 a.m. on a warm day. *Metapogon punctipennis* Coquillett was collected at the same time in both localities.

The specimens from near Portal have only the posterior corners of abdominal tergites 2–5 pollinose and some of the specimens from Sabino Canyon do not have the pollen on tergites 2–3 extending forward to the anterior margins on the sides of the tergites.

SINTORIA EMERALDA Hull

Sintoria emeralda Hull, 1962, U. S. Nat. Mus. Bull. 224: 199.

Type ♂, Nepantla, Mexico, 28 October 1923 (E. G. Smith) USNM; Allotype ♀, La Cascada, Mexico, 28 October 1922 (E. G. Smith) USNM.

MALE.—Length 7 mm. Face and frons golden, occiput gray pollinose; hairs all yellowish; face at antennae 19/28 width of one eye. Antennae black, hairs brown; segments 14:15:41:10 in length.

Mesonotum golden pollinose; central stripe, broad anterior and posterior intermediate spots and postalar calli, shining purple, anterior spots extend narrowly to humeri. Hairs white to yellowish and subequal in length to antennae 1–2. Scutellum shining bluish purple, very narrow posterior margin golden pollinose; discal and about 12 longer marginal hairs yellowish.

Abdomen bluish green; narrow posterior corners of tergite 1 and posterior corners of 2–5, golden pollinose. Genitalia blue black, hairs yellowish.

Legs bluish green, hairs and bristles yellowish.

Halteres lemon yellow, base and lower stem brown. Wings light brown; veins brown, at base anteriorly yellowish; anterior crossvein at 35/59 length of discal cell; third vein branched before end of discal cell, in one wing with minute stump vein.

FEMALE.—Length 7 mm. Posterior corners of tergites 1–6 yellowish pollinose. Anterior crossvein at 39/70 length of discal cell, third vein branched opposite end of discal cell.

ADDITIONAL SPECIMENS.—Mexico, Aguascalientes, 19 mi. S. Aguascalientes, Hy. 45, Km. 508, 19 August 1962 (Dorothy and C. H. Martin); Zacatecas, 10 mi. S. Jalapa, 17 September 1970 (G. E. and R. M. Bohart), Rio Grande, 4 September 1966 (G. E. and A. S. Bohart), 5 mi. N. Zacatecas, 19 September 1970 (G. E. and R. M. Bohart).

The following records were kindly supplied by Eric Fisher. Mexico: Guanajuato, 41 mi. N. Queretaro, 6,950 ft., 3 September 1963, (Scullen and Bolinger); Jalisco, 10 mi. S. W. Lagos de Moreno, 8 September 1970 (E. M. and J. L. Fisher); San Luis Potosi, 19 mi. S. San Luis Potosi, 7,200 ft., 4 September 1963 (Scullen and Bolinger).

Sintoria lagunae Wilcox, new species

MALE.—Length 8 mm. Head black, grayish white pollinose. Hairs of mystax black, the lower fourth white; hairs on frons black; about 12 long slender black bristles on ocellar tubercle; occipitals, beard and hairs on palpi and proboscis white. Face at antennae 21/38 width of one eye. Antennae black, brownish pollinose; hairs black, two bristle-like below on 2; segments 15:15:45:16 in length.

Mesonotum black; yellowish pollinose; central stripe subshining; intermediate spots with blue reflections, anterior ones twice as broad as long, posterior ones longer than broad and include postalar calli. Hairs on the anterior central stripe erect black and as long as antennae 1–2 with few yellowish anteriorly and mostly yellowish posteriorly; lateral hairs yellowish. Bristles yellowish, 2 presutural, others not separable from the hairs. Pleura and coxae yellowish pollinose; hairs on coxae white, on hypopleura yellowish. Scutellum black, narrow posterior margin yellowish pollinose; hairs yellowish, discal hairs sparse semierect, about 20 long erect marginals.

Abdomen blue-black; posterior corners of tergites 2–5 gray pollinose. Hairs yellowish, long on sides and short on dorsum. Sternites yellowish pollinose; hairs long erect yellowish. Genitalia black; hairs yellowish.

Legs black with blue reflections; hairs yellowish white; bristles yellowish; claws black; pulvilli and empodia light brown.

Halteres yellowish red, lower stem brown. Wings very light brown, veins brown, anterior crossvein at 37/62 length of discal cell, third vein branched slightly beyond end of discal cell.

FEMALE.—Length 8 mm. Face and frons with golden tinge; mystax black, hairs on sides below yellowish. Abdominal hairs white, short on sides of tergites 6–8; sternites 7–8 bare with short hairs; apical spines black. Anterior crossvein at 41/66 length of discal cell, third vein angulated and with suggestion of a stump vein.

Holotype male, MEXICO, BAJA CALIFORNIA SUR, SA. VICTORIA, LA LAGUNA, 5,500 ft., 20/23 October 1968 (E. L. Sleeper, F. J. Moore) CSCLB. Allotype female, same data, CSCLB. Types to be deposited in Los Angeles County Museum.

PARATYPES.—92 males, 79 females, same data, CSCLB; 7 males, 2 females, La Laguna, Sierra Laguna, L. Calif., 14 October 1941 (Ross and Bohart) CAS.

The mystax of both sexes varies from all black to the lower half white in the males and some of the oral hairs as well as the lateral hairs yellowish in the females. Some of the specimens show a distinct brown tinge in the wings while others are nearly hyaline.

Sintoria mojavae Wilcox, new species

FEMALE.—Length 10 mm. Head black, densely white pollinose. Hairs and bristles white; 6 bristles on ocellar tubercle. Face at antennae 24/40 width of one eye. Antennae black, brownish pollinose; hairs white; two yellowish white bristles below on segment 2; segment 3 tapers from base to apex; segments 18:18:45:20 in length.

Mesonotum black, gray pollinose; central stripe indistinctly brown; small intermediate spots and postalar calli, shining black. Hairs white; bristles white, 2 presutural and 2 fine supraalar and postalar. Pleura and coxae gray pollinose, hairs white. Scutellum gray pollinose, hairs white, about 12 long crinkly marginal hairs.

Abdomen purple-black; broad sides of tergites 1–6 expanded inward on posterior margins of 2–6, gray pollinose, fascia separated by about half width of abdomen on 2, widening gradually to 6; 7–8 bare; apical spines black. Hairs white, long on sides of basal segments becoming short apically; lateral bristles on 1 white. Sternites 1–7 gray pollinose, hairs long erect white on 1–5, dense on 1.

Femora greenish black, tibiae and tarsi blue black; hairs white; bristles yellowish white; claws black; pulvilli and empodia light brown.

Halteres light brown, lower stem brown. Wings hyaline, veins brown, anterior crossvein at 48/84 length of discal cell, third vein branched opposite end of discal cell.

Holotype female, GRAPEVINE SPRINGS (CUSHENBURY SPRINGS), SAN BERNARDINO COUNTY, CALIFORNIA, 18 September 1948 (J. Wilcox) CAS.

Sintoria pappi Wilcox, new species

MALE.—Length 7 mm. Head black, densely white pollinose, frons with slight golden tinge. Hairs and bristles white, on frons and 6 bristles on ocellar tubercle yellowish. Face at antennae 19/29 width of one eye. Antennae black, gray pollinose; hairs and one bristle on segment 2 yellowish white; segments 13:13:36:14 in length.

Mesonotum black, densely gray pollinose; divided central stripe and broad area behind humeri brown; small intermediate spots and postalar calli shining black. Hairs white, anteriorly in central stripe as long as antennae 1, longer posteriorly. Bristles yellowish, 2–3 presutural, 1 supraalar, 2–3 postalar and 3–4 anterior dorsocentral. Pleura and coxae grayish golden pollinose, hairs white. Scutellum black; narrow posterior margin and base of disc extending narrowly to posterior margin at middle, gray pollinose; hairs white, about 8 longer bristle-like marginals.

Abdomen blue-black; sides of tergite 1, broad sides of 2–7 and anterior margins of 2–6, gray pollinose, anterior fascia narrow at middle and interrupted on 2 and 6–7. Hairs long white laterally becoming shorter apically; 4–5 white lateral bristles on 1. Sternites gray pollinose, hairs white. Short genitalia blue black, hairs white.

Legs green black, hairs and bristles white; claws black; pulvilli and empodia light brown.

Halteres yellowish, base brown. Wings hyaline, veins brown except basally; anterior crossvein at 40/66 length of discal cell; third vein branched slightly beyond end of discal cell; anal cell broadly open.

FEMALE.—Length 6 mm. Face 16/24 width of one eye; antennal segments 11:11:25:15 in length. Central bisecting pollen on scutellum broad. Abdomen with blue-purple reflections; broad sides of tergites 1–6 gray pollinose, extending inward anteriorly on 2–6, narrowly entire on 3–5; sternites 1–6 gray pollinose; apical spines black. Halteres yellow, lower stem brown. Anterior crossvein at 28/46 length of discal cell.

Holotype male, 8.6 MI. S. W. OF NEW MEXICO STATE LINE, HWY. 180, CULBERSON COUNTY, TEXAS, 2 October 1962 (Chas. S. Papp) UCR. Allotype female, 2 mi. N. W. Mesa, Chaves County, New Mexico, 10 September 1961 (P. D. Hurd) *Gutierrezia lucida*, CIS.

The facial gibbosity of this species is very weak.

Named in honor of Charles S. Papp, scientific illustrator, University of California, Riverside and noted Coleopterist.

Sintoria rossi Wilcox, new species

FEMALE.—Length 10 mm. Head black (greased), pollen on face and frons yellowish, on occiput gray. Mystax long dense black with some yellowish white hairs intermixed on oral margin; hairs on frons and about 10 bristle-like on ocellar tubercle, black; occipitals yellowish white; beard and hairs on palpi and proboscis white. Face at antennae 23/34 width of one eye. Antennae black (greased); hairs black, three or four long ones below on segment 1 and two or three on 2; segment 3 narrowed on apical fourth; segments 15:17:45:18 in length.

Mesonotum black (largely greased), golden brown pollinose; bare intermediate spots before and behind suture confluent and postalar calli in part bare. Central line with dense crest of black hairs as long as antennal segments 1–3; long sparse hairs otherwise yellowish. Two yellowish presutural bristles, supraalars and postalars hair-like. Pleura and coxae yellowish gray pollinose, hairs yellowish white. Scutellum black with some gray pollen laterally; dense short discal hairs and about 20 long crinkly hairs on posterior margin, white.

Abdomen black with green-blue reflections; narrow sides of tergites 2–5 expanded a little on posterior corners, grayish pollinose; 1 and 6–8 bare; apical spines black. Hairs long yellowish white becoming shorter apically, bristles on 1 hair-like. Sternites 1–6 grayish pollinose, long sparse hairs yellowish white.

Legs black with blue reflections; hairs white; bristles yellowish; claws black; pulvilli and empodia light brown.

Halteres light brown, lower stem brown. Wings hyaline, veins brown; anterior crossvein at 46/79 length of discal cell; third vein branched a little beyond end of discal cell; anal cell broadly open.

Holotype female, N. SLOPE, 11,000 FT., MT. POPOCATEPETL, MEXICO, 20 November 1946 (E. S. Ross) CAS.

Named in honor of Edward S. Ross, California Academy of Sciences, who frequently collects rare specimens of insects other than his speciality on his many trips to numerous parts of the world.

LITERATURE CITED

HULL, F. M. 1962. Robberflies of the World. The genera of the family Asilidae. Part 1; Part 2. U. S. Nat. Mus. Bull., 224: 1–430, figs. 1–29, 1 pl.; 431–907, figs. 30–35 and 1–2536.

G Dallas Hanna,

1887-1970

PAUL H. ARNAUD, JR.
California Academy of Sciences, Golden Gate Park, San Francisco 94118

Doctor G Dallas Hanna, a "renaissance man," biologist, geologist, micropaleontologist, diatomist, malacologist, ornithologist, instrument maker and inventor, expert in optics, printer, photographer, was born on 24 April 1887 in Carlisle, Arkansas, and died in San Francisco, California, on 20 November 1970, during his 83rd year. He joined the Academy staff in 1919, and continued this association for 51 years. The diversity of his interests also included the planning and direction of the construction of the star projector for the Morrison Planetarium at the Academy's Instrument Shop. He adapted an Eastman Kodak Company three color printing process for illustrating the Academy's scientific publications (he and his wife Margaret produced approximately 165,000 color prints). Dr. Hanna received his A.B. (in 1909) and A.M. (in 1913) from the University of Kansas and the degree of Doctor of Philosophy (in 1918) from George Washington University. In May, 1970, Dr. Hanna was presented with the honorary degree of Doctor of Sciences by the University of Alaska.

For most of the period between 1911 and 1919, Dr. Hanna was employed by the United States Bureau of Fisheries in Alaska (first in the Bristol Bay area and from 1913 on in the Pribilof Islands). It was on the Pribilof Islands and later on Guadalupe Island and the adjacent Mexican West Coast Islands that he made his most significant contributions to the field of Entomology. During 1913-1914, he made important collections of insects and other arthropods from St. George Island, Alaska, and these were eventually published on in 1923 by various specialists in volume 46 of North American Fauna. Many species were recorded from these islands for the first time, including 17 species new to science; these collections are deposited in the United States National Museum. A second collection, made in the Pribilofs in 1920 was presented to the California Academy of Sciences. In 1921, 86 species (16 of them new) were recorded in the Proceedings of the California Academy of Sciences, ser. 4, vol. 11, no. 14, pp. 153–195. Dr. Hanna contributed an introduction to this paper on pages 153–155. From these combined Pribilof collections the following new species were dedicated to him: family Tipulidae—*Pedicia hannai* (Alexander), family Helcomyzidae—*Heterocheila hannai* (Cole), and family Muscidae—*Mydaea hannai* (Malloch).

FIG. 1. G Dallas Hanna. Photograph taken in 1966.

In 1922, Dr. Hanna was a key member of an expedition to Guadalupe Island and the islands of the west coast of Mexico aboard the motorship *Tecate*, from July 9th–August 16th. An article by Hanna and A. W. Anthony entitled, "A Cruise Among Desert Islands" was published in the National Geographic Magazine (vol. 44, no. 1, pp. 71–99, July 1923). On this expedition 1138 insects and arachnids were taken by Hanna and J. R. Slevin. The General Report of this expedition also was published by him in the Proceedings of the California Academy of Sciences (ser. 4, vol. 14, no. 12, pp. 217–275, text figs. 1–2, pls. 15–19, 1925). Dr. Frank E. Blaisdell, Sr. published an article in the same volume (pp. 321–343), recording 57 species of Coleoptera, of which 14 were new to science, including the patronym *Stibia hannai* Blaisdell (family Tenebrionidae) collected on Angulo Rock, Asunción Island. In subsequent years, Dr. Hanna continued to collect small lots of insects which he presented to the Department of Entomology, the last received in 1968.

On the occasion of Dr. Hanna's seventy-fifth birthday, volume 32 of the Proceedings of the California Academy of Sciences was dedicated as a "G Dallas Hanna Anniversary Volume." The first number, published on April 24, 1962, pages 1 through 40, contains a portrait, biography (written by Dr. Robert C. Miller) and bibliography of 438 writings and other scientific contributions through the year 1961. An additional 40 writings have been published, making a total of 478 contributions in a 61 year period, 1909 through 1970.

Dr. Hanna is survived by his wife, Margaret (née Moore) Hanna, three sisters, a brother, Dr. Marcus A. Hanna, two granddaughters, and four great grandchildren.

BOOK REVIEW

CURCULIONIDAE TRIBE OPHRYASTINI OF NORTH AMERICA (COLEOPTERA). David G. Kissinger, Taxonomic Publications, South Lancaster, Mass. 1970. 8½″ × 11″, 238 pp., 128 figures and groups of figures. $12.00 (paper).

This is the latest of Dr. David Kissinger's several substantial contributions to the knowledge of the Curculionidae and, at the same time, it constitutes the first part of a proposed revision of the weevil subfamily Leptopiinae in North and Central America. The major portion of this book is devoted to a revision of the 48 species of *Ophryastes*. These are large, broadnose weevils occurring in the arid regions of the western United States and northern Mexico. In addition to the thorough taxonomic treatment of *Ophryastes*, information is included on the generic characters and relationships of *Deracanthus*, a Central Asian genus which shares the tribe with *Ophryastes*.

In a section entitled "Ecology" Kissinger summarizes what little is known about the biology of *Ophryastes.* The paucity of information on this subject reflects the general lack of attention which entomologists have given to the study of weevil biology. The weevils under consideration here would seem to lend themselves well to such studies as they are large, sometimes relatively abundant, tend to form well-defined local populations, and above all, they should be interesting. Perhaps the present revision will provide the necessary impetus for investigation of their biology.

Four species of *Ophryastes* are described as new. Nomenclatural changes involve new synonymy for 3 generic and 20 specific names and new combinations for 29 names. Most of the species are placed in 3 species-groups on the basis of characters of the female genital tube; each of the 3 groups is further divided into species-subgroups. Eight species are not assigned to groups. The key works quite well for the determination of species of *Ophryastes.* One should have little or no difficulty correctly determining the large majority of members of the genus, especially if the key, descriptions and the many illustrations are carefully used together. The male and female genitalia are described more thoroughly than is usual in papers on weevils; otherwise the species descriptions and other taxonomic data are of the usual kind for such studies. Twelve pages are devoted to a summary of measurements of external characters of both sexes (where available) of the 48 species.

The list of references includes only those not cited by Kissinger in his 1964 generic key to the Curculionidae in America north of Mexico. It appears to me that the desirability of having this book complete within itself would have overshadowed the cost of adding the few additional pages required for a complete reference list.

The present book is profusely illustrated with photographs and line drawings in a manner similar to Dr. Kissinger's earlier work on weevils of the subfamily Apioninae. These illustrations and their accompanying explanations cover 142 pages. The photographs (of which there are several hundred) show dorsal, lateral and sometimes ventral habitus views, as well as views of specific external structures of taxonomic importance, and male and female genitalia. These photographs are mostly of excellent quality and add greatly to the taxonomic value of the publication. Because of the exceptionally large number of illustrations included, those referring to a given species are often arranged on widely separated pages. This, however, is only a minor inconvenience and does not detract from the general usefulness of the work.

Distribution maps, and tables and figures of statistical data involving principal component and multiple discriminant analyses cover 22 pages. An index to the new species described and new nomenclatural changes is also included.

Dr. Kissinger has once again demonstrated his ability to do high quality work on a taxonomically difficult group of weevils. The present revisionary study places the taxonomy of *Ophryastes* on firm ground and provides the information on which subsequent workers may base much-needed biological and population studies of the genus.—HORACE R. BURKE, *Texas A&M University, College Station, 77843.*

SCIENTIFIC NOTE

Thomas Wrentmore Cook Entomology Library.—The entomological library of the late Dr. Thomas Wrentmore Cook (1884–1962) was donated to the California Academy of Sciences by his widow, Mrs. Mary Manning Cook (now Mrs. George Wale) of Oakland, California. Arrangements for this important donation were made by Dr. and Mrs. Edward L. Kessel.

The Cook library on Formicidae, Hymenoptera, and General Entomology consists of 289 bound volumes (including 51 books and bound volumes of the papers of the renowned ant authority William Morton Wheeler), 25 parts of serials, 11 unbound volumes, and 1312 "reprints." The 51 volumes of the books and papers published by Dr. Wheeler are a virtually complete collection of the 470 items by this world ant authority, and there are probably few such sets in existence.

The library also includes numerous papers on world ants by many authors, including bound volumes of the works of Arnold, Clark, Creighton, Donisthorpe, Emery (7 volumes), Escherich, Fielde, Forel, Huxley, Janet (2 volumes), Mayr, McCook, M. R. Smith, and Wasmann; titles on Hymenoptera such as "Catalogus Hymenopterorum," vols. 1–10, by Dalla Torre, 1892–1902, "Nouvelle Méthode de Classer les Hyménoptères et les Diptères," vol. 1, "Hyménoptères," by L. Jurine, 1807, and "Additions et Corrections au Volume II de la Faune Entomologique du Canada traitant des Hyménoptères" by L'Abbé L. Provancher, 1889; and general works as "The Class Insecta" by Baron Cuvier (with supplementary additions by Griffith, Pidgeon, and Gray), 1832, "Über entomologische Sammlungen, Entomologen & Entomo-Museologie" by Walther Horn and Ilse Kahle, 1935–1937, and "Histoire Naturelle des Fourmis, et recueil de Mémoires et d'Observations sur les Abeilles, les Araignées, les Faucheurs, et autres insectes" by P. A. Latreille, 1802.

Dr. Cook, who wrote the book "The Ants of California" (Pacific Books, Palo Alto, pp. i–xiii, 1–462, illustrated, 1953), had a life-time interest in the Formicidae, having first undertaken graduate studies on this group of insects with Wheeler in 1932. It was mainly during the last fifteen years of his life, from 1948 on, that he assembled this extraordinary library on the ants of the world and on the order Hymenoptera.—PAUL H. ARNAUD, JR., *California Academy of Sciences, San Francisco, 94118.*

SCIENTIFIC NOTE

The Lost Type of *Brachinus sallei* Chaudoir (Coleoptera: Carabidae).—In my 1970 revision of North and Middle American Bombardier Beetles (Quaest. Entomol., 6: 4–215) I stated that the type(s) of *Brachinus sallei* Chaudoir was presumed lost. The basis for this statement was, first, the indication by Chaudoir that he saw the specimens he described in Sallé's collection, and second, the subsequent search in parts of this collection by George E. Ball in the Museum National d'Histoire Naturelle, Paris and by E. Taylor in the Hope Museum, Oxford, at my request. The specimen was not found in either museum where the type(s) should have been. Then, quite unexpectedly, during a recent visit to the British Museum (Natural History), supported in part by the American Philosophical Society, I discovered a specimen of *Brachinus sallei* labelled "Orizaba, Mexico, Sallé Coll., type," "108" on green paper, and further labelled "Brachynus Sallei Chd. after Sallé, Sallei Chaud."

Consequently, this specimen, a male, is herewith designated LECTOTYPE. The type locality was originally stated by Chaudoir to be Mexico, and later restricted by me to Tabasco, Mexico on the basis of material seen; but Sallé's label "Orizaba, Mexico . . ." indicates the real TYPE LOCALITY. This locality record also indicates a wider distribution than I previously reported; the northern most locality then known was Lake Catemaco, Veracruz, Mexico.—T. L. ERWIN, *Smithsonian Institution, Washington, D. C., 20560.*

SCIENTIFIC NOTE

Observations on the Life History of Bombardier Beetles: Mechanism of Egg-Hatching (Coleoptera: Carabidae).—In 1967 Dr. George Ball and I collected live specimens of various species of *Brachinus* throughout Mexico. These were kept alive in plastic bags until we returned to the University of Alberta, Canada. Subsequently, the specimens were sorted to species and placed in refrigerator trays containing moist peat, and maintained at room temperature. The specimens were fed injured insects and various cuts of beef. The colony of *Brachinus mexicanus* Dejean subsequently began mating and ovipositing, in a manner I have described previously [Erwin, 1967. Coleopt. Bull., 21(2): 41–55]. The eggs in this case were not rolled in mud as they normally would be, because the peat substrate was unnatural. This allowed me to make continuous observations on the developing embryo through the very thin-walled egg. The development of the embryos required 7–10 days.

Most carabid larvae have one or two egg-bursters or spines on the frons with which the egg membranes are rasped and broken. The frons of known *Brachinus* larvae are smooth with no evidence of egg-bursters.

The young embryo of *B. mexicanus* develops in a C-shape within the ellipsoid egg; the frons, clypeolabral area, and dorsum of the mandibles are against the side wall, rather than one end. As the young larva grows, the point of one mandible presses against the egg membrane. At the proper growth stage, the wall is pierced by this mandible, and is probably helped by some muscle contraction. In dry, mud-encased eggs (the normal condition) the amniotic fluid moistens the dry mud covering the egg and allows the first instar to struggle free. It's subsequent behavior and development has been described before (Erwin, *ibid.*).—T. L. ERWIN, *Smithsonian Institution, Washington, D. C., 20560.*

ZOOLOGICAL NOMENCLATURE: Announcement A. (n.s.) 88

Required six-month's notice is given of 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.* 28, pts. 1/2, 10 August 1971):

1937. Suppression of *Papilio actaeon* Fabricius, 1775 (Insecta, Lepidoptera)

(see *Bull. Zool. Nomencl.* 28, pts. 3/4, 8 December 1971)

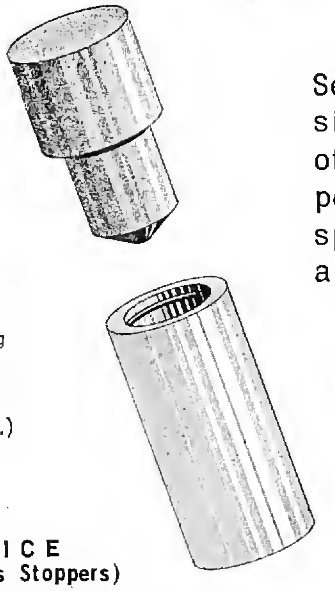
1954. Type-species for *Sminthurinus* Börner, 1901 (Insecta, Collembola)

1962. Validation of *Polyzonium germanicum* Brandt, 1837 (Diplopoda)

(see *Bull. Zool. Nomencl.* 28, pts. 5/6, 31 December 1971)

1966. Type-species for *Heniola* Uvarov, 1940 (Insecta, Orthoptera)

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.*



PACIFIC COAST ENTOMOLOGICAL SOCIETY

F. L. Blanc	D. G. Denning	M. S. Wasbauer	P. H. Arnaud, Jr.
President	*President-elect*	*Secretary*	*Treasurer*

Proceedings

Three Hundred and Thirty-Eighth Meeting

The 338th meeting was held Friday, 19 February 1971, at 7:45 p.m. in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco. President Blanc presided.

Members present (34): R. P. Allen, P. H. Arnaud, Jr., W. E. Azevedo, D. Bacon, J. Benedict, G. S. Benham, Jr., F. L. Blanc, I. Boussy, G. Brady, R. Bushnell, S. L. Clement, Karen S. Corwin, A. R. Dutton, J. F. Emmel, F. Ennik, K. E. Frick, E. Grissell, J. Guggolz, K. S. Hagen, J. T. Hjelle, E. A. Kane, R. L. Langston, H. B. Leech, R. Lem, D. P. Levin, A. E. Michelbacher, A. R. Moldenke, C. B. Philip, H. I. Scudder, R. E. Stecker, J. W. Tilden, M. S. Wasbauer, S. C. Williams, D. L. Wilson.

Visitors present (10): V. Cheney, Alexandria Ennik, T. M. Glenine, K. Heston, Netta Leong, Martha Michelbacher, Alison Moldenke, Hazel Tilden, Constance Wilson, R. Wong.

The minutes of the meeting held 18 December, 1970, were summarized.

The following names were proposed for membership: C. D. Langston, Jeannette N. Wheeler, Harriet B. Reinhardt.

President Blanc asked for introductions from the floor. Mr. Steve Clement introduced John Benedict, a graduate student at U.C. Davis. Dr. Ron Stecker introduced Don Henley, a student at San Jose State College, recently returned from Viet Nam.

President Blanc read an announcement of the First International Congress of Systematic and Evolutionary Biology which will be held at the University of Colorado, Boulder, from 4–11 August 1973. The Society of Systematic Zoology and the International Association for Plant Taxonomy are co-sponsors of this midterm congress of botanical and zoological interaction at the international level.

President Blanc announced that the first thirteen volumes (1924–1937) of the *Pan-Pacific Entomologist* are still on sale to members at the reduced price of $1.50 per volume or $19.50 for the entire thirteen. At today's prices, these would run $10.00 per volume.

President Blanc announced his appointment of Dr. J. W. Tilden to the Program Committee, and Dr. Fred G. Andrews to head up an ex-officio refreshment committee.

He also pointed out that the date given on the meeting notice cards for the March meeting was in error. There will be no March meeting. The next scheduled meeting will be 16 April. Mr. Ian Boussy asked why we are having so few meetings and was answered by Dr. Stecker, who stated that the number of meetings follows the tradition of past years with three meetings in the Spring and three in the Fall, but that the policy is flexible, and if the membership wishes to have more the Program Committee will do its best to find additional speakers. Dr. Stecker then asked that anyone with suggestions on a site for the annual picnic and field day contact him as soon as possible, so plans can be made for this year.

The following notes were presented:

The red dragonflies of Tokyo.—There was an apparent mistaken reference to "red horseflies" (Diptera: Tabanidae) in a recent World Press broadcast, rather than to red dragonflies (Odonata) which was actually intended. The reference was in a broadcast on Channel 9 Television in early November, and a letter of inquiry to the participant, Professor Chalmers Johnson at the Center for Chinese Studies, University of California, Berkeley, brought a letter and a copy of the Japanese paper *Asahi* used. The insect pictured was the characteristic and well-known red dragonfly of Tokyo, which had made the news because it has largely disappeared as a result of air pollution. Dr. Johnson commented: "The government is making an effort both to control smog and to bring back red dragonflies." The newspaper, showing a photograph of a man holding a red dragonfly on the Ginza in Tokyo, was exhibited at the meeting.—C. B. PHILIP, *California Academy of Sciences.*

F. C. Hottes, 1899–1970.—Frederick Charles Hottes, born October 20, 1899, died at Grand Junction, Colorado, 27 October 1970. His brother, Howard H. Hottes, has sent the following information to the Pacific Coast Entomological Society.

Fred Hottes was born at Mascoutah, Illinois. He graduated from Mt. Lincoln High School in Palisade, Colorado, in 1919, obtained his B.S. from Colorado Agricultural College (now Colorado State University), Fort Collins, in 1923, his M.S. from Iowa State College in 1925, and his Ph.D. in entomology from the University of Minnesota in 1927. He was Professor of Biology at James Milikin University, Decatur, Illinois, 1928–1947, and head of the department from 1929 until his retirement in 1947. At that time he returned to Grand Junction, Colorado, to care for his widowed father, H. G. Hottes, who passed away in 1957. Fred Hottes began publishing descriptions of new species of aphids before receiving his doctorate, and one of his early major papers was 'The plant lice, or Aphididae of Illinois' with T. H. Frison, 1931. He continued to publish after his retirement, and had a lifelong special interest in the genus *Cinara.* He published on aphids in co-authorship with other workers, notably E. O. Essig, and on surface and shore bugs (veliids, halobatids, saldids, etc.) with C. J. Drake.—HUGH B. LEECH, *California Academy of Sciences, San Francisco.*

The Sonora Blue—1971 the earliest season for the north.—*Philotes sonorensis* (Felder & Felder) adults were collected in late January in Santa Clara County, California, and in abundance in early February in El Dorado and Placer counties. It appears that the "peak" flight for 1971 has already occurred, and adults will be scarce in March or April at the lower elevations. Almost half of the males in these northern colonies have a few orange scales on the hindwings corresponding to the prominent orange splotch on the females. This has not been observed on numerous Southern California specimens. There is also variation in the number and location of the black spots on the forewings within the colonies throughout the species range from Northern to Baja California. Although the percentages may vary from coast to desert, or from north to south, no subspecific status seems to be warranted. These populations are referred to as "colonies," as *P. sonorensis* is a very weak flier and is seldom found far from its *Dudleya* host. The acceptable stonecrop species (Crassulaceae) have such a spotty distribution, that one wonders why the insect shows so little variation, or how some of the more isolated colonies could have become established.—ROBERT L. LANGSTON, *Kensington, California.*

The principal speaker of the evening was DR. J. W. TILDEN, San Jose State College, emeritus. His beautifully illustrated talk was entitled "Insects and their Western Habitats."

Coffee and other refreshments were served during a social hour in the entomology rooms following the meeting.—M. S. WASBAUER, *Secretary.*

THREE HUNDRED AND THIRTY-NINTH MEETING

The 339th meeting was held Friday, 16 April 1971, at 7:45 p.m. in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Blanc presiding.

Members present (28): R. P. Allen, F. G. Andrews, P. H. Arnaud, Jr., W. Azevedo, F. L. Blanc, G. Brady, T. Briggs, S. L. Clement, J. E. Cronin, D. G. Denning, A. R. Dutton, J. F. Emmel, F. Ennik, W. E. Ferguson, J. R. Gabel, L. Gormley, T. E. Hewton, Jr., R. L. Langston, H. B. Leech, G. A. H. McClelland, A. E. Michelbacher, C. B. Philip, E. S. Ross, O. Shields, R. Stecker, R. W. Thorp, M. S. and J. S. Wasbauer, R. H. Whitsel, S. C. Williams.

Visitors present (21): Madelaine Arnaud, J. Bass, Grace Bass, D. Carroll, C. Crawley, T. W. Davies, Sue Dolcini, Alexandria Ennik, Stephenie Ferguson, Toni Gabel, D. Jolly, W. Rausden, Pam Ringhoff, Ann Sibole, Karen Stecker, R. Stecker, R. Taylor, Ruth Taylor, Joyce Thorp, W. Vaundell, R. L. Wong.

The minutes of the meeting held 19 February 1971 were summarized.

The following names were proposed for membership: David W. Berggren, Jacques Chassain, J. Eric Cronin, Carol D. Crosswhite, Timothy L. Delgman, Dennis R. Engel, Carl Goodpasture, Donald J. Jolly, James D. Marshall, Albert E. Rackett, Keith B. Taylor, Richard J. Taylor, Norman E. Woodley.

Dr. Ferguson announced that Dr. J. W. Tilden, recently emeritus from San Jose State College, had undergone open heart surgery at the Stanford Medical Center last week. Dr. Stecker added that blood donations in Dr. Tilden's name would be gratefully accepted.

Mr. Leech exhibited some cardboard boxes with pinning bottoms suitable for temporary storage of Lepidoptera, etc. Twenty-five of these are available from the Academy at $0.20 each.

The program chairman, Dr. Stecker, announced the forthcoming picnic and field day is to be held at Del Puerto Canyon, Stanislaus County on Saturday, 15 May. President Blanc had been there earlier today and described the area as one of an abundance of various plants, notably digger pine, *Senecio* and manzanita, with a picnic area and paved roads. Dr. Stecker announced that the speaker for the next regular meeting on 15 October will be Rick Main, who will speak on insect collecting in the Grand Canyon of Mexico.

President Blanc called for introductions. Dr. Wasbauer introduced Miss Pam Ringhoff and Miss Sue Dolcini, both of the California Department of Agriculture. These girls serve the Society well in that they do all of the typing and record keeping for the Secretary and so leave him free to concentrate on other duties.

The following notes were presented:

Oviposition of the California Damsel fly, *Archilestes californica* MacLachlan.—On 25 September 1968, while collecting insects in the stream bed of Alameda Creek in Sunol Valley Regional Park, Alameda County, California, I observed a pair of *Archilestes californica* MacLachlan in the process of oviposition on the small stems of White Alder, *Alnus rhombifolia.*

The White Alder found along inland foothill and mountain streams in California is a large upright growing tree. The Alder in this observation was a small (about ½ meter in height) immature plant or the leafed sucker stems of a larger tree. The plant grew out from beneath a large rock and hung over a shallow pool in the stream.

Closer observation of this plant showed three and sometimes four pairs of *A. californica*, the males riding tandem with females in oviposition. Almost all the small stems of this miniature Alder were girdled by egg punctures.

The male California Damsel fly seizes the female by the prothorax with the clasping terminal appendages of the abdomen and maintains this posture all through oviposition. The female arches her long abdomen so that the ovipositor rests on the bark of the plant stem. She lays six eggs in each puncture that is made with an incising tool, the terebra of the ovipositor. The punctures are easily recognizable by the reddish puckered scars on the twigs. The flat elongated ovate eggs are inserted beneath the outer bark and into the cambium layer in fan-like fashion three on each side from the puncture. As many as seventy five to one hundred seventy five eggs may be inserted by one female in numerous incisions on the twigs. The eggs lie dormant beneath the bark through the winter. Hatching in spring the young naiads then drop to the water below.

A return trip on 5 October 1968 revealed only one pair of Damsel flies in oviposition on the same plant. The terminal twigs of the branches of the larger alders hanging over Alameda Creek were examined at this time but no indications of scarring by *Archilestes* could be found. The supposition proposed herein is that *Archilestes californica* prefers only the small tender shoots of the immature alder trees for ovipositing in this area.—T. W. Davies, *California Academy of Sciences, San Francisco.*

Sound production in *Agrilus pulchellus* Bland (Coleoptera: Buprestidae).—At the American Museum's Southwestern Research Station, 5 miles west of Portal, in Cochise County, Arizona, on 11 September 1966, while inspecting an insect flight trap situated in a small meadow, partly surrounded by *Salix* sp., I sighted a specimen of a beautifully colored *Agrilus* resting on one of the inside panels of the flight trap. The specimen was collected by hand and held between my thumb and index finger. To my surprise I could discern stridulatory sounds. The specimen was held so that the elytra and abdomen were tightly held, with the head of the beetle free. The stridulatory sounds were produced at the time the *Agrilus* rotated its head from side to side in its prothoracic socket. The specimen was subsequently determined as a female of *Agrilus pulchellus* Bland.

Carlson and Knight (1969, Contrib. Amer. Entomol. Inst., 4(3): 69–71) discuss stridulation in four sympatric species of *Agrilus* in Michigan. The method of stridulation is apparently unique to *Agrilus.* The sounds produced are considered stress sounds, are identical in both sexes, and are not species specific. With their *Agrilus* species the stridulations could not be heard without amplification or by placing the insect next to the ear. In the case of *Agrilus pulchellus* the stridulatory sounds were audible at a distance of at least 15 inches.—Paul H. Arnaud, Jr., *California Academy of Sciences, San Francisco.*

The principal speaker of the evening was to have been Mr. Michael R. Gardner, but Mr. Gardner was taken ill the day of the meeting and Dr. G. A. H. McClelland very kindly offered to fill in by narrating a film he had made on his mosquito research in Africa.

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

THREE HUNDRED AND FORTIETH MEETING

The 340th meeting was the annual field day and picnic. It was held on Saturday, 15 May 1971 at Frank Raines County Park in Del Puerto Canyon, Stanislaus County, California.

Members present (19): F. L. Blanc, R. J. Bushnell, J. E. Cronin, A. R. Dutton, J. G. Edwards, F. Ennik, W. E. Ferguson, J. R. Gabel, A. Gillogly, Anita Gillogly, H. B. Leech, C. B. Philip, Harriet Reinhard, R. E. Stecker, R. Taylor, K. Taylor, M. Wasbauer, Joanne Wasbauer, R. F. Wilkey.

Visitors present (17): Fern Blanc, Marcia Cronin, Pam Dutton, Alice Edwards, Sasha Ennik, J. Ennik, A. Ennik, Stephenie Ferguson, Toni Gabel, Gladys Philip, Karen, Phyllis, Susan and R. Stecker, Jean Walker, Carol and D. Wasbauer.

The day was pleasant, clear and warm. A west wind came up in the afternoon which kept temperatures down to a pleasant level. Insects were in evidence throughout the area. Craneflies were particularly abundant in the grass surrounding the irrigated picnic area. Insect collecting and photography were major activities noted during the day. Frisbee games and sunbathing were also enjoyed by some. Franklin Ennik reported collecting a number of scorpions in the canyon and Dr. Edwards collected some interesting aquatic Coleoptera. Dr. Wasbauer reported that, despite the wind, he took nearly a thousand specimens in two Malaise traps operated in the Canyon for three hours.—M. S. WASBAUER, *Secretary.*

THREE HUNDRED AND FORTY-FIRST MEETING

The 341st meeting was held Friday, 15 October 1971, at 7:45 p.m. in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Blanc presiding.

Members present (29): F. G. Andrews, C. Armin, F. L. Blanc, R. M. Bohart, I. Boussy, T. Briggs, R. M. Brown, K. S. Corwin, J. Eric Cronin, A. R. Dutton, W. E. Ferguson, J. R. Gabel, M. R. Gardner, L. Green, J. Guggolz, J. T. Hjelle, E. A. Kane, H. B. Leech, R. Main, A. E. Michelbacher, C. B. Philip, H. G. Real, E. S. Ross, R. B. Stecker, K. Taylor, R. Taylor, R. W. Thorp, S. C. Williams.

Visitors present (31): H. P. Allemndrizen, Fern Blanc, Mr. and Mrs. G. Cabral, Kathy Cheap, M. P. Cronin, T. Delaman, Thomas Dimock, Cristine Duncan, Janie Edwards, Beverly Ehreth, Don Emlay, Stephenie Ferguson, P. C. Galam, T. M. Glimme, Roberto H. Gonzalez, Sue Goodwin, Martha Hjelle, Bob Hishop, Ron Limandde, Dennis Merrill, Martha Michelbacher, Wayne Nelson, Carl Pinto, Phyllis Stecker, Don Streke, Joyce Thorp, Marilyn Trochman, Darrell Ubick, Gregory H. Walker, Wendy Hofman, Robert Wong.

President Blanc announced that Secretary Wasbauer is recovering from a back operation and is not able as yet to resume his duties as Secretary. President Blanc, therefore, appointed Michael Gardner acting interim Secretary for the duration of Dr. Wasbauer's recuperation.

The minutes of the meeting held 16 April 1971 were summarized. The annual Field Day and Picnic (340th meeting) was also reviewed.

The following names were proposed for membership: Student members: John MacDonald, Carl Goodpasture, Steven Haskett. Regular members: George Tamaki, C. E. Langston, John D. Glaser, Wayne L. Vaundell, Donald V. Jolly, Beverly Ehreth, David E. Foster, Fred Roberts, Jim Batts.

Program Chairman Ron Stecker announced that the next meeting may be held on the 12 November 1971 and that the principal speaker would be Dr. Henry Robinson. Dr. Robinson is expected to speak on his work in medical entomology done for the World Health Organization in Southeast Asia. Dr. Stecker also announced that the following meeting's main speaker will be the outgoing President, Louis Blanc, who will deliver the traditional presidential address.

Dr. Stecker announced that the San Jose Entomology Club had torn 30,000 reprints from excess issues of the *Pan-Pacific Entomologist.* These were to go on sale, and the proceeds to benefit both the Pacific Coast Entomological Society and the San Jose State Entomology Club.

President Blanc expressed his appreciation on behalf of the Society to the San Jose State Entomology Club for their fine job in making these papers available.

President Blanc announced that the Treasurer, Dr. Arnaud, had received correspondence from the Internal Revenue Service concerning the status of the Pacific Coast Entomological Society as a non-profit organization. President Blanc proposed an addition to the Society's Articles of Incorporation to meet the federal requirements for a tax-exempt corporation. The addition to the Articles was thereupon put to the vote of the members and unanimously approved.

President Blanc called for notes and exhibits. The following notes were submitted:

Some Observations on Tarantula Behavior.—On 27 July 1971, a large, brown tarantula (Araneae: Theraphosidae) was given to the Department of Entomology of the California Academy of Sciences. Unfortunately, the origin of the spider is unknown because it was originally purchased from a biological supply company. Also, due to the incomplete knowledge of the systematics of this group, the generic and specific assignment is not known.

On 7 September 1971, the tarantula constructed a whitish egg sac which was approximately 1.75 in. long, 1 in. wide and ½ in. thick. The sac was flaccid, assuming, to some degree, the shape of whatever substrate it was placed on. The egg sacs of many other spiders, such as the Black Widow (*Latrodectus mactans*), *Argiope* spp., and the wolf spiders, are strong enough to maintain a circular shape. It was not tightly packed with eggs, since the contents would shift from one end to the other when handled. The sac was carried about at times, held tightly by the chelicerae, and at other times it was left on the ground, seemingly ignored.

On 1 October 1971, the tarantula destroyed and ate the egg sac and much of its contents. At this time, I salvaged a portion of the sac and was able to determine that it consisted of five separate layers of silk, the outermost layer being thicker than the others. The space inside would have had an approximate diameter of 1½ in. if circular.

The eggs were a shimmery yellowish-green with irregular white spots which moved, as the egg was moved, as if suspended between the "shell" and an inner central mass. Of the several eggs examined, none showed any trace of embryonic development.

This spider had been kept as a pet for two years prior to coming to the California

Academy of Sciences, and during that time never came in contact with a male. Thus, even though copulation had not occurred, an egg sac was constructed to accommodate infertile eggs.—John T. Hjelle, *California Academy of Sciences, San Francisco.*

High Flight of Butterflies in San Francisco, California.—The purpose of this note is to report observations made by Mr. Russell W. LaBelle, a stock broker, who has an office in the Bank of America building in the Business district of San Francisco. The Bank of America building is San Francisco's highest; 52 stories and 779 feet in height. It is located in the block surrounded by California, Kearny, Pine, Montgomery Streets. From his 43rd story window, which is at a elevation of over 600 feet, on 4 and 5 October 1971, Mr. LaBelle noted butterflies flying in sufficient numbers to warrant telephoning the Academy to report this occurrence. During mid-day a butterfly was seen every few minutes. He observed, from his windows facing on California Street, that the butterflies were flying mostly from west to east. This direction of flight would direct them inland rather than towards the coast.

The species involved in this flight is not definitely known. It was not possible to collect voucher specimens, and an entomologist did not view the flight. It was at first thought that the Monarch, *Danaus plexippus* (Linnaeus) was responsible for this flight. However, from information on extensive flights of the California Tortoise Shell, *Nymphalis californica* (Boisduval) reported in the bay area by Dr. J. Powell at this same time, this latter species may have been involved in this flight.—Paul H. Arnaud, Jr., *California Academy of Sciences, San Francisco.*

Mass movements of *Nymphalis californica*.—*Nymphalis californica* undergoes periodic or sporadic massive population increases and mass movements which have been called migrations in the literature. The last time this occurred in the San Francisco Bay area was in 1960, when several aggregations of the butterflies were observed in spring, followed by tremendous populations developed in June. During intervening years the species is scarce and may not be a breeding resident here. Data which will be published elsewhere were given concerning movements of the butterflies in the Berkeley Hills during 5–14 October 1971. A request was made for recording of any observations of *Nymphalis*, particularly mass movements, during this fall and next year. Circumstances indicate that the note given earlier in this meeting, on high-flying butterflies over San Francisco, involved observations on *N. californica*.—J. A. Powell, *University of California, Berkeley.*

Further Observations of Theraphosid Tarantula Burrows.—Two groups of colonies of tarantulas are being observed; one is located at Frank Raines County Park in Stanislaus County, 17 miles west of Patterson. The other is at Los Gatos Creek County Park, Fresno County, 21 miles west of Coalinga. These colony sites have been visited once a month since their discovery over a year ago. Usually the observations have been made during the first weekend of each month.

The Frank Raines Park colonies are on grassy slopes in oak woodlands with a mixture of digger pines, juniper and chamise and are on the north facing slopes. At Los Gatos Park, the area is an almost level grassland with oak-juniper woodlands having a sparse distribution of digger pine and chamise. Both areas have been disturbed by man in the making of the parks, but this apparently has had little effect on the existence of the tarantula colonies.

In late summer and early fall, the tarantula burrow is easy to distinguish because its occupant has woven a collar of webbing around the edge of the opening and usually has a thin veil of webbing across the entrance. If the veil web is destroyed by inquisitive poking with a twig, the tarantula will usually emerge, examine its doorway and then descend head-first and spin a new veil web. The constant respinning of the veil web builds up the collar around the opening. On several occasions it has been observed that rosettes of dried leaves have been created around the burrow opening, particularly if the hole emerges on a grassless, hard, earth-surface of a campground or picnic area. Late in the summer, some of the tarantulas at Los Gatos Park pushed empty egg cases out of the burrows and left them beside the entrances. Mature females and males usually have a burrow entrance about the size of a 25¢ piece (2.4 cm). However, when the webbing collar is removed, the burrow may be as much as 6 to 7.5 cm in diameter.

With the onset of winter, several tarantulas closed their burrows. It has not been observed how they do this, and there is variation in their techniques. Some plug their burrows at the surface, while others plug the entrance from 2 cm below the surface to 20 to 25 cm below the surface. The veil web and collar are destroyed in the plugging. Sometimes the burrows will develop a growth of grass around the edges or across the plug. Relocation of the burrows is difficult unless they are marked.

What the stimulus for reopening the holes may be has not been determined, nor has the stimulus for plugging the holes been determined. So far there is little indication of correlation between hole-plugging activities and temperature drop. Some tarantulas remained active all winter, even when temperatures at Frank Raines Park dropped to below freezing at night. Others plugged their holes early in the Fall and remained closed through May. Rain doesn't seem to be a direct cause of closure. At Frank Raines Park there was much more rain, yet all occupied burrows observed at Los Gatos Park, were closed this winter and the rainfall there has been extremely sparse this year. In the laboratory "colony" of 13 female and 5 male tarantulas, six females were stimulated to dig holes after an artificial "rainy season" was created by pouring water on them every other day for two weeks. In the field, spiders sometimes plug their burrow entrances after water was poured into the burrow in attempts to wash them out of the tunnel. One female in the laboratory closed her burrow entrance after a "rainstorm" where both the ground and the tarantula were well dampened by water.

The "watering" technique has proved to be a good means of "sexing" colony members. Theraphosid tarantulas usually emerge from the burrow when water is poured into the opening; sometimes half a liter is all that is necessary to bring emergence and at other times it has been necessary to pour over three to five liters into the burrow. This technique saves the need to dig out the tarantula and thus destroy its home. Sometimes, these spiders will plug the entrance with their bodies when water is introduced—the hairy body forming an impenetrable plug. This may be a "defensive" mechanism against sudden flash flooding.

It is unwise to poke fingers into open burrows because the tarantula is often quite agressive when in the burrow. When teasing spiders out of the entrance with a twig, pencil or similar tool, the tarantula frequently attacks the object with its chelicerae. It has been observed that the spider can sink its fangs into the wood of a pencil. However, once the spider has emerged from its burrow, it then usually assumes the docile attitude of the Theraphosidae.—J. RUSSEL GABEL, *San Francisco State College, San Francisco.*

Death of E. R. Leach.—Mr. Edwin R. Leach of 217 Hillside Avenue, Piedmont, California, died the 22nd of July 1971, age 93. He was a member of the Pacific Coast Entomological Society for 55 years, having joined in 1916. He later became a Life Member, and in 1948 was elected an Honored Member. His interest in the society was an active one: he helped it with gifts of money, and served as Treasurer from 1931 to 1942.

Mr. Leach joined the California Academy of Sciences in 1920, became a Life Member and Patron in 1946, and a Fellow in 1955. Through the kindness of his wife and daughter, his wish that his collection of beetles be given to the Academy has been complied with, and the material not yet accessioned but estimated to be between 40,000 and 50,000 specimens, has just been received. His interest centered in the Cetoninae of the Scarabaeidae, and the Lucanidae, in each of which he had outstanding world wide collections of identified species. In addition, there are strong collections of the black tiger beetles, *Omus spp.*, and the rain beetles, *Pleocoma spp.*, as well as ruteline Scarabaeidae, Australian Cerambycidae, etc. With the collections there is a fine working library.—HUGH B. LEECH, *California Academy of Sciences, San Francisco.*

The principal speakers of the evening were MR. RICHARD MAIN AND MR. HERMAN REAL, of San Jose State College. Their illustrated talk was entitled "5,000 Miles Through Baja California."

Coffee and other refreshments were served during a social hour in the entomology rooms following the meeting.—M. R. GARDNER, *Acting Secretary.*

THREE HUNDRED AND FORTY-SECOND MEETING

The 342nd meeting was held Friday, 12 November 1971, at 7:45 p.m. in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Blanc presiding.

Members present (32): J. D. Anderson, P. H. Arnaud, Jr., J. W. Bass, M. Bentzien, R. G. Blair, F. L. Blanc, T. Briggs, R. M. Brown, R. Bushnell, D. C. Dailey, D. G. Denning, A. R. Dutton, J. G. Edwards, F. Ennik, W. E. Ferguson, M. R. Gardner, A. R. Gillogly, L. Green, J. T. Hjelle, D. Jolly, E. A. Kane, R. L. Langston, H. B. Leech, R. Lem, A. E. Michelbacher, C. B. Philip, F. C. Roberts, H. I. Scudder, R. B. Stecker, K. Taylor, R. Tassan, S. C. Williams.

Visitors present (25): G. M. Bass, Fern Blanc, L. Campbell, T. Delgman, L. Denning, A. Edwards, S. Ferguson, B. Gushkowitz, L. S. Hawkins, D. Jamieson, P. Jamieson, A. Jung, E. Kemz, A. H. Kreuger, M. A. Kwok, C. LaPoint, L. B. Mak, M. Michelbacher, R. L. Peterson, R. Poole, H. W. Robinson, R. P. Swaitzell, L. Tassan, D. Tiemann, R. Zaiate.

The minutes of the previous meeting held 15 October 1971 were summarized.

The following names were proposed for membership: Student members: Albert Jung, Carolyn Rees, Robert Wong, Steven Haskett; Regular members: Fred C. Roberts, Lyndon Hawkins, Dean Jamieson, and Raymond L. Peterson.

The following notes were presented:

Contiguous Areas of Arizona and Pacific Slope Floras in Northern Baja California, Mexico.—*Quercus turbinella* Green is a common shrubby oak of the Southwestern U. S. and was described from "northern Baja California," but Weld (1960) in *Cynipid Galls of the Southwest* indicated he didn't think *Q. turbinella* occurred in Baja because he had never seen it or it's distinctive cynipid fauna there. However, it does occur throughout the Sierra de Juarez of northcentral Baja California, Mexico. In two papers on the interrelationships between *Quercus dumosa* Nutt. (a California oak) and *Q. turbinella*, Tucker (Madrono, 1952, 11: 234–251; 1953, 12: 49–60) stated that Wiggins thought these two oaks were isolated in Baja California. During a trip to this area in August 1969, I found members of the Arizona flora including *Q. turbinella, Artemisia tridentata* Nutt., *Pinus quadrifolia* Parl., and *Quercus dunnii* Palmer, (= *Quercus palmeri* Engelm.) directly adjacent to representatives of the California flora including *Adendostoma fasciculatum* H. & A. and *Quercus dumosa.* Within five miles southwest of El Condor, Baja California, (approx. 32° 25′ N. Lat., 116° 9′ W. Long.), I found three areas where *Q. turbinella* and *Q. dumosa* occur within two feet of each other. This would be an ideal area to study the environmental conditions restricting these two floras and associated faunas.

Because of morphological and ecological similarity between *Q. turbinella* and an oak in a relict section of the Great Basin flora in the Inner South Coast Range of California, Tucker described it as *Quercus turbinella californica.* Although Munz (1963), *A California Flora,* (p. 906) and Benson (1967, Amer. J. Bot., 54(8): 1017–1026) accept this classification, Jepson (1966, *Manual of the Flowering Plants of California,* p. 274) refers to it as a variety of *Q. dumosa.*

Most oaks in any single subgenus of *Quercus* with contiguous distributions have a large percentage of their total gall-making cynipid wasps in common (between 40 and 100% on California oaks). Tucker (1970, Amer. J. Bot., 57(1): 74–84) and Tucker and Muller, (1958, Evolution, 12: 1–17) have used cynipid host patterns in the analysis of hybrid oak populations. The distinctive faunas of *Q. dumosa* and *Q. turbinella* in northern Baja California suggest host-parasite relationships might be an additional means of evaluating the taxonomic status of *Q. t. californica.* Since Tucker has shown *Q. t. californica* to have an overlapping distribution with *Q. dumosa* (1953, Madrono, 12: 49–60) these contiguous areas of distribution could also provide a means of studying the development of these oak and cynipid patterns and the role of isolation in the development of Pacific Slope and Southwestern floras and faunas.—D. CHARLES DAILEY, *Sierra College, Rocklin, California.*

Mass movement of *Sympetrum corruotum* (Hagen) (Odonata: Libellulidae) in central California.—The observations of unidirectional mass movements of the dragonfly *Sympetrum corruptum* (Hagen) have been reported in the Kensington-Albany-Berkeley area in central California in recent years in notes by Turner (1965, Pan-Pac. Entomol., 41: 66–67) and Opler (1971, Pan-Pac. Entomol., 47: 223). In these references the species *corruptum* was assigned to the genus *Tarnetrum.* Turner suggested that these dragonflies were "probably migrating from lakes and ponds in Marin County."

Records of a flight of *Sympetrum corruptum* in the fall of 1969 in Marin County are presented. On 11 October 1969 at 17:15 hours, Daylight Saving time, while traveling north on Dais Road, just south of the intersection of Sequoia Valley Road and Muir Woods Road (which is in an area west of the city of Mill Valley), hundreds of dragonflies were observed flying uphill and eastward. It was possible to look westward, with the sunlight shimmering on their wings, where they could be seen for a distance of more than a hundred yards—it was a mignificent sight and flight. At the road level the dragonflies flew from about 4 to 25 feet in height.

Looking west and downhill some were flying one hundred and more feet above the dried grassy fields. Rarely a specimen was observed to settle on some vegetation. The flight was continuing at 17:40 hours when I had to leave. The afternoon was warm with only the lightest breeze. A continuation of their flight in an easterly direction would have brought them into the areas where Turner and Opler had reported their flights in other years.

Sympetrum corruptum is a species with a very wide distribution. It occurs from Canada to Honduras and is also known from Asia. The single female specimen, collected at the time of the observed flight, was confirmed as belonging to this species by Dr. D. R. Paulson of the University of Washington, in April 1970. Dr. Paulson reported that he and other Odonata specialists now prefer to include *corruptum* in the genus *Sympetrum* Newman.—PAUL H. ARNAUD, JR., *California Academy of Sciences, San Francisco.*

On the photocopying of entomological literature.—Apart from its legal and ethical aspects, photocopying is of real significance to our society. We have kept a stock of back issues of the *Pan-Pacific Entomologist* in the expectation of future sales of single copies and complete sets. Copying machines are now installed not only in research and business centers but also in many stores, and are inexpensive to use. If students have library volumes of our journal available, and photocopy the pages of interest, this may well affect the value of our back issue holdings, and policy on how many extra copies we should order in the future.

Photocopying can be also of great value of our Historical File. We have many newspaper clippings, some dating back 75 years and more. Newsprint deteriorates and discolors rather quickly, but bond paper can be used in "Xerox" machines so it may be highly desirable to copy such articles, and in the future put photocopies rather than the original newsprint into the files.

The following clear and pertinent statements are from the journal *Philatelic Literature Review* (Vol. 20, No. 3, 30 September 1971), from John Alden's letter to the Editor "On the photocopying of Philatelic Literature," and comments thereon by the editor, Charles J. Peterson, to whom I an indebted for permission to quote. Page 133 (Alden) ". . . Readers should perhaps also be reminded that the photocopying of copyrighted material, though often ignored in practice, is still illegal. Although the American library profession has attempted to have incorporated in American copyright law a 'fair use' provision to permit an individual to make such copies, it has not yet been passed. The economic effect on publishers caused by the electrostatic copying (by 'Zerox' or other comparable processes) have become increasingly serious, and have led to the devising of paper which will forestall such copying. Potential . . . clients . . . might bear in mind that in many countries—particularly the United Kingdom—registration is not required to secure copyright: publication is in itself sufficient." Page 134 (Peterson) ". . . There are broad questions here involving principles of copyright law and of personal ethics: Is it all right for a non-profit organization to make photocopies, but not business firms? Can an individual make a copy for himself, but not for a third party? What about the copying machines which are now being installed in public libraries as a customer service: isn't this tactic endorsement of the practice?"—HUGH B. LEECH, *California Academy of Sciences, San Francisco.*

The Australian sod fly *Altermetoponia rubriceps* (Macquart) in Marin County, California.—*Altermetoponia rubriceps* was first recorded from the New World by E. L. Kessel (1948, Science, 108(2813): 607–608) on the basis of specimens from San Francisco. It proved to be already widespread within the city; in a mimeographed article, "A study of the Australian sod fly" (1959, Occas. Pap. No. 1. Student Section, Calif. Acad. Sci., p. I–VII) D. C. Rentz cited its economic importance in Australia and New Zealand, and gave field notes for San Francisco, including localities. Part of this appeared in somewhat different form in the Proceedings of the 272nd Meeting of the Pacific Coast Entomological Society *in* the Pan-Pac. Entomol., 37(1): 65. Subsequently it has occurred in numbers at Berkeley, Contra Costa County, and presumably in adjacent areas on the east side of San Francisco Bay. It is still very numerous in San Francisco, and in 1971 the spring brood congregated in such numbers on the taller grass stems as to make black patches on many lawns.

On 9 October 1971, adults were abundant at Black Point, Marin County, at a parking area and boat ramp under the western end of the bridge by which Highway 37 crosses the Petaluma River at tidewater. The day was hot and almost windless; at noon *A. rubriceps* singletons and some pairs in copulation were flying in all directions and could easly be picked out of the air by hand. This locality is in the north western corner of San Pablo Bay, only about 20 miles airline north of San Francisco, but Dr. Kessel thinks the species has not been recorded from Marin before. It is probable that it occurs in adjacent southern Sonoma County, and in Napa and Solano counties just east of there.—HUGH B. LEECH, *California Academy of Sciences, San Francisco.*

The evening's main speaker was DR. HENRY W. ROBINSON, Professor of Parasitology, San Jose State College, who spoke on "Epidemiologic Aspects of Parasitic Infections in Developing Nations—Some Personal Reflections."

Coffee and other refreshments were served during a social hour in the entomology rooms following the meeting.—M. R. GARDNER, *Acting Secretary.*

THREE HUNDRED AND FORTY-THIRD MEETING

The 343rd meeting was held Friday, 17 December 1971 at 7:45 p.m. in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco, with President Blanc presiding.

Members present (26): F. G. Andrews, P. H. Arnaud, Jr., J. W. Bass, R. G. Blair, F. L. Blanc, J. A. Chemsak, H. V. Davies, D. G. Denning, A. R. Dutton, F. Ennik, W. E. Ferguson, J. R. Gabel, L. Gormley, E. A. Kane, H. B. Leech, P. A. McClelland, R. Main, R. L. Peterson, C. B. Philip, J. A. Powell, H. G. Real, F. C. Roberts, R. E. Stecker, R. W. Thorp, M. S. Wasbauer, S. C. Williams.

Visitors present (11): Nancy Blair, Anna-Marie Bratton, Kathy Cheap, L. Hawkins, Sandy Jordan, Pat McClelland, S. Montague, L. Roberts, Mollie Schneider, R. Swaitzell, Joyce Thorp, Barbara Towbridge, Barbara VanKirk.

The minutes of the meeting held 19 November, 1971 were summarized.

Drs. Stecker and Williams introduced the following guests: Anna-Marie Bratton, Kathy Cheap, Sandy Jordan, Mollie Schneider and Barbara Trowbridge.

The following names were proposed for membership: Mr. Don Dilley, Mr. Charles Farrell (student membership).

The following notes were presented:

Distribution of *Enlinia californica* (Diptera: Dolichopodidae) in Oregon.—The genus *Enlinia* contains some of the smallest species of Dolichopodidae. The small size of the species—about a millimeter in total body length—

can account for their infrequent collection. It was in the Proceedings of the meeting of 20 December 1968 (1969, Pan-Pac. Entomol., 45(1): 79) that I reported the first occurrence of this genus in the western Nearctic. 1970, Robinson and Arnaud (1970, Occas. Pap. Calif. Acad. Sci., No. 83: 2–7) described *Enlinia californica* from one locality in central California—from a spring in Arroyo Ojo de Agua, at Redwood City, California. It is now possible to report a major extension in the distribution of this species by recording it from Oregon. On 1 July 1969, Mr. Kenneth Goeden, of the Oregon State Department of Agriculture, collected a single male 10 miles north of Imnaha, in Wallowa County, at a waterfall. Wallowa County is in the north-eastern portion of Oregon, and is partly bordered by the states of Washington and Idaho.—P. H. ARNAUD, JR., *California Academy of Sciences, San Francisco.*

Butterflies at flowers of *Escallonia rubra* (Saxifragaceae) in central California.—In October 1971, my wife, Madelaine Milliet-Arnaud mentioned that she had seen a flowering shrub in the Strybing Arboretum and Botanical Garden, Golden Gate Park, San Francisco, that was especially attractive to butterflies. On 22 October at noon, we visited the area. It was noted that at one large shrub, which attained a height of about fourteen feet, at least 15 Monarchs, *Danaus plexippus* (Linnaeus), nymphalids, pierids, and hesperiids were visiting its reddish flowers. The plant was identified by Dr. Elizabeth McClintock as *Escallonia rubra* (Ruiz and Pavon) Persoon. It is a native of Chile. The genus *Escallonia* is widely distributed in the Andes and in eastern South America. There are several species of *Escallonia* that are grown in the cool coastal regions of California, and they are widely planted in Golden Gate Park. *Escallonia rubra* can be recommended as a butterfly plant for gardens.—PAUL H. ARNAUD, JR., *California Academy of Sciences, San Francisco.*

President Blanc called for reports from the Chairmen of the standing committees.

Mr. Hugh B. Leech, chairman of the Historical Committee stated that the following items were received during 1971:

From new members of the society, personal data sheets; over the years these membership records will form one of our most valuable accessions. Through the kindness of Dr. John Thomas, botanist at Stanford University and at the California Academy of Sciences, a large number of original pen and ink drawings of scale insects, lice, etc., by the late Professor G. H. Ferris; there are also a number of zinc cuts of his figures, and drawings by others, which were used in the journal *Microentomology.* In addition there is an old (undated) student notebook containing the late L. H. Knoche's notes on Professor Vernon Kellogg's lectures in entomology; Mr. Knoche was a botanist who left a very large collection of plants to Stanford. Through the kindness of Mrs. J. Birchim, we received a file of correspondence and notes from the effects of the late Jim Birchim; they relate chiefly to his interests in Diptera and Orthoptera. Also added are a few photographs of entomologists, gift of Dr. E. S. Ross, and a miscellany of newspaper clippings and small items.

Dr. P. H. Arnaud, Jr., read the treasurer's financial report and Mr. H. Vannoy Davis, chairman of the auditing committee reported that the financial records of the Society for 1971 are in good order.

President Blanc announced his appointment to the publication committee for 1972 through 1974 of Dr. J. A. Powell and Mr. M. R. Gardner.

Mr. M. R. Gardner, chairman of the nominating committee presented a slate of candidates for offices in the Society for 1972: Dr. D. G. Denning, President; Dr. J. A. Chemsak, President-Elect; Dr. M. S. Wasbauer, Secretary; Dr. P. H. Arnaud, Jr., Treasurer. There were no nominations from the floor. The nominees were unanimously elected to office for 1972.

The principal speaker of the evening was the outgoing president of the Society, Mr. F. L. Blanc who presented his presidential address entitled "Human influences on endemic and exotic insect distributions in California."

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

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Space is available to members and non-members who wish to advertise entomological exchanges, sales, announcements, etc. We can offer an ad in four issues for $1.50 per line. Ads will be arranged in order of their receipt. Contact the Advertising Manager, W. H. Lange, Department of Entomology, University of California, Davis, California 95616.

Lepidopterist needed to describe new species in genus *Comadia* (Cossidae). All stages, life history, and preliminary manuscript available; genus needs revision. R. P. Allen, California Department of Agriculture, Sacramento 95814.

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SHARP & MUIR: THE COMPARATIVE ANATOMY OF THE MALE GENITAL TUBE IN COLEOPTERA. The classic 1912 monograph and six other papers by the same authors; 304 pp., 43 pls., bound. $10.00. An essential book for all coleopterists. Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740.

Current developments in the sugarbeet industry in the United States are pinpointed in *ADVANCES IN SUGARBEET PRODUCTION: PRINCIPLES AND PRACTICES*, just published by the Iowa State University Press. The control of insects, plant diseases, nematodes and weeds are discussed in addition to other phases of production. Available at $12.50 from bookstores or from the Iowa State University Press.

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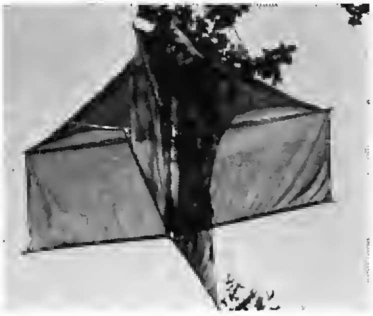

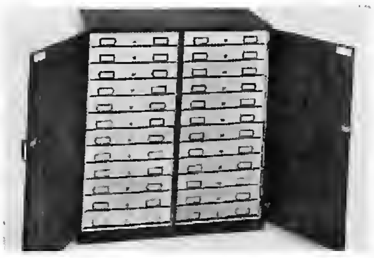

THE PAN-PACIFIC ENTOMOLOGIST

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Essig, E. O. 1926. A butterfly migration. Pan-Pac. Entomol., 2: 211–212.
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Notes on Bigot's North American type-specimens at the University Museum, Oxford

(Diptera: Anthomyiidae, Muscidae)

H. C. HUCKETT
Riverhead, New York 11901

Bigot (1885, 1886, 1887) in his descriptive work on new or little known species of Diptera included several that were recorded from North America and that occur in the neighboring region of Mexico. This material, with its type-specimens, has been in the possession of the Verrall Collection at Newmarket, at which time it was reviewed by Stein (1907) along with other exotic taxa. Recently that part of the Bigot material containing anthomyiid and muscid forms, with the exception of three nominal species (*vide infra*), has been donated by the late Mr. J. E. Collin, in whose custody the Verrall Collection had remained, to the Hope Department of Entomology at the University Museum, Oxford, along with his own extensive collection of British Diptera.

Through the curtesy of Professor G. C. Varley and the staff at the Hope Department of Entomology I was given access to the collections for the purpose of studying the types of Bigot's North American species belonging to the families Anthomyiidae and Muscidae, and was provided with the necessary facilities for their examination. To Mr. D. M. Ackland I am particularly indebted for assistance in guiding me to the various sections of the collection related to my current work, and for drawing my attention to the questionable status of *Nemopoda obscuripennis* Bigot, classed with the Acalyptratae.

The types of Bigot's species have been transferred to separate trays headed by the large original dark-edged label, on which the specific name is written in a large formalized hand. Beneath the name and to the left is written in smaller lettering the locality, e. g. "*Am. Sept.* (*Mt. Roche*)," and to the right "J. Bigot."

The type-specimens, with few exceptions as duly noted, possess a label attached to their pins, on which the name of the species is repeated in

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ink in Collin's handwriting, followed by "EX COLL. BIG." in large print.

I have noted various discrepancies in the labelling of species and with earlier records concerning the spelling of names, the sex cited, and in the number of specimens present, for sake of avoiding ambiguity or error.

The Bigot names are listed in alphabetical order accompanied by a reference to their publication date and page.

anthracina, Anthomyia. (1885, p. 298). 2♂, 4♀, from the Rocky Mountains, all as treated by Ackland (1968) and belonging to the type series, of which one female remains undetermined. The named specimens are identical with *Calythea separata* Malloch.

anthrax, Limnophora. (1885, p. 274). 1♂, from Mexico. The male is notable for the brown calyptrae. The species belongs to the genus *Spilogona* Schnabl.

argentina, Ophyra. (1885, p. 302). 1♀, from Buenos Ayres, agrees in all particulars with females of *Ophyra aenescens* (Wiedemann), as has been corroborated by studies of Oliveira (1941).

calopus, H.?. (1885, p. 275). 1♀, from Mexico, and named in writing *H. calopoda* on Bigot's type label, to which is added "Type" in Collin's handwriting. Stein (1907, p. 215) gives the genus as *Hydrophoria,* in compliance with the context. The specimen is conspecific with *Bithoracochaeta leucoprocta* (Wiedemann).

dentata, Homalomyia. (1885, p. 284). 1♂, from the Rocky Mountains, agreeing in all respects with males of *Limnophora narona* (Walker).

flavicaudata, Hylemyia. (1885, p. 299). 1♂, from Washington Territory, having the name *H. flavicauda* written on Bigot's type label. The specimen in conspecific with *Hylemya alcathoe* (Walker).

fulviventris, Spilogaster. (1885, p. 291). 1♂, from California, a variant of the species *Helina tröene* (Walker), having the thorax gray, with humerals and scutellum partly reddish tinged, abdomen mainly fulvous and with two pairs of weak spots.

fulvus, Spilogaster. (1885, p. 289). 1♂, from Washington Territory, having abdomen, one hind leg and much of one wing missing. The type specimen has head, thorax and legs fulvous, thus markedly differing from associated species within *Hebecnema* Schnabl.

mexicana, Homalomyia. (1885, p. 284). 3♂, from Mexico, all conspecific, and may be recognized readily as belonging to the species *Fannia canicularis* (Linnaeus).

monticola, Anthomyia. (1885, p. 297). 6♂, 2♀, from the Rocky

Mountains, all as treated by Ackland (1968) and belonging to the type series, of which one female is recognized as *Delia platura* (Meigen). As noted by Ackland, the species *monticola* and *anthracina* of Bigot are conspecific, hence the name *monticola*, due to claims of page precedence, may be accepted as the valid name for the species. Both taxa are identical with *Calythea separata* Malloch.

nigricauda, Hydrophoria. (1885, p. 276). 2♂, from the Rocky Mountains, one of which has lost its antennae. Both specimens have basal segments of abdomen reddish testaceous, and the tubular haustellum together with the slender labellum one and a half times as long as height of head, thereby differing from its congeners *Neohylemyia tenuirostris* (van der Wulp) and *N. mallochi* Huckett, that have a shorter haustellum and a uniformly gray abdomen. The calyptrae and wings of the type specimens of *N. nigricauda* possess a brownish tinge. The species belongs to the genus *Neohylemyia* Malloch.

obscuripennis, Nemopoda. (1886, p. 392). 1♀, from California, with the name *N. obcuripennis* written on Bigot's type label, and the sex cited as a male in the description. The type specimen is in poor condition, owing chiefly to the covering of much of the abdomen in a pinkish mold. The remaining parts except the forelegs that are missing can with due care be perceptible, and indicate clearly that the specimen is a female and is conspecific with *Chelisia elegans* Stein, N. SYN.

oculifera, Anthomyia. (1885, p. 299). 1♂, from Baltimore. The dark brown marks on the whitish mesonotum are striking and may be described in some detail. The longish oblong presutural marks becloud the planes of dorsocentral bristles, extending to anterior border of mesonotum and ending caudad shortly before reaching the transverse suture: on postsutural region a band or fascia adjoining the transverse suture that medially encroaches as a slight wedge between the caudal pair of presutural acrosticals, laterad the fascia extends to prealar bristles, and caudad to the third pair of postsutural dorsocentrals, from thence as a tongue to base of wings. Scutellum entirely black on dorsum. A chitinous fold or lobe extends distinctly mesad beyond apex of each process on fifth abdominal sternum.

rubifrons, Anthomyia. (1885, p. 297). 3♀, from Chile, with the name written *A. rubrifrons* on Bigot's type label. The specimens closely resemble the female of *Delia platura* (Meigen), from which I disassociate them owing to the presence of two anterior sternopleural bristles. Collin (in letter, 28 March 1951) has indicated that these specimens are in all probability females of the male *A. sancti-jacobi* described by Bigot on the previous page (1885, p. 296), and that all had arrived in the same lot from Chile. Stein (1907, p. 285) denoted the species under the name *Chortophila cilicrura* Rondani.

rupecula, Homalomyia. (1885, p. 285). 2♂, from the Rocky Mountains, agreeing in all particulars with the male of *Delia platura* (Meigen). The name is written *H. rupicola* on Bigot's type label.

siphonina, Proboscidomyia. (1885, p. 267). 2♂, from the Rocky Mountains, that are without the usual Collin label attached to pines of type specimens. The males possess an extremely long slender tubular proboscis and minutely haired arista, otherwise, in habitus, resembling the species of *Neohylemyia* Malloch.

spinipes, Chortophila. (1885, p. 279). 1♀, from the Rocky Mountains, agreeing closely with the female of *Delia platura* (Meigen), and with which I regard it to be conspecific. The description of the species accords the sex to be a male.

To Mr. A. C. Pont of the British Museum I am indebted for information concerning three nominal species from the Rocky Mountains that Bigot (1887) described in a later contribution, the types of which are deposited in the British Museum (Natural History). Two of these taxa have recently been commented on by Pont (1970) in an article dealing with the European species of *Myospila* Rondani.

anthomydea, Curtonevra. (1887, p. 614). 1♂, with midlegs missing, is conspecific with *Myospila meditabunda* (Fabricius) of authors.

nigriceps, Curtonevra. (1887, p. 615). 3♂, the antennae and midlegs lacking in one specimen, one mid and one hind leg missing in the two others, all conspecific and agreeing with *Myospila meditabunda* (Fabricius) of authors.

flavipennis, Musca. (1887, p. 605). 1♂, 1♀, both in poor condition, but clearly recognizable as belonging to *Musca domestica* Linnaeus. The female is without a locality label.

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BOOK NOTICE

CATALOGUE OF THE THYSANOPTERA OF THE WORLD (PART 1). By C. F. Jacot-Guillarmod. 20 February 1970. Annals of the Cape Provincial Museums, Natural History, vol. 7, pt. 1. Pp. iii + 216 (numbered pages 217 and 218 are blank pages). Soft cover. R5.00 (about US$ 7.00).

In November 1970 Dr. Howell V. Daly, Jr., mailed from Grahamstown, a copy of Mr. Jacot-Guillarmod's catalog for review in the *Pan-Pacific Entomologist.* It is a pleasure to do so, for this is an important work that is well done. This first volume of a projected monumental work of possibly six or more parts when completed, is dedicated to Dr. J. C. Faure, under whose guidance it was started some 30 years ago. It begins (pp. i–iii) with a brief introduction including "Scope and Method." The general classification followed is that of Priesner with slight modification. Part one covers the suborder Terebrantia families Aeolothripidae, Mesothripidae, Paleothripidae, Permothripidae, Merothripidae, Heterothripidae, and Uzelothripidae. Fifty genera (24 are monotypic) and 339 valid species are cataloged. Both fossil and recent species are included. For each valid name, the original description and all subsequent publications are cited; for each genus the type species is cited; for each species the location of type, distribution, type locality, and habitat are cited; invalid names are cross-indexed. This publication, in this economically important order, should have an extensive use.—PAUL H. ARNAUD, JR., *California Academy of Sciences, San Francisco, 94118.*

Review of the Genus *Cirrhicera* Thomson

(Coleoptera: Cerambycidae)

JOHN A. CHEMSAK
University of California, Berkeley 94720

The hemilophine genus *Cirrhicera* Thomson is comprised of a number of rather pretty, moderate-sized species occurring from about central Mexico to Panama. Thomson (1857) included three Mexican species (one erroneously cited as "Patrie: Venezuela") and another in 1860 from the same country. Bates (1881) added four species from Mexico and Guatemala and one from Panama (1885). The remaining two known species were described from Mexico by Gahan (1892).

Specimens of *Cirrhicera* are rather rare in collections and there are at hand only 92 specimens representing eight species. The types or determined material of all of the unrepresented species have been examined at the British Museum (Natural History).

These studies were undertaken during a National Science Foundation sponsored study on North American Cerambycidae (Grant GB-4944X). The following institutions and individuals are gratefully acknowledged for making material available: American Museum of Natural History; British Museum (Natural History); California Academy of Sciences; J. M. Campbell; Canadian National Collection; Cornell University; Field Museum of Natural History, Chicago; Los Angeles County Museum; Museum of Comparative Zoology, Harvard; Ohio State University; United States National Museum; University of California, Davis; and University of Kansas. Special thanks are given to Celeste Green for preparing the illustrations.

Genus CIRRHICERA Thomson

Cirrhicera Thomson, 1857, Arch. entomol. 1: 309; Thomson, 1860, Class. de cérambycides, p. 63; Thomson, 1864, Systema cerambycidarum, p. 128; Lacordaire, 1872, Genera des coléoptères, 9(2): 892; Bates, 1881, Biologia Centrali-Americana, Coleoptera, 5: 213.

This genus is characterized by the tufts of black hairs on the fifth and sixth antennal segments. The third antennal segment is longer than the first and the fourth shorter than the third but longer than the first. The distal segments are short. The eyes are finely faceted and almost separated, the two lobes connected by a single row of facets. The pronotum is cylindrical, transverse and not laterally produced. The

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prosternal process is narrow, arcuate and expanded apically. The elytra have strong costae extending from the humeri making the epipleurae almost vertical. The legs are slender, tibiae lacking a sinus, and the tarsal claws are bifid.

TYPE SPECIES.—*Hemilophus leuconotus* Laporte (Thomson designation, 1864).

Eleven species are presently known.

KEY TO SPECIES OF CIRRHICERA

1. Elytra without pale pubescent spots, pale pubescent patches either covering most of surface, transverse, or absent 2

Elytra with pale, pubescent spots usually at base and behind middle 5

2(1). Elytra with pubescent fasciae covering most of surface or basally and medially transverse 3

Elytra uniformly densely pubescent with black spots at middle and at apical one-third; pronotum densely grayish pubescent except for narrow, median, longitudinal line. Length, 9–13 mm. Mexico to El Salvador .... *cinereola* Bates

3(2). Elytra with pubescent fasciae extending over most of surface; pronotum with lateral pubescence same color as that of elytra 4

Elytra black with broad yellow pubescent bands transverse, one basal, one post-median; pronotum orange pubescent laterally. Length, 15–16 mm. Mexico .... *conspicua* Gahan

4(3). Abdomen with last sternite emarginate at apex; antennae usually dark. Length, 9–17 mm. Mexico .... *leuconota* (Laporte)

Abdomen with last sternite rounded at apex; antennae testaceous. Length, 10–12 mm. Costa Rica to Panama .... *panamensis* Bates

5(1). Elytra without two elevated tubercles at base 6

Elytra with two strongly elevated tubercles at base; antennae with scape densely fringed with long pubescence beneath. Length, 8.5 mm Mexico and Guatemala .... *cristipennis* Bates

6(5). Elytra with two pairs of pubescent spots, one basal and one post-median .. 7

Elytra with two pubescent spots behind the middle only; color black. Length, 9 mm. Mexico .... *nigrina* Thomson

7(6). Elytra with basal pubescent spots sutural, lying behind scutellum 8

Elytra with basal pubescent spots well separated, lying on basal margin. Length, 8–12 mm. Nayarit to Veracruz, Mexico .... *basalis* Gahan

8(7). Elytra with pubescent spots not circled with black 9

Elytra with pubescent spots circled with black, apices deeply emarginate, margins acute. Length, 7–11 mm. Southern Mexico and Guatemala .... *championi* Bates

9(8). Pubescent spots yellow; long erect hairs absent or sparse on pronotum and elytra 10

Pubescent spots white; long erect hairs numerous on pronotum and elytra. Length, 7.5 mm. Veracruz, Mexico .... *niveosignata* Thomson

10(9). Abdomen without pubescent spots; antennae with basal segments dark, fifth and sixth segments black. Length, 10–11 mm. Guatemala .... *longifrons* Bates

Abdomen with yellow pubescent spots; antennae pale throughout, segments five and six brownish. Length, 6.5–13 mm. Mexico to Panama .... *sallei* Thomson

CIRRHICERA CINEREOLA Bates

(Fig. 1)

Cirrhicera cinereola Bates, 1881, 5: 215.

The body entirely clothed with grayish to ochraceous appressed pubescence. The elytra have four dark spots at the apical one-half.

TYPE LOCALITY.—Guatemala, near the city.

ADDITIONAL RECORDS.—1 ♂, 1 ♀, Chiapas, Mexico, Pacific slope Cordellerus, 800–1,000 M (L. Hotzen '19); 1 ♂, San Jeronimo, Volcan Tacana, Chiapas, Mexico, 9 September 1970 (E. C. Welling); 1 ♂, Mexico (F. C. Bowditch); 1 ♂, 1 ♀, Antigua, Guatemala, October 1965 (N. L. H. Krauss); 1 ♂, Chicacoa Such., Guatemala, 2,000 ft., 22 June 1965 (J. M. Campbell); 1 ♂, Ahuachapan, El Salvador, 18 August 1960.

CIRRHICERA CONSPICUA Gahan

(Fig. 2)

Cirrhicera conspicua Gahan, 1892, 1892: 269, pl. 12, fig. 13.

This species is very distinctive by the orangish lateral bands of the pronotum and by the yellow transverse bands of the elytra, one basal and one post-median.

TYPE LOCALITY.—Guerrero, Mexico.

Known only from the type series (male, female).

CIRRHICERA LEUCONOTA (Laporte)

(Fig. 3)

Hemilophus leuconotus Laporte, 1840, 2: 489.
Cirrhicera leucronota, Thomson, 1857, 1: 309.
Cirrhicera leuconota, Thomson, 1860, p. 64; Thomson, 1864, p. 128; Bates, 1881, 5: 213.

Ground color brown to dark brown with the elytra extensively clothed by pale pubescence. The median dark band of the pronotum is broad and the antennae dark. The abdomen has the last sternite emarginate apically in both sexes. The extent of the pale patch of the elytra is somewhat variable and usually emarginate toward the suture at the middle.

TYPE LOCALITY.—Mexico.

MATERIAL EXAMINED.—Mexico: 4 ♂ ♂, 1 ♀, Orizaba, Veracruz, 12–22 August 1961 (R. & K. Dreisbach); 4 ♂ ♂, Fortin de las Flores, Veracruz, 10 June 1959 (H. E. Evans), 6 July 1963 (W. A. Foster); 6 ♀ ♀, Cordoba, Veracruz, 8 July

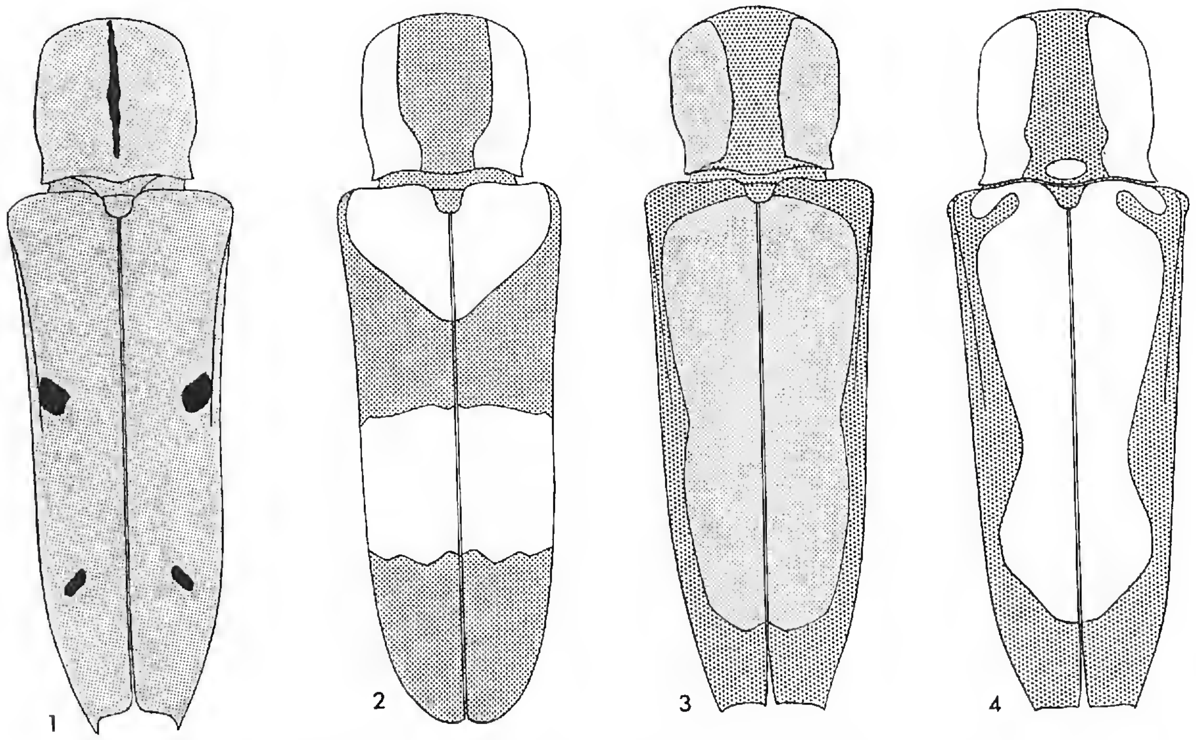


FIG. 1. *Cirrhicera cinereola* Bates. FIG. 2. *C. conspicua* Gahan. FIG. 3. *C. leuconota* (Laporte). FIG. 4. *C. panamensis* Bates.

1961 (D. H. Janzen), 8 October 1941 (DeLong, Good, Caldwell & Plummer), 23 July 1936 (C. H. Seevers); 1♀, El Fortin, Veracruz, 8 July 1941 (H. S. Dybas); 1♀, 2 miles NE San Andreas Tuxtla, Lago Encantada, 460 M, Veracruz (B. & B. Valentine); 1♂, 5 miles W Orizaba, Veracruz, 7 July 1962 (J. M. Campbell); 1♀, Mexico (Deyer); 1♀, Temescal, Oaxaca, 11, 12 September 1964.

CIRRHICERA PANAMENSIS Bates
(Fig. 4)

Cirrhicera sallaei var. *panamensis* Bates, 1885, 5: 429; Chemsak and Linsley, 1970, 43: 409 (lectotype design.).

In coloration this species is quite similar to *C. leuconota.* In addition to the pale antennae, *C. panamensis* also has the apex of the last abdominal sternite rounded.

TYPE LOCALITY.—Volcan de Chiriqui, Panama.

MATERIAL EXAMINED.—1♂, 6 Km S San Vito, Puntarenas, Costa Rica, 2 May 1967 (D. F. Viers).

CIRRHICERA CRISTIPENNIS Bates
(Fig. 5)

Cirrhicera cristipennis Bates, 1881, 5: 214.

This species is easily recognizable by the two prominent tubercles near the base of the elytra and the highly elevated pronotal disk. The antennae are densely fringed on the scape and segments three and four also have

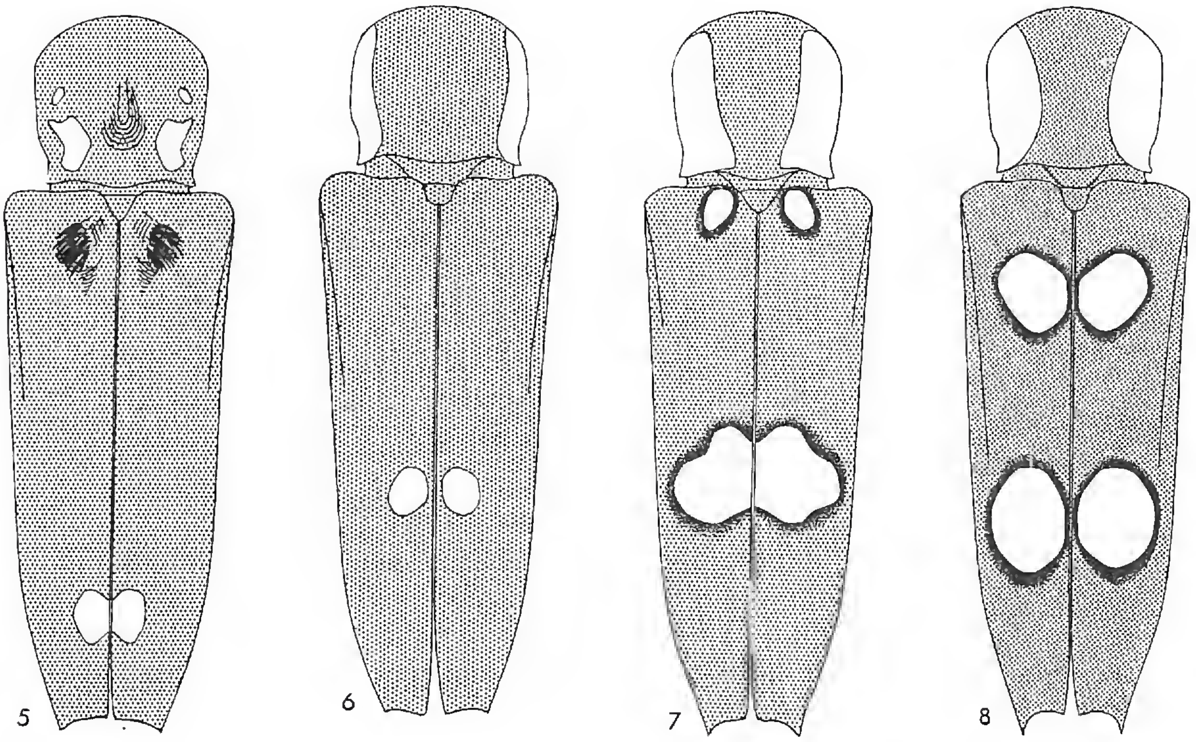


FIG. 5. *C. cristipennis* Bates. FIG. 6. *C. nigrina* Thomson. FIG. 7. *C. basalis* Gahan. FIG. 8. *C. championi* Bates.

a small fringe. The elytra are finely clothed by very short pubscence having a lavender cast.

TYPE LOCALITY.—Mexico.

MATERIAL EXAMINED.—1 ♂, Orizaba, Veracruz, Mexico, 12–22 August, 1961 (R. & K. Dreisbach); 1 ♂, Morales, Guatemala, 8 March 1905.

CIRRHICERA NIGRINA Thomson
(Fig. 6)

Cirrhicera nigrina Thomson, 1857, 1: 310; Bates, 1881, 5: 214.

The characterization of this species is based on a specimen determined by Bates in the Sallé Collection. The ground color is black with two rounded pale spots a little behind the middle of the elytra.

TYPE LOCALITY.—Mexico (erroneously cited as Venezuela by Thomson).

CIRRHICERA BASALIS Gahan
(Fig. 7)

Cirrhicera basalis Gahan, 1892, 1892: 269, pl. 12, fig. 5.

The color is pale to dark brown with the pubescent patches of the pronotum and elytra white. The median dark area of the pronotum is broad apically, converging toward the base. The basal white patches are placed on each side of the scutellum while the post-median pair is sutural and usually posteriorly oblique.

The two separated basal spots will separate this species from *C. sallei.*

TYPE LOCALITY.—Guerrero, Mexico.

MATERIAL EXAMINED.—Mexico: 1♀, 6 miles E San Blas, Nayarit, 27 August 1959 (A. S. Menke, L. A. Stange); 1♂, San Blas, 7 August 1964 (W. R. M. Mason); 1♀, 18 miles N Tepic, Nayarit, 16 August 1960 (D. C. Rentz); 1♂, Tepic, 13 September 1951 (R. & K. Dreisbach); 1♂, 4 miles W Tepic, 31 August 1961; 1♀, Barra de Navidad, Jalisco, September 1965 (N. L. H. Krauss); 1♀, Km 108 on Hwy 110 to Manzanillo, Jalisco, 20 July 1956 (R. E. Beer and party); 1♂, Puerto Vallarta, Jalisco, 6 July 1957 (J. A. Comstock); 2♂♂, Acapulco, Guerrero, 1 August 1934 (C. C. Plummer), 4 October 1945; 1♂, Temascaltepec, D. F., 1931 (G. B. Hinton); 1♂, Cordoba, Veracruz, 4 August 1965 (A. B. Lau).

CIRRHICERA CHAMPIONI Bates

(Fig. 8)

Cirrhicera championi Bates, 1881, 5: 214, pl. 15, fig. 12; Chemsak and Linsley, 1970, 43: 409 (lectotype design.).

Very similar to *C. sallei* but having the yellowish elytral spots separated but contiguous and outlined in black or dark brown. The appendages are pale except for segments one, five and six of the antennae.

TYPE LOCALITY.—Zapote, Guatemala.

MATERIAL EXAMINED.—4♂♂, San Jeronimo, Volcan Tacana, Chiapas, Mexico, 12, 21 August 1970, 2 September 1970, 10 October 1970 (E. C. Welling); 1♀, Moca, Such., Guatemala, 3,000 ft., 16 July 1959 (P. & C. Vaurie); 1♀, 15 Km S La Reforma, S. M., Guatemala, 3 September 1965 (J. M. Campbell); 1♀, 1 Km N Yecocapa, Chi., Guatemala, 1,500 M, 29 May 1966 (Campbell); 1♂, 4 Km N Palin, Esc., Guatemala, 4,500 ft., 21 June 1966 (Campbell); 1♀, Finca Moca, Santa Barbara, Such., Guatemala, 3,000 ft., 12 June 1966 (Campbell).

CIRRHICERA NIVEOSIGNATA Thomson

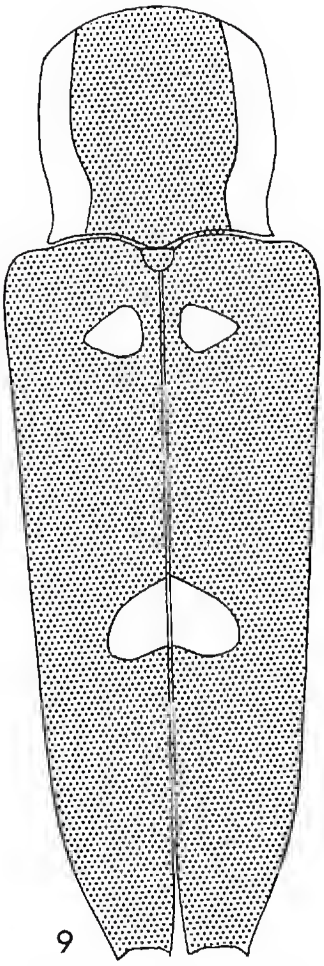
(Fig. 9)

Cirrhicera niveosignata Thomson, 1860, p. 64; Bates, 1881, 5: 214.

This species may be recognized by the small white, almost scale-like pubescent patches. The basal pair is separated and behind the scutellum and the post-median pair is contiguous at the suture. The body is moderately clothed with long erect hairs and the short appressed pubescence is relatively sparse.

TYPE LOCALITY.—Mexico.

MATERIAL EXAMINED.—1♀, Tezonapa, Veracruz, Mexico, 8 August 1941 (H. S. Dybas).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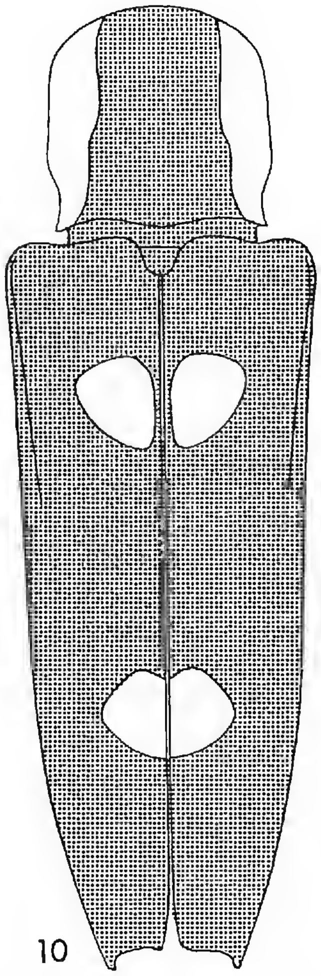
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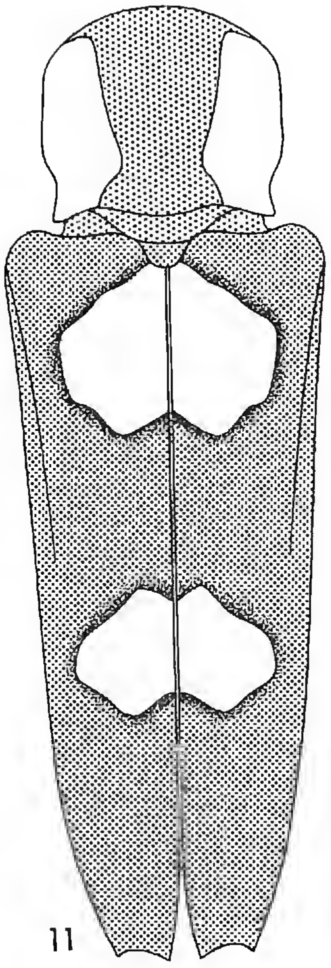
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FIG. 9. *C. niveosignata* Thomson. FIG. 10. *C. longifrons* Bates. FIG. 11. *C. sallei* Thomson.

CIRRHICERA LONGIFRONS Bates

(Fig. 10)

Cirrhicera longifrons Bates, 1881, 5: 214; Chemsak and Linsley, 1970, 43: 409 (lectotype design.).

This species is known only from the originally described male and female. It greatly resembles *C. sallei* but the two apparently differ by the lack of pubescent patches on the abdomen and dark basal antennal segments of *C. longifrons*. These two species may ultimately prove to be the same.

TYPE LOCALITY.—Purulá, Guatemala.

CIRRHICERA SALLEI Thomson

(Fig. 11)

Cirrhicera sallei Thomson, 1857, 1: 310.
Cirrhicera sallaei, Bates, 1872, 1872: 231; Bates, 1881, 5: 214.

This appears to be the most common and widespread species of *Cirrhicera*. The subbasal yellowish patches are irregular and contiguous at the suture. The postmedian pair are variable in size and shape but also meet at the suture.

TYPE LOCALITY.—Mexico.

MATERIAL EXAMINED.—Mexico: 1♂, Cotaxtla, Veracruz, 26 August 1959 (R. F. Smith); 1♂, Fortin de las Flores, Veracruz, 6 August 1963 (W. A. Foster); 1♂, Cordoba, Veracruz (A. Fenyes); 1♂, Coyame, Lake Catemaco, Veracruz, 10–18 July 1963 (D. R. Whitehead); 1♀, Comoapan Falls, Veracruz, 14 July 1963 (Whitehead); 1♂, Teapa, Tabasco, 11 July 1964 (E. Fisher); 1♀, X-can, Quintana, Roo, 27 July 1967 (E. C. Welling); 1♀, 72 miles E La Ventosa, Oaxaca, 21 July 1963 (J. T. Doyen); 1♂, 1♀, Cuernavaca, Morelos, July 1945 (N. L. H. Krauss). Guatemala: 1♂, Matias de Galvez, 14–15 August 1965 (P. J. Spangler); 1♂, Dept. El Progreso, Virgen, 11–12 August 1965 (Flint and Ortiz). British Honduras: 1♀, Belize (Peck); 1♀, Augustine Mt., Pine Ridge, 3–7 July 1963 (C. C. Porter); 2♂♂, M-tee District, 12 June 1906. El Salvador: 1♂, 1♀, 6 miles W Quezaltepeque, 12 August 1963 (D. Q. Cavagnaro, M. E. Irwin); 1♀, San Salvador, 19 September 1960; 1♀, La Libertad, November 1959 (Krauss); 1♀, Metepan, 5 August 1954. Honduras: 1♀, Zamorano, September 1953 (N. L. H. Krauss). Costa Rica: 1♀, 4 Km N Canas, Guanacasta, 15 July 1965 (D. Viers); 1♀, Boca de Barranca, Puntarenas, 19 June 1963 (C. L. Hogue); 1♂, 1♀, Piedras Negras; 2♂♂, 1♀, Turrialba, 21, 29 May 1951 (O. L. Cartwright), 28 May 1962 (H. Ruckes); 1♂, Barranca, Puntarenas, 24 July 1929 (F. Nevermann); 1♀, Hamburgfarm, Reventazon, 25 March 1935 (Nevermann); 1♀, Costa Rica. Panama: 2♂♂, Sumit, Canal Zone, June, July 1953 (Krauss); 1♀, Porto Bello, 18 February 1912 (A. Busck).

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The Robber Fly *Callinicus calcaneus* (Loew) As A Predator on *Andrena omninigra* Viereck

(Diptera: Asilidae; Hymenoptera: Andrenidae)

E. GORTON LINSLEY
University of California, Berkeley 94720

In an earlier note, (Linsley, 1944), I reported on the predatory behavior of 22 individuals from a population of *Callinicus calcaneus* (Loew) foraging on a hillside near Oakhurst, Madera County, California, which was densely clothed with the common ground cover of the lower Sierra Nevada yellow pine forests known as mountain misery or bear-clover (*Chaemaebatia foliolosa* Benth.). The robber flies were capturing bees which were taking pollen and/or nectar from *Chaemaebatia* blossoms. The prey in this sample consisted entirely of solitary bees of the families Megachilidae and Andrenidae (*Osmia* spp. and *Andrena* spp.). Among the captures, brightly colored *Osmia* outnumbered dull colored *Andrena* by approximately 3:1, although sweep samples of *Chaemaebatia* blossoms yielding 536 individual bees indicated that *Andrena* outnumbered *Osmia* by about 5:1. It appeared that the asilids were selectively capturing the brilliant or metallic colored *Osmia*. The flies were foraging in the brightly sunlit areas among the trees where most of the bees were working and their prey were captured while in flight between flowers.

It has been suggested previously that bee- and wasp-killing robber flies tend to locate a suitable foraging site and remain there, selecting their prey either fortuitously or on the basis of size, coloration, or some other identifiable attribute, depending upon the extent and range of choice and prior experience (cf. Linsley, 1960). Further evidence that this may be true in the case of *Callinicus calcaneus* was obtained on 2 June through 5 June 1970 on a hillside 1.5 miles east of Railroad Flat, Calaveras County, California. Here, as in the Madera County locality, the robber flies were foraging over *Chaemaebatia foliolosa*. However, unlike the earlier situation the observed prey, with one exception, were exclusively females of *Andrena* (*Onagrandrena*) *omninigra omnigra* Viereck, a wholly black species which was taking nectar from blossoms of those *Chaemaebatia* plants which were shaded by scattered pine trees (*Pinus ponderosa*). They were the dominant bees visiting *Chaemaebatia* at this time but by no means the only ones. The others, although relatively few in numbers, were confined to sunny areas and

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involved both sexes of two species of brightly colored *Osmia* and two *Andrena* species, the females of which were taking pollen. However, based on collections from the same hillside in the previous year, these must have been early seasonal arrivals because in late June of 1969 *Osmia* and *Andrena* were abundantly active both in individuals and species, with much the same species composition as that found at the Oakhurst site.

These observations suggest that when *Callinicus calcaneus* adults emerged (the individuals seen still had their wing margins and body pubescence intact) the first prey encountered were the densely black *Onagrandrena*, which were probably seeking nectar from shaded rather than sunlit plants in order to minimize integumental heat absorption while feeding in the exposed cup-like flowers. Presumably having learned to exploit bees in this situation the robber flies retained this behavior pattern while the *Onagrandrena* remained abundant, in spite of the increasing availability of suitable prey on plants in adjacent sunny sites. Regrettably, the locality could not be revisited after an interval of ten days or two weeks to observe the behavior of *Callinicus* at that time.

Altogether, 15 female *Onagrandrena* were taken from *Callinicus* by observing their capture, which invariably took place when the bees were in flight. The robber flies were swept gently into the net shortly after they settled on a plant with their prey, and were allowed to drop the then dead bee in the net and escape with a minimum of disturbance. Under these circumstances marking was not feasible and it is not possible to say with certainty whether or not the same robber fly was captured more than once, although the presumption is high that this may have been so, since only one or two individuals of *Callinicus* were visible in the observation area at any one time. Also, the *Onagrandrena* were localized to shady spots in an area about 65 yards long by 50 yards wide near a dirt road, although *Chaemaebatia* extended on both sides of the road for hundreds of yards. However, *Callinicus* are fast fliers and cover more territory than many other asilid bee predators. They moved in and out of this foraging site, both when disturbed and undisturbed.

It should be noted that *Andrena* (*Onagrandrena*) *omninigra* is a *Clarkia* (Onagraceae) oligolege, yet none of the females had traces of *Clarkia* pollen in their scopae and, as would be expected, none were taking pollen from *Chaemaebatia* (Rosaceae). No *Clarkia* plants were evident near the site where the females were working and the only colony of *Clarkia* noted in prior years, a substantial population of *C. speciosa*, was slightly more than one air mile away on the other side of two 300 to 500 ft. ridges. On this date these plants were examined but they were not yet in bloom. Although they had been sampled twice in previous years, other *Clarkia* oligoleges were abundant but no *Onagrandrena* were present in the collections. The localized occurrence of the females in an extensive area of *Chaemaebatia*, and the capture of a male nearby, suggested that they might be coming from an adjacent nest site, but a careful search failed to reveal one if it was in the vicinity.

Diurnally, the earliest *Callinicus* with *Onagrandrena* prey was observed at 8:30 a.m. PST, the latest at 4 p.m. Most were taken shortly before noon (11–11:30 a.m.) and at mid-afternoon (3–3:30 p.m.) although the site was visited intermittently during several days, it was not under continuous surveillance on any one day.

The identification of two female *Callinicus calcaneus* captured as voucher specimens was kindly confirmed by E. I. Schlinger.

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BOOK NOTICES

The following two facsimile reprint editions have been issued by E. W. Classey, Ltd.

CENTURIE DE LÉPIDOPTÈRES DE L'ILE DE CUBA. P. H. Poey. 1832. E. W. Classey, Ltd., 97 p., 20 color plates, + xii. Reprinted 1970. $30.00

This reprint contains a foreword by Lt. Col. C. F. Cowan explaining the arrangement of the *Centurie*, bibliographical problems and dates of publication. An annotated table of contents also is included.

AN ILLUSTRATED ESSAY ON THE NOCTUIDAE OF NORTH AMERICA. A. R. Grote 1882. E. W. Classey, Ltd., 85 p., 4 color plates, + 17 p. foreword. Reprinted 1971. $16.95.

The foreword by Dr. R. S. Wilkinson is an extensive biography of A. R. Grote. This volume also includes a five page reprint of an essay entitled "A Colony of Butterflies" which was first printed in 1876, *American Naturalist*, 10:129–132.

These books are available from the North American distributor: Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, California 90007.—R. W. THORP, *University of California, Davis, 95616.*

Reproductive Compatibility Between Two Widely Separated Populations of *Pyemotes scolyti*

(Acarina : Pyemotidae)

John C. Moser and Lawrence M. Roton
Southern Forest Experiment Station, USDA Forest Service, Pineville, Louisiana 71360

Pyemotes scolyti (Oudemans) (1936) is an external parasite of *Scolytus* spp., and apparently occurs throughout the range of *Scolytus*. It was described from specimens reared on *Scolytus multistriatus* (Marsham) in elm near Arnhem, Netherlands, and designated by Krczal (1959) as the genotype.

Specimens of *Pyemotes scolyti* reared from galleries of *Scolytus ventralis* LeConte in *Abies grandis* collected near Moscow Mountain, Idaho, were recently forwarded to us for identification by Alan A. Berryman and Bernard Scott. Although the material was morphologically inseparable from that taken in galleries of *Scolytus multistriatus* in *Ulmus americana* from Delaware, Ohio (det. E. A. Cross), the possibility still remained that the two populations might be cryptic species similar to those found for spider mites by Boudreaux (1963).

Methods

Five mothers were reared from each population and five female and male progeny from each mother were selected for cross matings. Thus, 25 virgin females reared from 5 mothers of the "ventralis" strain were mated with 25 males from the "multistriatus" strain and their hybrid progeny tallied. A similar cross was then made using females of the "multistriatus" strain and males of "ventralis" strain.

Since the first individual born is usually a male, care had to be exercised in the cross matings to see that these and any subsequent males were immediately removed so as not to interfere with the mating activities of males from the opposite strain. Test males were identified by a small paint droplet on a seta (Moser and Roton, 1970).

Results and Discussion

The data in Table 1 show little reproductive isolation between the two populations, and indicate that they are indeed the same species. However, some genetic breakdown may have occurred in the male "multistriatus" × female "ventralis" cross. Although the progeny

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TABLE 1. Number of F_1 progeny of "ventralis" and "multistriatus" strains of *Pyemotes scolyti.*

		Progeny (F_1)							
Strain	n	Mean		Standard deviation		Maximum		Minimum	
		♀	♂	♀	♂	♀	♂	♀	♂
Ventralis (mated)	20	94.5	2.1	30.5	1.0	152	5	40	1
Ventralis (unmated)	5	–	63.8	–	46.8	–	135	–	21
Multistriatus (mated)	20	120.6	2.0	20.8	1.6	168	4	59	1
Multistriatus (unmated)	5	–	23.6	–	4.8	–	31	–	19
♂ Multistriatus × ♀ Ventralis	25	106.0[1]	1.1[2]	30.8	0.4	174	50	2	1
♂ Ventralis × ♀ Multistriatus	25	96.9[1]	1.3[3]	28.5	0.6	168	48	3	1

[1] Hybrid females.
[2] "Ventralis" males.
[3] "Multistriatus" males.

count was normal, males did not appear until about 75 percent of the females had been born. In addition, one preliminary rearing resulted in 9 of 20 mothers producing normal numbers of females, but no males. Production of all-female progeny in *Pyemotes parviscolyti* Cross and Moser was induced by restricting the feeding period of mothers to 3 days (Moser, Cross, and Roton, 1971). In *Pyemotes scolyti,* the virgin females are normally fertilized as they emerge tail first from the birth canal. The male is embedded head first in the canal and mating occurs as the female abdomen tip slides past the male abdomen. Males extracted from the birth canal behaved in a manner similar to that described by Krczal (1959). They mated with virgin females, but only with difficulty. They reentered the canal as soon as possible, usually mating with only a few of the available females. Normally, males leave the birth canal when they are pushed out by the next male to be born. Occasionally, males left the canal for no apparent reason, but in both cases, they usually died within 12 hours, and never were observed to reenter the canal. In at least 3 cases where virgin females were present when males left the canal, no matings took place. Hence, any females born before the first male emerge unfertilized, and probably remain so even when males are born later. Thus, in the male "multistriatus" × female "ventralis" matings, there was a 75 percent loss in reproductive potential of progeny.

Virgin females of both populations were reluctant to attack the host, *Scolytus multistriatus* larvae. When they did, swelling was usually minimal, resulting in a reduced number of progeny, all of which were male. As Boudreaux (1963) showed in his experiments with tetranychid mites, rearing through the F_2 generation is not necessary to show reproductive isolation in species exhibiting haplo-diploid parthenogenesis (arrhenotoky) such as we observed. Since the F_1 males carry the same genes as the female parent, the F_2 generation is really a backcross of the F_1 generation and not a true F_2 cross. Therefore, the F_2 generations will exhibit an average of characters closer to the average original female parent, and succeeding generations will even be more biased.

Cross (1965) notes that many pyemotids, due to their small size, are cosmopolitan within their ecological limits, and that greater morphological variation may occur between nearby localities than between continents. Perhaps this phenomenon also applies to breeding barriers between widely separated populations of *Pyemotes scolyti.*

The "multistriatus" population is probably of European origin and introduced with the elm bark beetle sometime prior to 1909. The "ventralis" population may or may not be native, but the formidable ecological barriers between the host beetles make it unlikely that this population was recently derived from the "multistriatus" population.

ACKNOWLEDGMENTS

We thank Drs. H. B. Boudreaux and E. A. Cross for interest and advice on methodology. We also thank Dr. Alan Berryman, Mr. Bernard Scott, Dr. Bruce H. Kennedy, and Dr. John W. Peacock for collecting the mites and bark beetles used in the study.

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A Report on the Arthropods Collected by the Edinburgh University Galapagos Islands Expedition, 1968[1]

PATRICIA PARKIN,[2] D. T. PARKIN,[2] A. W. EWING,[3] AND H. A. FORD[4]

The Galápagos Archipelago has attracted much scientific study since Charles Darwin's visit in 1835 first drew the attention of the world's biologists to its potential. The initial studies were of collections obtained for description and taxonomic determination of the plants and animals present among the islands. Linsley and Usinger (1966) list 21 expeditions of various sizes and eight individual collectors who worked in the islands for greater or lesser periods of time.

The primary objects of non-taxonomic study have been the vertebrates, notably the birds (Lack, 1947; Bowman, 1961, 1963; and many others), while the terrestrial invertebrates have been comparatively neglected (important exceptions being Curio, 1966, and Linsley, 1966). Even distributional data of invertebrates is fragmentary. Hence, casual collecting by non-specialists can yield valuable information, and new species can even be found in routine sampling of insects around the lights of the Research Station on Santa Cruz.

The authors of this paper worked in the Galápagos Archipelago from July to November 1968. Arthropods were collected whenever time could be spared from principal research projects. The material is consequently highly non-random, being concentrated around the Research Station in Academy Bay with supplementary material from the highlands of Santa Cruz. Additional collections were made on Santiago and Floreana, with only a few specimens being taken on several other islands.

This paper lists, for the interest of students of Galápagos entomology, the material which we collected. Details are given of the islands, locality, habitat zones and date. The number of specimens is also given together with the depository if other than the Royal Scottish Museum, Edinburgh. We are extremely grateful to the authorities who identified the material. Their names are given below, and all identifications and notes or comments in the checklist are initialled for the authority concerned.

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[1] Contribution No. 142 from the Charles Darwin Research Station.

[2] Present Address: The Genetics Laboratory, School of Botany & Zoology, University Park, Nottingham, England.

[3] Present Address: Department of Biological Sciences, Portsmouth Polytechnic, Portsmouth, England.

[4] Present Address: Department of Biology, University of Stirling, Bridge of Allan, Stirling, Scotland.

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It is interesting to note that Linsley & Usinger (1966) list 618 species of insects from the Galápagos Archipelago reported in the literature prior to 1966. We collected 72 of these, approximately 11.5%. To obtain such a high proportion of the known species in such a short time suggests either that we collected in the same localities as previous workers and duplicated their samples, or that the fauna is very impoverished and many species are widespread. An argument in support of the latter alternative is furnished by the consideration that we amassed 80 species from individual islands, of which no less than 38 are island records new to Linsley & Usinger's list. Our authorities were unable to put names to 8, leaving 30 records of previously known insects on new islands–about 42% of our material. This suggests strongly that the Galápagos insect fauna is limited in number of species, but that many species occur on several islands.

In the systematic list which follows, an asterisk in front of the species name indicates that the species is not listed by Linsley & Usinger (1966). An asterisk in front of the island name signifies that the species is not recorded from that island in the same work. All dates refer to 1968.

Class ARACHNIDA

SCORPIONES: VEJOVIDAE

Hadruroides lunatus L. Koch. Santiago: At settlement in James Bay, Arid Zone, 18 August, 1; Waterhole by James Bay, Arid Zone, 18 August, 1; Floreana: base of highest volcano under stone, 1,200 ft. SW side, Transition Zone, 31 August, 1.

SCORPIONES: BUTHIDAE

Centrurus princeps Karsch. Santa Cruz: East of Research Station, coastal scrub, Arid Zone, 4 August, 1.

ARANEAE: ARGIOPIDAE

Gasteracantha insulana Thorell. Santa Cruz: East of Research Station, 30 yards from sea, ca 40 ft., Arid Zone, 4 August, 1 female.

All Arachnida determined by D. J. Clark, (NH) 1970, who adds that these species have been recorded from the Galapagos Is. by Banks (1902, *Proc. Wash. Acad. Sci.*, 49–86).

Class INSECTA

DERMAPTERA

Euboriella annulipes Lucas. (= *Anisolabis bormansi* Scudder, *tests* A. Brindle). (*) Floreana: 2,100 ft., at top of volcano, grassland, short vegetation, Transition Zone, 31 August, 1 nymph. (Det. A.B. 1970).

DICTYOPTERA: BLATTIDAE

Periplaneta australasiae Fabricius. Floreana: 31 August, 1 (Det. D.R.R. 1969).

DICTYOPTERA: PYCNOSCELIDAE

Pycnoscelus surinamensis Linnaeus. (*) Floreana: base of main volcano, three miles from Black Beach, Arid Zone, 31 August, 1. Santa Cruz: half way along old trail from Puerta Azora–Bella Vista, Transition Zone, 8 September, 2 juvs. (Det. D.R.R. 1969).

SALTATORIA: TETTIGONIIDAE

Nesoecia cooksoni Butler. (*) Santiago: on volcano in James Bay, Arid Zone, 17 August, 1 male (Det. D.R.R. and retained by BM (NH)).

SALTATORIA: GRYLLIDAE

Cryptoptilum sp. (*) Santiago: on volcano in James Bay, Arid Zone, 17 August, 1 female (Det. D.R.R. 1969).

MANTODEA: ACRIDIDAE

Schistocerca melanocera Stal. (*) Santiago: in crater of salt mine, James Bay, Arid Zone, 15 August, 1 female & 1 juvenile; at Settlement in James Bay, Arid Zone, 18 August, three males. (Det. V.M.D. 1969).

Halmenus choristopterus Snodgrass. Floreana: 30 August, 1 female. (Det. V.M.D. 1969).

Halmenus robustus Scudder. Santa Cruz: on vegetation near La Caseta, Humid Zone, 1. (Det. V.M.D. 1969).

ODONATA: AESCHNIDAE

Anax amazili Burmeister. (*) Santa Cruz: La Caseta, Humid Zone, 15 October, one male. (Det. A.R.W. 1970).

HEMIPTERA: LYGAEIDAE

Heraeus pacificus Barber. Santiago: 11 August, 1 female (Det. G.M.B. 1970).

NEUROPTERA: HEMEROBIIDAE

Megalmus darwini Banks. Santa Cruz: Research Station, Arid Zone, 25 September–14 October, six (Det. A.R.W. 1970).

NEUROPTERA: CHRYSOPIDAE

Chrysopa nigripilosa Banks. (*) Santa Cruz: Research Station, Arid Zone, 12–27 October, 25. (*) Santiago: near hut, James Bay, Arid Zone, 14 August, 1; settlement, Arid Zone, 22 September, 1. (Det. A.R.W. 1970).

Chrysopa sp. near *galapagoensis* Banks. (*) Floreana: Wittmer Farm, Humid Zone, 29 August, 1. (*) Santa Cruz: Research Station, Arid Zone, 22 September, 1. (*) Santiago: Humid Zone, 23 September, common, 1 specimen taken. (Det. A.R.W. 1970).

NEUROPTERA: MYRMELEONTIDAE

Myrmeleon perpilosus Banks. Santa Cruz: Research Station, Arid Zone, 21 August–28 October, 6 males, 11 females, 2 larvae. (*) Santa Fe: came to light, 14 September, 1 male. (Det. A.R.W. 1969).

(*) *Brachynemurus darwini* Stange. Santiago: James Bay settlement, 21 September, 1 female, 1 larva. (Det. A.R.W. 1969).

LEPIDOPTERA: PIERIDAE[5]

Phoebis sennae Linnaeus. San Cristóbal: 600 ft. in Humid Zone below village, 1 August, 5 females. Santa Cruz: half mile west of Research Station, on coast by brackish pool, Arid Zone, 22 August, 2 females. Santiago: James Bay, around flowering shrubs growing between lava blocks, Arid Zone, 14 & 21 August, 9 males & 3 females; James Bay, at settlement, Arid Zone, 21 September, 1 male.

LEPIDOPTERA: DANAIDAE

(*) *Danaus gilippus* ssp. near *strigosus* Bates. San Cristóbal: near village, 600 ft., Humid Zone, 1 August, 4 males & 4 females.

LEPIDOPTERA: HESPERIIDAE

Urbanus dorantes galapagensis Williams. San Cristóbal: near village, 600 ft., Humid Zone, 1 August, 1 male. Santa Cruz: La Caseta, Humid Zone, 16–18 October, 10 males.

LEPIDOPTERA: SPHINGIDAE

Erinnyis ello encantada Kernbach. Santa Cruz: Research Station, at light, Arid Zone, 4 August, 1 female.

Erinnyis obscura conformis Rothschild & Jordan. Santa Cruz: Research Station, Arid Zone, 19 August–21 October, 2 males & 1 female.

Pholus labruscae yupanquii Kernbach. Santa Cruz: Research Station, Arid Zone, 10 August, 1 male.

Celerio lineata florilega Kernbach. Santa Cruz: Research Station, Arid Zone, 28 October, 1 female.

LEPIDOPTERA: ARCTIIDAE

Utetheisa galapagensis Wallengren. Santa Cruz: Research Station, at light, Arid Zone, 3–5 August, 5 females; 25 September–3 October, 1 male & 6 females; Hornemann Farm, near Bella Vista, 650 ft., Humid Zone, 9 October, 2 females (Det. A.H.H. 1970).

Utetheisa ornatrix Linnaeus. (*) Santa Cruz: La Caseta, Humid Zone, 15 October, 1 female.

LEPIDOPTERA: NOCTUIDAE: AGROTINAE

Agrotis ipsilon Hufnagel. (*) Santa Cruz: Research Station, Arid Zone, 27 September, 1 male.

Lycophotia oceanica Schaus. (*) Santa Cruz: Research Station, at light, Arid Zone, 5 August, 1 female; 21 September–12 October, 1 female & 1 male.

LEPIDOPTERA: NOCTUIDAE: HADENINAE

Mythima sequax Franclemont. Santa Cruz: Hornemann Farm, near Bella Vista, 650 ft., Humid Zone, 9 October, 1 male. (American authors put this in *Pseudaletia* Franclemont).

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[5] All Lepidoptera determined by E. C. Pelham-Clinton unless otherwise stated.

LEPIDOPTERA: NOCTUIDAE: AMPHIPYRINAE

Magusa sp. (*) Santa Cruz: Research Station, Arid Zone, 21 August, 1 male; 4 October, 2 males. (*Teste* A.H.H. 1970, the *Magusa* of Galápagos is not *M. orbifera* (Walker), but is undescribed).

Platysenta apameoides Guenée (= *ebba* Schaus). (*) Santa Cruz: Research Station, Arid Zone, 6 October, 1 female; Hornemann Farm, near Bella Vista, 650 ft., Humid Zone, 9 October, 1 female. (Teste A.H.H. 1970, the species formerly known as *P. apameoides* and so listed by Linsley & Usinger (1966) is *P. plagiata* (Walker)).

Harrisonia williamsi Schaus. Santa Cruz: Research Station, Arid Zone, 22 August–14 October, 6 females.

Amyna insularum Schaus. Santa Cruz: Research Station, Arid Zone, 26 September–4 October, 1 male & 2 females.

Elaphria dubiosa Schaus. Santa Cruz: Research Station, Arid Zone, 4–21 October, 4 females & 1 male, (described by Schaus as a *Rivula* and so listed by Linsley & Usinger (1966), in Catocalinae–A.H.H., 1970).

LEPIDOPTERA: NOCTUIDAE: CATOCALINAE–INCLUDING OPHIDERINAE

Melipotis harrisoni Schaus. Santa Cruz: Research Station, Arid Zone, 5 August–12 October, 2 females & 1 male.

(*) *Lyncestis* sp. near *acontioides* (Guenée). Santa Cruz: Research Station, Arid Zone, 12–13 October, 1 male & 1 female (*Teste* A.H.H. 1970, the species near *acontioides* should be separated from *Melipotis*).

Epidromia zephyritis Schaus. This species occurs in two forms in both sexes; the forms appear to be inseparable by genitalia. Typical (dark) form–Santa Cruz: Research Station, at light, Arid Zone, 5 August, 2 females; 13 October, 1 female. Light form–Santa Cruz: Research Station, at light, Arid Zone, 25 September–12 October, 3 males & 1 female.

Psorya hadesia Schaus. (*) Santa Cruz: Research Station, at light, Arid Zone, 3 August, 1 female; 3–4 October, 1 male & 1 female.

Mocis incurvalis Schaus. Santa Cruz: Research Station, Arid Zone, 4 October, 1 female.

(*) *Glympis* sp. Santa Cruz: Research Station, Arid Zone, 25 September–14 October, 3 males & 2 females. (Det. A.H.H. 1970).

LEPIDOPTERA: GEOMETRIDAE

(*) *Eupithecia leleupi* Herbulot. Santa Cruz: Research Station, Arid Zone, 12 October, 1 female. (Det. D.S.F. 1970).

Camptogramma stellata Guenée. Santa Cruz: Research Station, at light, Arid Zone, 3 August–6 October, 12 females.

Cosymbia impudens Warren. Santa Cruz: Research Station, at light, Arid Zone, 3 August–4 October, 2 males & 1 female. Santiago: Settlement, Arid Zone, 23 September, 3 females.

(*) *Semiothisa cruciata* Herbulot. Santa Cruz: Research Station, Arid Zone, 26 September, 2 females (1 without abdomen). (Det. D.S.F. 1970).

LEPIDOPTERA: PYRALIDAE

(*) *Hymenia perspectalis* Hubner. Santa Cruz: Hornemann Farm, 650 ft., near Bella Vista, Humid Zone, 8 October, 1 female.

(*) *Stemorrhages* sp. near *lustralis* (Guenée). Santa Cruz: Research Station, Arid Zone, 12 October, 1 male. (Det. M. Shaffer 1970).

Piletocera bufalis Guenée. Santa Cruz: Research Station, 3 October, 1 male.

Beebea guglielmi Schaus. (*) Santa Cruz: Research Station, at light, Arid Zone, 4 August, 1 female.

Lepidoptera: Tortricidae

Crocidosema plebeiana Zeller. (*) Santa Cruz: Research Station, Arid Zone, 3 October, 1 female (without head).

Lepidoptera: Gelechiidae

Aristotelia naxia Meyrick. (*) Santa Cruz: Research Station, Arid Zone, 3 October, 1 male.

Lepidoptera: Blastobasidae

Blastobasis crotospila Meyrick. (*) Santa Cruz: Research Station, Arid Zone, 26 September, 1 female.

Lepidoptera: Hyponomeutidae

Atteva hysginiella Wallengren. Santiago: James Bay, near hut, Arid Zone, 14 August, 1 female.

Coleoptera: Carabidae

Selenophorus galapagoensis G.R. Waterhouse. (*) Pinta: Arid Zone, 22 September. (Det. P.M.H.).

Coleoptera: Oedomeridae

Alloxacis collenettei Blair. Santa Cruz: Research Station, 14 October, 2 (Det. by C.M.F. von H. as *Oxacis collenettei*).

Coleoptera: Elateridae

Physorinus quirsfeldi Mutchler. Santa Cruz: Research Station, Arid Zone, 12–14 October, 2. (Det. C.M.F. von H. 1970).

Coleoptera: Coccinellidae

Cycloneda sanguinea Linnaeus. Santa Cruz: On *Mora* vegetation, about 1.5 miles west of La Caseta in the tortoise reserve, Wet Zone, 2; Research Station, Arid Zone, 9 August, 1. (Det. R.P.D. 1970).

Coleoptera: Rhipiphoridae

(*) Genus and species unknown at the British Museum (Natural History). Santa Cruz: Research Station, Arid Zone, 28 August, 1; 13–14 October, 2.

Coleoptera: Tenebrionidae

Stomion galapagoensis G.R. Waterhouse. Floreana: 2.5 miles east from Black Beach along track, 1100 ft., Arid Zone, 3; On top of volcano, 2,100 ft., in grass and short vegetation, 31 August, 4; 3 miles east of Black Beach, at foot of final cone of volcano, 1,500 ft., Arid Zone, 31 August, 2. (Det. M.J.D.B. 1970).

Stomion laevigatum G.R. Waterhouse. Santiago: On top of volcano in James Bay, Arid Zone, 11 August, 1. (Det. M.J.D.B. 1970).

Stomion rugosum Van Dyke. Pinta: Arid Zone, 22 September, 1. (Det. M.J.D.B. 1970).

Ammophorus bifoveatus G.R. Waterhouse. (*) Santiago: On top of volcano in James Bay, Arid Zone, 11 August, 3. (Det. M.J.D.B. 1970).

Pedonoeces bauri Linell. (*) Floreana: 3 miles east of Black Beach, at foot of final cone of volcano, 1,200 ft., Arid Zone, 31 August, 1. (Det. M.J.D.B. 1970).

Pedonoeces opacus Van Dyke. (*) Santa Cruz: 1 mile east from Research Station, 150 yards from coast, Arid Zone, 4 August, 1 (Det. M.J.D.B. 1970).

COLEOPTERA: BOSTRICHIDAE

Amphicerus cornutus galapaganus Lesne. Santa Cruz: Research Station, Arid Zone, 23 October, 1 (Det. C.M.F. von H. 1970).

COLEOPTERA: CERAMBYCIDAE

Eburia lanigera Linell. (*) Santa Cruz: Research Station, Arid Zone, 12–13 October, 2. (Det. R.T.T. 1970).

Estoloides galapagoensis Blair. Santa Cruz: Research Station, Arid Zone, 13–14 October. (Det. R.T.T. 1970).

Acanthoderes galapagoensis Linell. Santa Cruz: Research Station, Arid Zone, 13 October, 1. (Det. R.T.T. 1970).

COLEOPTERA: CURCULIONIDAE

Pantomerus galapagoensis Linell. (*) Floreana: 3 miles east of Black Beach, in dry scrub, 1,500 ft., Arid Zone, 31 August, 1. (Det. R.T.T. 1970).

DIPTERA: TIPULIDAE

Limonia (*Geranomyia*) *tibialis* Loew. Santa Cruz: Media Luna, in grassland, Wet Zone, 18 October, 1 female. (Det. A.M.H. 1970); Research Station, at night, Arid Zone, 20 August, 1 male. (Det. A.R.W. 1970).

DIPTERA: CULICIDAE

Aedes (*Ochlerotatus*) *taeniorhynchus* Wiedemann. Santa Cruz: Research Station, found dead on lab. bench in morning, Arid Zone, 5 August, 1 female. (Det. A.H.H. 1970).

DIPTERA: TABANIDAE

Tabanus vittiger Thomson. Santa Cruz: Research Station, Arid Zone, 2 September, 1 female. (Det. H.O. 1970).

DIPTERA: CALLIPHORIDAE

Sarcophaga sp. Santa Cruz: Research Station, 2 August, 1 male.

HYMENOPTERA: APIDAE

Xylocopa darwini Cockerell. Santa Cruz: found near brackish pool, 0.5 mile west of Research Station, Arid Zone, 22 August, 1 female. (Det. A.R.W. 1970).

HYMENOPTERA: MUTILLIDAE

Photopsis sp. (*) Santiago: settlement, Arid Zone, 23 September, 1 male. (Det. M.C.D. 1970).

ACKNOWLEDGMENTS

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The authorities who performed the identifications are: G. M. Black (Hemiptera), M. J. D. Brendell (Coleoptera), A. Brindle (Dermaptera), D. J. Clark (Arachnida), M. C. Day (Hymenoptera), V. M. Dirsch (Mantodea), D. S. Fletcher (Lepidoptera), P. M. Hammond (Coleoptera), C. M. F. von Hayek (Coleoptera), A. H. Hayes (Lepidoptera), A. M. Hutson (Diptera), H. Oldroyd (Diptera), E. C. Pelham-Clinton (Lepidoptera), R. D. Pope (Coleoptera), D. R. Ragge (Orthoptera), R. T. Thomson (Coleoptera), A. R. Waterson (Odonata, Neuroptera, Hymenoptera and Diptera).

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NOTICE

An annual Directory of Environmental Consultants, will be published beginning in 1972. Environmentally concerned professionals interested in having their name and short résumé appear in the Directory should send a No. 10, self-addressed, stamped envelope to: Directory of Environmental Consultants, P. O. Box 8002, University Station, St. Louis, Missouri 73108.

A New Genus and Species of Jumping Shore Beetle from Mexico

(Coleoptera: Limnichidae)

T. J. Spilman

Systematic Entomology Laboratory, Entomology Research Division, Agr. Res. Serv., USDA[1]

In the fall of 1966 William G. Evans of the University of Alberta collected insects, pseudoscorpions, and chilopods from the intertidal zone of the western coast of Mexico. As he says in his introductory report (1968), he studied about one thousand miles of Mexican mainland coast from Guaymas in Sonora to Barra De Navidad in Jalisco; this coast and that of the southern tip of Baja California and the Hawaiian Islands comprise a distinct marine littoral faunal zone, which Evans designates the Subtropical Zone. His objective was, among other things, to compare the ecology of the Mexican coast with that of others he had studied. However, an interesting by-product of his trip came at the southernmost point when he discovered a remarkable new genus and species of intertidal beetle.

These little beetles, about two millimeters long, dark, compact and somewhat streamlined, have long hind legs bearing heavy long setae or spurs. Their morphology, given below in formal descriptions, places them in the subfamily Thaumastodinae of the Dryopoid family Limnichidae. Evans' beetles were aggregated in groups of six to twelve in high and mid-tide rock crevices, and they jumped an inch or two when disturbed but were otherwise slow moving. One other member of the subfamily, *Martinius ripisaltator* Spilman, lives in the marine intertidal zone of Cuba and also jumps. Although all other Thaumastodinae do live near water, either fresh or salt water, none of those near fresh water has been recorded as being a jumper.

Heretofore this subfamily contained three genera: *Acontosceles* Champion, with one species in India and another in the Philippines; *Pseudeucinetus* Heller, with a single species in the Philippines and Malay Penninsula; *Martinius* Spilman, with one species in the Canal Zone and another in Cuba. I reviewed the taxonomy and morphology of the subfamily (1959) and then added the Cuban species (1966). In the first article I tried to indicate similarities and relationships of the three genera and came to the conclusion that *Pseudeucinetus*

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[1] Mail address: c/o U. S. National Museum, Washington, D. C. 20560

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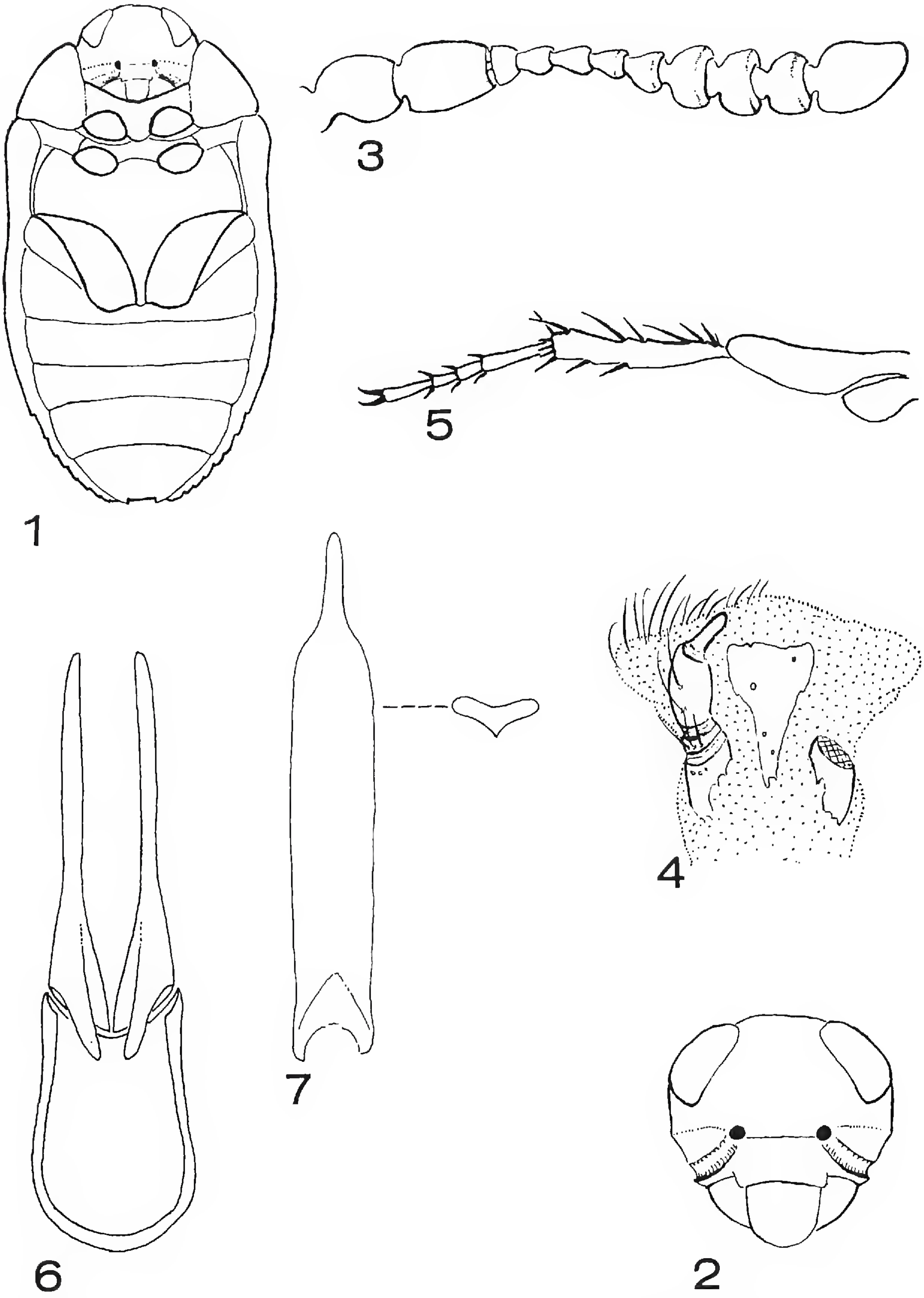
is an intermediate genus, but it is much more closely related to *Martinius* than to *Acontosceles*. In other words, *Acontosceles* stands well apart.

This new genus, described below under the name *Mexico*, has five outstanding characteristics. First, the antenna is very odd. At first glance the general shape of the antenna seems similar to that of *Pseudeucinetus*, but the number of articles appears to be 10 instead of the normal 11 because the second and third articles seem to be one. However, what appears to be a mere line or constriction on the apical third of this seemingly single article is actually a division or joint, and the morphology becomes obvious when the two are separated. The second article is large, the third small (Fig. 3). The apex of the second is concave, and the base of the third has an opposing concavity and a slender medial stalk; that stalk is actually the base of the third and fits into a hole in the center of the concavity of the second. I wonder about the function of such an arrangement; why should there be opposing, close-fitting concavities on neighboring antennal segments? One other genus, *Martinius*, also has an odd antenna, but that oddity is not in its shape but in its number of articles—it has only seven. Both *Acontosceles* and *Pseudeucinetus* have normal antennae of eleven articles. Second, *Mexico* has a sharply margined, deep, bare antennal groove immediately above the mandible, just wide enough to contain the antenna (Fig. 2). The groove does not exist in other genera. This groove is located in the broad, shallow, setose depression that is present in other genera; I had previously called that broad depression the antennal groove. Third, the eyes of *Mexico* are widely separated, very nearly vertical in position, and suboval (Fig. 2). However, this genus is not alone in having distinctive eyes; the eyes of each genus are differently shaped and arranged. The eyes of *Mexico* are the most widely separated in the subfamily, and their shape and position are intermediate between those of *Acontosceles* and *Pseudeucinetus*. Fourth, the prosternum of *Mexico*, the longest in the subfamily (Fig. 1), is one and a half times as long as the prosternum of *Pseudeucinetus* and twice as long as that of *Martinius*. Fifth, the metasternum is long (Fig. 1), almost as long as that of *Acontosceles*; this structure is very short in *Pseudeucinetus* and *Martinius*. Also, the metacoxae of *Mexico* are moderately oblique, of moderate size, and have moderately large plates. In *Acontosceles* the metacoxae are only slightly oblique, are relatively small, and have small plates; in *Pseudeucinetus* and *Martinius* they are very oblique, are very large, and have very large plates. The

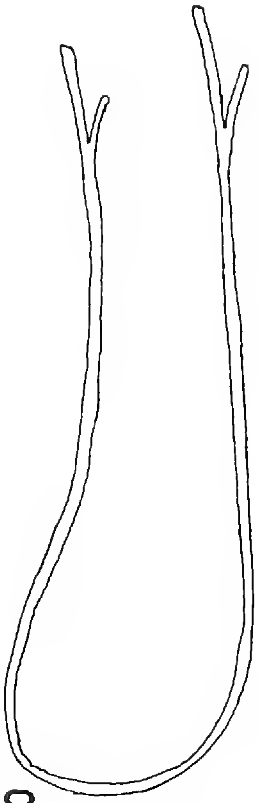


FIGS. 1–7. *Mexico litoralis*, new species. FIG. 1. Beetle, ventral view. FIG. 2. Head, anterior view. FIG. 3. Antenna. FIG. 4. Labium, aboral view. FIG. 5. Hind leg, anterior view. FIG. 6. Male parameres and pars basalis, dorsal view. FIG. 7. Male penis, dorsal view; outline of cross section at right.

length of the metasternum is inversely proportional to the size of the metacoxae in all four genera.

The majority of comparisons made in the generic description of *Mexico* indicates a close relationship to *Pseudeucinetus* and *Martinius.* However, I feel that the five characteristics discussed in the preceding paragraph indicate that *Mexico* is intermediate between *Acontosceles* on the one hand and *Pseudeucinetus* and *Martinius* on the other. That relationship, surely only a conjecture, might be expressed in a linear manner as follows, with the number of hyphens being directly proportional to distance of relationship: *Acontosceles----Mexico---Pseudeucinetus-Martinius*

Each time I look critically at members of this subfamily some different facet of functional morphology catches my eye. In my first paper (1959) I commented on several structures and their functions; in my second (1966) I discussed the functional significance of position of setae on the metatarsi. Now I am able to report on the morphology of the closure of the cavity formed by the elytra and abdomen. Closure is effected by three structures: a lateral seal, a lateral clasp, and an apical clasp. First, a lateral seal is formed by a dorsally projecting, continuous, longitudinal, thin, sclerotized plate or flange on each side of the dorsum of the abdominal segments (Fig. 10). This plate is actually a dorsal projection of all the combined sternites, and the lightly sclerotized tergites are continuous with the plate. The plate fits tightly against the underside of the lateral edge of the elytra when the latter are at rest. Second, a lateral clasp (Fig. 11) is formed by a very small, thin, dorsal projection on the lateral edge of the metacoxa. That projection fits into a very small, very narrow and short slit on the lower edge of the elytral pseudopleuron. Third, an apical clasp is formed in two different ways in the subfamily. The clasp is similar in *Pseudeucinetus*, *Martinius*, and *Mexico* (Fig. 12). The last visible abdominal sternite has a notch on each side of the midline of the posterior border and a slightly expanded process at the apex of that notch. The elytral apex has a truncate process, and the lateral surface of that process is concave. When the combined elytra are closed against the abdomen, the processes of the elytral apices fit between the processes of the abdominal sternite; the medial surface of each abdominal process fits snugly into the concavity of the lateral surface of the elytral process. However, the apical clasp in *Acontosceles* is different (Fig. 13). The apex of the elytron is slightly projected, but the projection is not parallel sided nor is it truncated. Proximad to the apex of the elytron the



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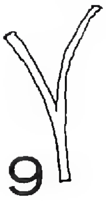

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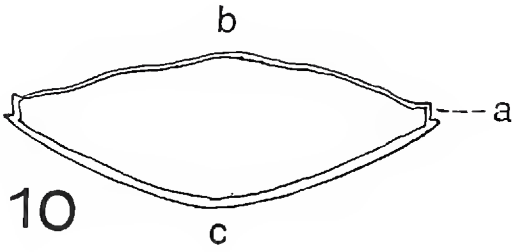

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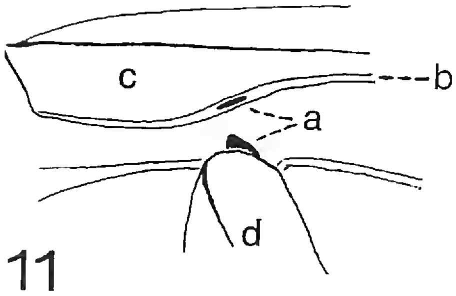

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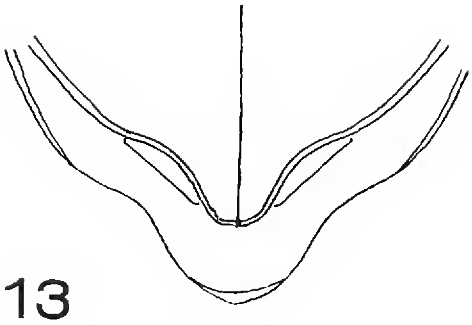

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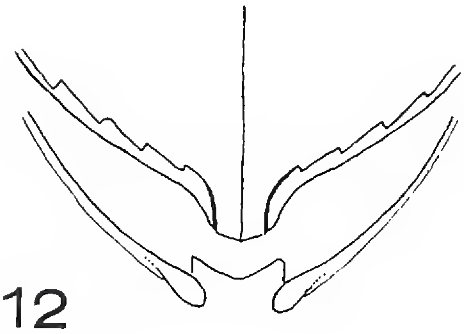

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FIG. 8–12. *Mexico litoralis*, new species. FIG. 8. Male sternite 9, dorsolateral view. FIG. 9. Male tergite 9, dorsolateral view. FIG. 10. Abdomen in region of 2nd visible sternite, diagrammatic cross section; a-lateral plate, b-dorsal surface, c-ventral surface. FIG. 11. Lateral area of left elytron and abdomen, showing lateral clasp opened; a-lateral clasp, b-elytral epipleuron, c-elytral pseudopleuron, d-metacoxa. FIG. 12. Apex of elytra and abdomen, showing apical clasp opened. FIG. 13. *Acontosceles hydroporoides* Champion. Apex of elytra and abdomen, showing apical clasp opened.

lateral border is incurved and from that incurved section a small vertical flange projects downward. The posterior border of the last visible abdominal sternite does not have notches or processes, but it is slightly rolled upward or recurved on its lateral thirds. When the combined elytra are closed against the abdomen, the recurved border of the sternite presses against or grips the flanges of the elytra.

Each of these three structures has a distinct function in the common cause of closure. The lateral seal forms a tight seal, keeping water from the subelytral cavity. The lateral clasp aligns the borders of the elytra and abdomen, preventing lateral movement of the elytra. The apical clasp functions as a locking mechanism and as a seal in the area where movement of the apical abdominal sternite must be possible. All three structures serve to maintain the integrity of the subelytral cavity.

KEY TO THE GENERA OF THAUMASTODINAE

1. Tarsal formula 4-5-5. Eye acutely angulate ventrally. Antenna inserted very near eye .... *Acontosceles* Champion
   Tarsal formula 4-4-4. Eye evenly arcuate or broadly angulate ventrally. Antenna inserted near mandible and distant from eye 2
2. Antenna with 7 articles .... *Martinius* Spilman
   Antenna with 11 articles or apparently with 10 articles 3
3. Antenna with articles 2 and 3 seemingly united, with continuous border (Fig. 3). Elytra with lateral border serrate posteriorly .... *Mexico* Spilman, new genus
   Antenna with 11 obvious articles, all articles distinct. Elytra with lateral border entire posteriorly .... *Pseudeucinetus* Heller

The four genera in the Thaumastodinae are compared in each character in the following description of the new genus. If the character mentioned is identical or similar to that same character in *Acontosceles*, an "(A)" is placed after the character. A "(P)" indicates similarity or identity to *Pseudeucinetus*, and an "(M)" indicates *Martinius*. If the character is unique or greatest in *Mexico*, the exclamation mark "(!)" is used.

Mexico Spilman, new genus

Head (Fig. 2) with face weakly convex in lateral aspect (PM); epistomal suture present (PM). Eyes (Fig. 2) subovate, dorsolateral, widely separated (!). Antennal groove (Fig. 2) broad, margined dorsally, with shiny, deep, acutely margined groove in ventral third of broad groove (!). Antenna (Fig. 3) inserted near mandible (PM); short, with 11 articles (PA); middle segments submoniliform (PM); with club of four articles (!); 2nd article large, 3rd small, 2nd and 3rd almost fused and together appearing as one (!). Labrum with lateral borders evenly arcuate (PM). Mandible with apical slender part not offset from lateral border of main body of mandible (!); lacinia mobile longer, its apex at level of apex of mandible proper (!); without elevation at base of lacinia mobile (!). Maxilla slender, with galea simple apically (PM). Labium (Fig. 4) with postmentum as wide as long (PM); ligula with broad, blunt lateral projections (!); 2nd palpal article longer (PM) and much broader than 3rd (!). Pronotum evenly convex (PM). Prosternum (Fig. 1) relatively long anterior to procoxal cavities, longest prosternum in tribe (!). Mesosternum (Fig. 1) on same level as prosternal process (PM), with distinctly bordered depression for reception of prosternal process (M), linear in area anterior to each mesocoxa (PM). Metasternum (Fig. 1) evenly convex, short anterior to metacoxae, slightly expanded laterally, posterior borders moderately converging medially, becoming triangular between coxae (in all respects intermediate between A and PM). Metepisternum (Fig. 1) very narrow, widest anteriorly, becoming linear posteriorly (PM). Hind tibia (Fig. 5) with many heavy spurs (PM). Tarsal formula 4-4-4 (PM). Foreleg not exhibiting sexual dimorphism (A). Metacoxa (Fig. 1) oblique, large, its length equal to distance between it and mesocoxa (A). Elytra with lateral border posteriorly serrate (M); apex with truncate process (PM) (Fig. 12). Abdomen (Fig. 1) with first visible sternite very long laterally and very short medially where large hind coxae encroach (PM); with border of ultimate visible sternite bidentate (PM) (Fig. 12). Metendosternite with stalk not bulbous anteriorly (PM); vertical plate not thickened on dorsal border (PM); anterior tendons not visible (PM). Male with aedeagus (Fig. 6) with tegmen ventral to penis when retracted within abdomen (M); with pars basalis symmetrical, not sclerotized dorsally, forming trough for penis (M); with parameres obviously longer than basal piece (!) and not acuminate apically (PM); sternite nine (Fig. 7) symmetrical (M); sternite eight (Fig. 8) small, modified V-shaped (PM).

TYPE-SPECIES: *Mexico litoralis* Spilman, new species.

The generic name *Mexico* should be considered to be in the third declension: *Mexico, Mexiconis.* The name would be similar to *Dido* and *Leo*; it is masculine.

Mexico litoralis Spilman, new species

Dorsal surface covered with dense, fine, setigerous punctures. Setae on dorsal surface of head similar to those on pronotum and elytra except directed anteriorly; setae on anterior surface of head strongly arched and directed ventrally. Setae on pronotum and elytra of three kinds. First kind very dense, short, fine, appressed, and brown, and covering most of surface. Second kind very dense, short, broad, appressed, and silvery or white, and forming irregular bands or spots on elytra; bands or spots obscured when lighted from certain directions. Third kind evenly dispersed among other kinds, dense, longer, fine, recurvate, and brown. Ventral surface covered with very dense, fine, setigerous punctures; setae whitish yellow, posteriorly directed, appressed, and fine. Ultimate visible sternite with four rows of very long, coarse, brown, curved setae, each row with four or five setae; setae not very obvious because of length of very dense finer setae. Antenna clothed with long whitish setae; much longer setae sparsely distributed and especially noticeable on apex of last article. Legs with dense whitish setae. Tarsi with pair of course setae on apex of each article except distal article. Sexual dimorphism not visible.

Eyes with overall surfaces continuous with surfaces of head; dorsal separation of eyes equal to 0.8 length of eye; anterior borders widely divergent ventrally in anterior view and almost straight, posterior borders strongly curved; dorsally and ventrally evenly arcuate. Antenna attaining middle point of procoxa; with club of 4 articles; article 1 large, subglobular, article 2 long, 3 short, 3 to 7 becoming gradually broader, 8 to 10 broad, submoniliform, 11 elongate. Pronotum with anterior border moderately incurved; anterior angles only moderately projecting; lateral borders evenly arcuate; posterior border sinuate on lateral thirds and with broad, posteriorly projecting, truncate lobe on middle third. Elytra parallel-sided in anterior half, evenly arcuate in posterior half, together forming semicircle at apex. Surface transversely evenly convex and longitudinally weakly convex; pseudopleural carina, or angulation of dorsal surface with pseudopleuron, visible throughout its length in dorsal view, forming lateral border of elytra; pseudopleural carina with approximately 10 small serrations on posterior half; apex of each elytron with small truncated projection which lies medial to apical projections on ultimate sternite of abdomen; pseudopleuron wide anteriorly, gradually narrowing posteriorly, visible throughout its length.

Length: 1.7–2.0 mm; width, 0.9–1.1 mm.

Holotype, USNM No. 71706, Allotype, and 13 Paratypes, TENACATITA BAY, JALISCO, MEXICO, 19°16′45″N., 104°48′30″W., W. G. Evans, 4 November 1966. Evans in a letter to me said, ". . . they hopped like flea beetles. I found the beetles, aggregated in groups of 6 to 12, in crevices of high tide-zone and splash-zone rocks on the protected south end of Tenacatita Bay. These rocks were scattered irregularly on a shingle beach. Collembola, as yet unidentified, were also found on the surface of these rocks as well as in crevices, but algae were not present."

ACKNOWLEDGMENT.—Of course, this study would have been impossible without William George Evans. His scientific ability, his generosity, and his gentlemanliness make working with him a pleasure.

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A New Species of *Mystrops* from Costa Rica

(Coleoptera: Nitidulidae)

LORIN R. GILLOGLY
San Pedro, California 90731

Nitidulid beetles of the genus *Mystrops* Erichson are found in the New World from Mexico south to Argentina. Not a great deal is known of their life histories and food preferences. At the present time three species are known definitely from feather-leafed palms, where the larvae and adults are found in the blossoms feeding on pollen. The beetles may occur in great numbers on the male inflorescence. If disturbed, they fly around it like a swarm of gnats.

Bondar (1940) reported an agricultural pest, *Mystrops fryi* Grouvelle (*M. palmarum* Bondar), in blossoms of *Cocos coronata* Mart. and *Cocos nucifera* Linnaeus. From male flowers of the palm *Cocos romanzoffiana* Chamille, he collected another species, *Mystrops bondari* Gillogly.

The queen palm, known variously as *Cocos plumosa* Hook., or *Arecastrum romanzoffianum* Beccari, is associated with a third species. A large number of specimens of *Mystrops heterocera* Sharp were collected with a long-handled net from blossoms of the queen palm on 28 August 1965 by the author. The locality was Mexico, near Acayucan on the highway across the Isthmus of Tehuantepec.

A new species of *Mystrops* infesting palm blossoms is herein described and figured, with illustrations by G. M. Gillogly. Because of its potential economic importance, the nitidulid beetle will merit further observations and studies.

Mystrops costaricensis Gillogly, new species

MALE.—(Fig. 1). Oblong, strongly convex, surface finely reticulate, moderately shiny but surface obscured by rather dense, recumbent, golden pubescence, color uniformly testaceous except for black coarsely faceted eyes. Scutellum enclosed by somewhat darker triangular area when viewed at certain angles.

Head transverse, with dense, coarse, close lying golden pubescence obscuring surface. Eyes coarsely faceted, prominent. Front nearly quadrate, only slightly narrower in front of eyes than behind. Labrum (Fig. 4) very deeply bilobed, indentation nearly attaining clypeus, lobes fairly evenly rounded. Mandibles (Fig. 3) with outer margin rather evenly curved, tip almost sharp with inner margin crenate; two teeth at base of inner margin of tip, somewhat obscured by beard; molar area rasplike, with larger teeth toward tip and becoming rather small at base. Maxillae (Fig. 5) with lacinia broad, truncate, inner angle produced into definite spur, outer angle acute but not attenuate, tip

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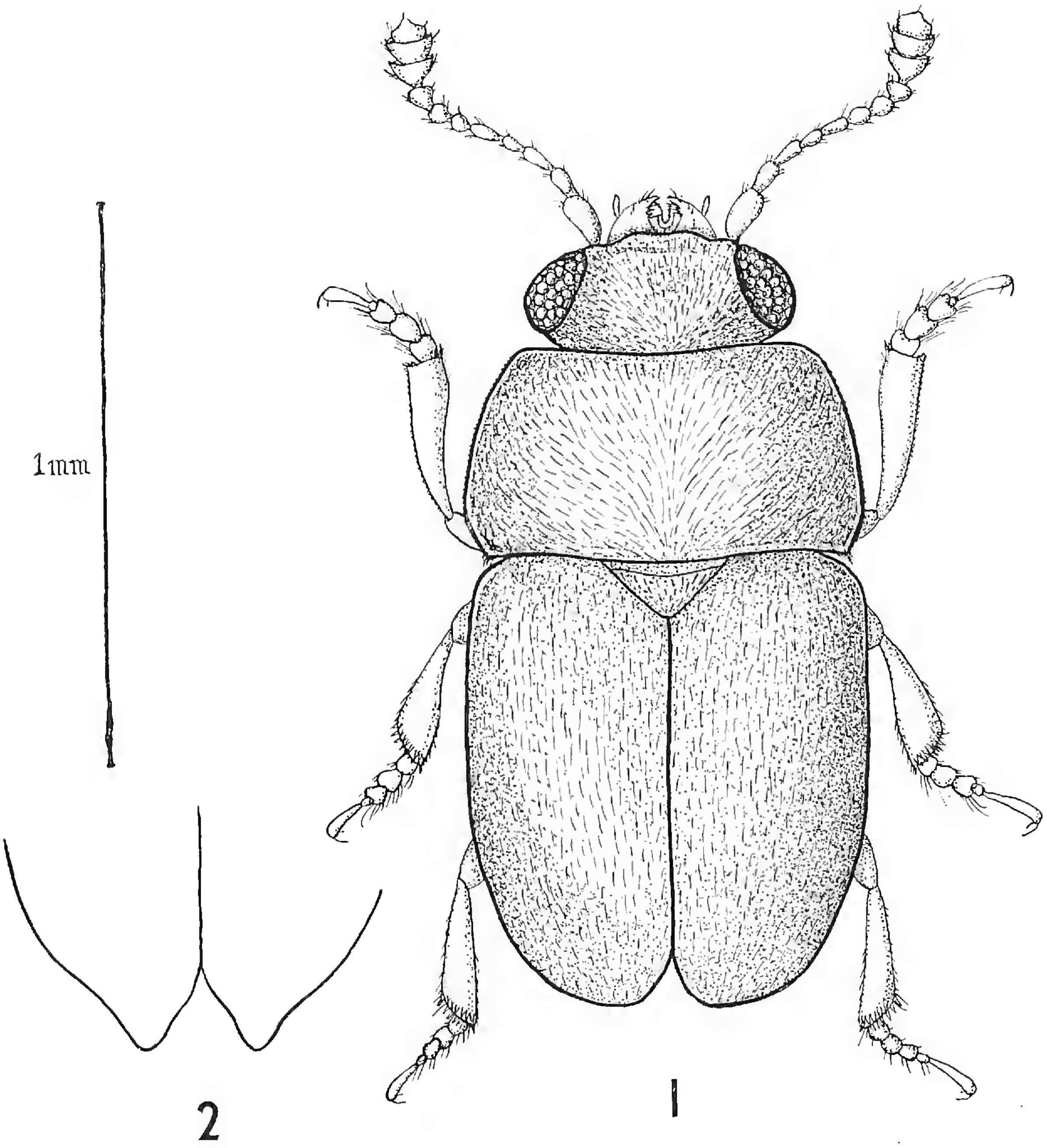
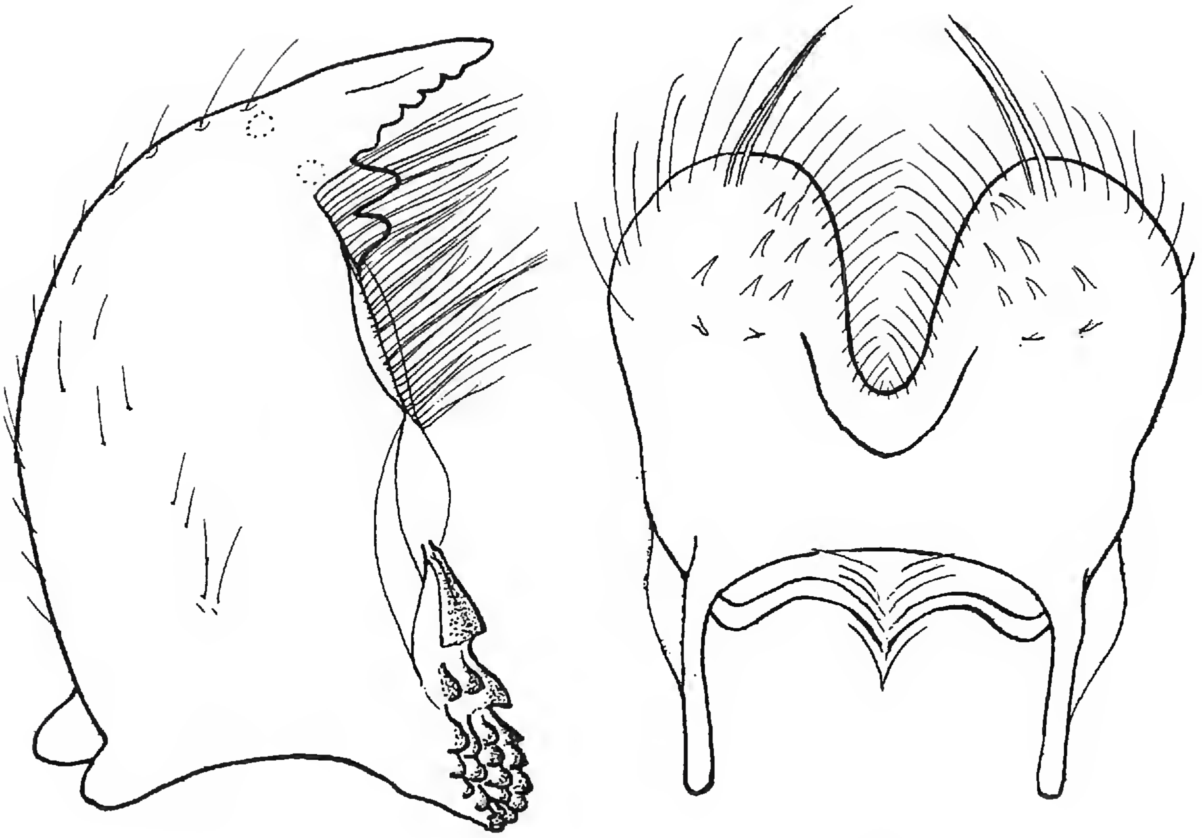


FIGS. 1 and 2. *Mystrops costaricensis.* FIG. 1. Adult male. FIG. 2. Female. Elytra tips attenuate.

heavily bearded; palpi with first segment minute, twice as wide as long, second segment transverse, nearly elbowed, about three times as long and three times as wide as first segment, third segment nearly square in outline being somewhat narrower at tip than at base; terminal segment elongate, nearly twice as long as first three segments together, widest at basal one-fourth narrowing to tip and base. Labium (Fig. 6) with ligula spatulate; paraglossae broad, obliquely truncate tips, strongly bearded; palpi, first segment minute, second clavate, third thick, slightly sigmoidal; submentum bilobed distally with small protuberance in middle of sinuation, strongly indented on each side near base. Antennae short, reaching to mesosternum, pubescence fine with few erect hairs on each segment; club distinct, of three equal segments. Prothorax almost rectangular, nearly twice as wide as long, anterior margin straight, a little narrower than base; sides narrowly margined, hardly explanate, evenly arcuate



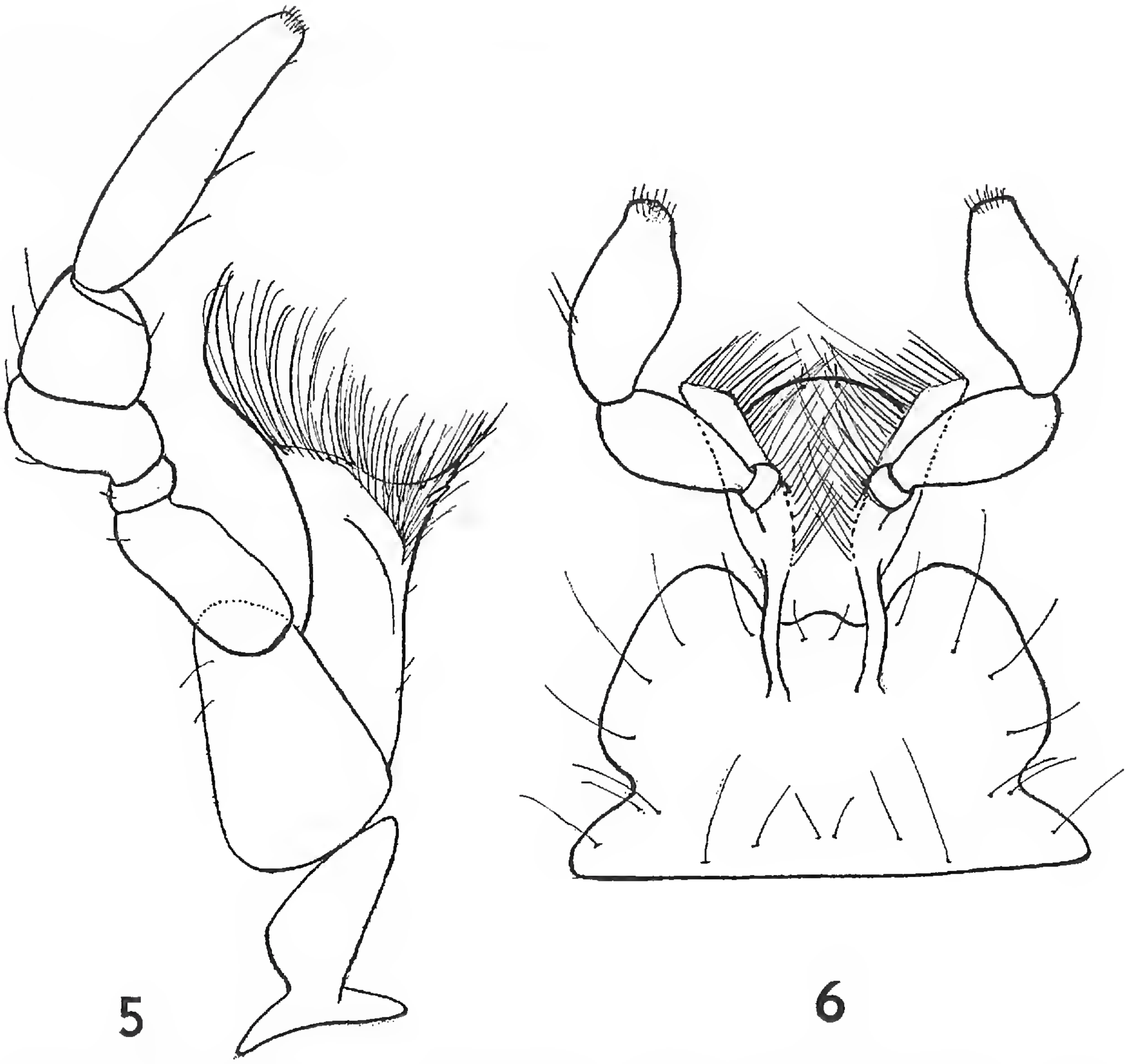
FIGS. 3. and 4. *Mystrops costaricensis.* Adult male. Mouthparts. FIG. 3. Mandible. FIG. 4. Labrum.

from apex to three quarters then strongly retracted to distinct obtuse angle; base narrowly margined, lightly sinuate at each side of scutellum, more strongly sinuate near hind angles which project slightly to rear; surface rather closely moderately finely punctate with pubescence somewhat less dense than on head; texture of surface smooth between punctures. Scutellum triangular, twice as wide as long, surface distinctly finely reticulate. Elytra length to width as 1.3 to 1, sides parallel, tips rounded, sutural angles rounded, pubescence and punctation more sparse than on prothorax. Pygidium convex, evenly curved, strongly closely pubescent. Prosternum convex, sparsely finely punctate, lightly pubescent, surface strongly finely reticulate, process narrow, depressed behind coxae. Metasternum sparsely punctate, strongly finely reticulate; axillary space large, extending along episternal suture nearly to hind coxae. Abdominal segments of equal length, rather pubescent, surface reticulate. Supplementary segment not visible from above, hardly visible from below but usually to be seen from behind.

FEMALE.—Punctation more sparse than male, pubescence finer. Tips of elytra strongly attenuate (Fig. 2). Pygidium tip simple. Antennae similar to those of male.

LENGTH.—1.4 to 1.7 mm. Width: 0.6 to 0.8 mm.

Holotype male and allotype GUÁPILES, LIMÓN, COSTA RICA, altitude 300 m, 16 November 1968 are deposited in the California Academy of Sciences. Paratypes are deposited in the collections of the University



FIGS. 5 and 6. *Mystrops costaricensis.* Adult male. Mouthparts. FIG. 5. Maxilla. FIG. 6. Labium.

of Costa Rica; the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica; American Museum of Natural History; and the United States National Museum.

Type and allotype and all 322 paratypes (159 males and 163 females) were taken with the assistance of Ingeniero Francisco Matamoros from the same male inflorescence of *Elaeis guineensis* Jacq., African oil palm, on the afternoon of 16 November 1968 at Guapiles in the state of Limon. The oil palms are grown at the Experiment Station Los Diamantes, a cooperative project of the Department of Agriculture of Costa Rica with the A.I.D. program of the United States.

Mystrops costaricensis falls in the key (Gillogly, 1955) at couplet #3 with *M. discoidea* Murray from which it may be separated by its short antennae. The antennae of *M. discoidea* are nearly as long as the body in both sexes.

My visit to the station was arranged through the kindness of Dr. Vargas of the Department of Agriculture of Costa Rica. I gratefully acknowledge the counsel and assistance of the ecologists at the Tropical Science Center of San Jose, Costa Rica: Joseph A. Tosi, Jr. and Dr. L. R. Holdridge.

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BOOK NOTICES

The following bulletins have been published recently by the Research Division, Virginia Polytechnic Institute and State University.

THE INSECTS OF VIRGINIA:

No. 3. A systematic review of the genus *Culicoides* (Diptera: Ceratopogonidae) of Virginia with a geographic catalog of the species occurring in the eastern United States north of Florida. Frank V. Battle and E. Craig Turner, Jr. Res. Div. Bull. 44, V.P.I. and State Univ., 129 p., 36 pls. 1971.

No. 4. Shield bugs (Hemiptera; Scutelleroidea, Scutelleridae, Corimelaenidae, Cydnidae, Pentatomidae). Richard L. Hoffman. Res. Div. Bull. 67, V.P.I. and State Univ., 61 p., 16 figs. 1971.

STUDIES ON THE MORPHOLOGY AND SYSTEMATICS OF SCALE INSECTS:

No. 3. Morphology and systematics of *Cerococcus parrottii* (Hunter) with notes on its biology (Homoptera: Coccoidea: Asterolecaniidae) James O. Howell, Michael L. Williams, and Michael Kosztarab. Res. Div. Bull. 64, V.P.I. and State Univ., 23 p., 5 pls., 1 map. 1971.

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The above publications are available on an exchange basis from the Mailing Room, Research Division, Hutcheson Hall, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.—R. W. THORP, *University of California, Davis, 95616.*

A New Species of *Thaumalea* from California

(Diptera: Thaumaleidae)

DONALD R. BROTHERS
Biological Sciences Department, San Jose State College, California 95114

The genus *Thaumalea* Ruthe is represented in North America by five relatively rare species (Stone *in* Stone *et al.* 1965, Schmid 1970). Of these, only one species, *T. fusca* (Garrett), has been cited as possibly occurring in California (Wirth and Stone *in* Usinger 1963). Cole (1969) cites a specimen "near *fusca*" from Bodie, Mono County, California.

In an attempt to determine the identity of *Thaumalea* specimens collected from Santa Clara County, California, it was discovered that the terminalia of the male specimens differed considerably from those of an unpublished illustration of the *T. fusca* holotype. The ninth tergite of *T. fusca* is void of elongated ventral projections, and the dististyles are without setose lobes or terminal elongated processes. The following description of the undescribed species is published to make the name available for taxonomic studies of this genus.

Thaumalea santaclaraensis Brothers, new species

(Figs. 1, 2)

MALE.—Body length 2.5–3.0 mm. Thorax brown. Abdomen brownish black. Antennae 12 segmented; pedicels very large, with long setae; flagellar segments 1, 2, 3, 4, 6, and 8 each bearing long, stout seta. Tip of each terminal segment of antennae also bears two long setae. Wing length 2.75–3.25 mm, uniform light brown; uniformly covered with microtrichia; veins brown; macrotrichia on veins C, R, and R_1; 8–10 on vein R, and 10–12 on vein R_1. Halteres elongate, yellow. Legs light brown, darkened distally. Ninth tergite brown, heavily chitinized, about as long as broad, tapering and slightly round apically. Medial ventral edges of ninth tergite produced inward on both sides, forming elongated projections. Basistyles about as long as broad, sparsely and coarsely setose. Dististyles about same length as basistyles; each with prominent setose basal lobe; outer margin bearing two setae; apical end with stout tooth and expanded, elongated, curved process. Parameres simple, rather slender; tips slightly pointed inwards.

FEMALE.—Body length 3–4 mm. Valves of genital plate setose and pointed; tips each bearing two setae. Posterior corners of ninth tergite rounded. Other structures as for male.

Holotype male and allotype, from ALUM ROCK PARK, SANTA CLARA COUNTY, CALIFORNIA, elevation 900 feet, 31 July 1971, and 31 May 1971 respectively, (D. R. Brothers). Thirteen male and eight female

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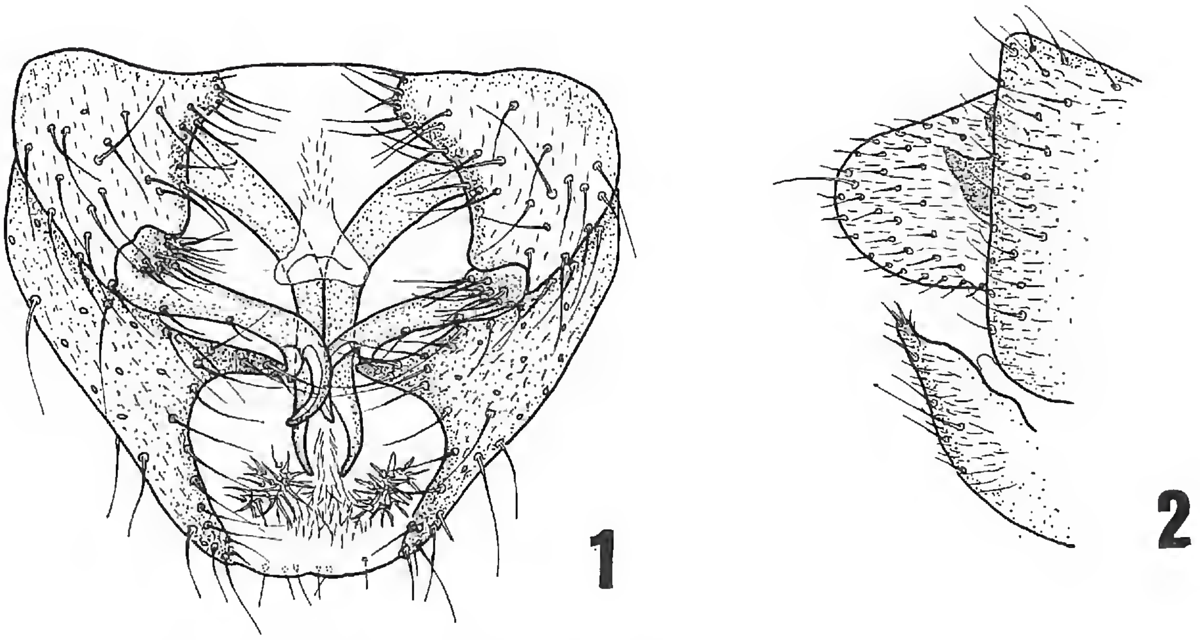

FIG. 1 and 2. *Thaumalea santaclaraensis* Brothers, new species. FIG. 1. Male terminalia, ventral view. FIG. 2. Female terminalia, lateral view.

paratypes were collected from the type locality during June and July, 1971, (D. R. Brothers).

The holotype male and allotype female will be deposited in the California Academy of Sciences, San Francisco, California; paratypes at the California Academy of Sciences, and the U. S. National Museum, Washington, D. C.

Terminalia illustrations are of mounted paratypic material.

ACKNOWLEDGMENTS

I thank Dr. P. H. Arnaud, Jr. of the California Academy of Sciences for providing an illustration of the male terminalia of the *T. fusca* holotype.

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New Species of *Baetodes* from Mexico and Central America
(Ephemeroptera: Baetidae)

SANDRA D. COHEN AND RICHARD K. ALLEN[1]
California State College, Los Angeles, 90032

The genus *Baetodes*, described by Needham and Murphy (1924), was based upon nymphs of two species collected in Brazil. *Baetodes serratus* was described, named, and designated as the genotype, and the other was described and reported as *Baetodes* Nymph No. 1. Traver (1943) reported the adult stage of the genus when she described *B. spiniferum* from a male imago and a female subimago collected in Venezuela. In this same paper, she reported an undescribed species of *Baetodes* from Mexico, and in 1944, published additional records of *B. serratus* from Brazil. Edmunds (1950) reported a nymphal record of the genus from Texas, and a second Mexican record from Culinevera (Cuernavaca?), south of Mexico City. Demoulin (1955) described *B. itatiayanus* from nymphs collected in Brazil, and Packer (1966) was the first to report the genus from Central America when he published records from twelve localities in Honduras. Mayo, in 1968, described two additional species, *B. levis* and *B. spinae*, from nymphs collected in Ecuador.

This report includes descriptions and names for nymphs of nine species of *Baetodes* collected in Mexico, Guatemala, El Salvador, and Honduras, and the number of named species now stands at fourteen. The characters most useful in distinguishing the species of *Baetodes* in the nymphal stage are: (1) the presence or absence, the number, and the degree of development of the median tubercles on the pronotum, metanotum, and abdominal terga; (2) the presence or absence of coxal gills; (3) the color on the abdominal gills; and (4) the color on the thoracic and abdominal segments. Coxal gills are of limited taxonomic value. In some species, they are always present, in others they are always absent, but in others they may be present or absent.

Baetodes adustus Cohen and Allen, new species

NYMPH.—Length: body 5.0–6.0 mm; caudal filaments 6.0–7.0 mm. General color brown with darker brown, red, reddish brown and pale markings. Head brown with darker brown markings; occiput with sparse setae. Thoracic nota brown with darker brown markings; pronotum with a dorsal, median, posterior elevation; metanotum with moderately developed dorsal, median, posterior tubercle

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[1] The research upon which this report is based was supported by National Science Foundation.

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(Fig. 1); thoracic nota with sparse setae; thoracic sterna pinkish red; legs brown with pale markings; femora brown with variable pale markings; tibiae brown with thin, pale longitudinal streak; tarsi brown with pale markings and brown at apices; coxae with finger-like gills; tarsal claws with 7 denticles. Abdominal terga usually brown to reddish brown, color often darker along anterior margin of segments; abdominal terga 1–8 with median tubercle; tubercles moderately developed on terga 1–7, small on tergum 8 (Fig. 1); abdominal terga with sparse setae; abdominal gills pale, often tinged with pinkish red; abdominal sterna brown with reddish brown and pale markings; abdominal sterna 1–6 brown, suffused with red and with reddish brown lateral markings; sterna 7–10 brown with pale median macula, and reddish brown lateral markings. Caudal filaments light brown.

Holotype, mature female nymph, STREAM 5 MI. S. CIUDAD MENDOZA, VERA CRUZ, MEXICO, 7 November 1968, R. K. Allen. Paratopotypes: 2 male and 3 female nymphs, same data as holotype, 1 male and 1 female in collection University of Utah, Salt Lake City, others in collection California State College at Los Angeles. Paratype: 1 female nymph, Rio Jamapa, 32 mi. N. E. Coscamatipec, Vera Cruz, Mexico, 14 July 1966, R. K. Allen, in collection California State College at Los Angeles.

REMARKS.—*Baetodes adustus* is superficially similar to *B. pallidus* n. sp. from Mexico and Honduras. Both species bear median abdominal tubercles on segments 1–8, a moderately developed metathoracic tubercle and only a small elevation on the posterior margin of the pronotum, and the coxae with finger-like gills. Mature nymphs of *B. adustus* are longer than those of *B. pallidus*, and the abdominal terga are brown to reddish brown and without pale markings (Fig. 1).

Baetodes caritus Cohen and Allen, new species

NYMPH.—Length: body 3.0–4.0 mm; caudal filaments 4.0–5.0 mm. General color brown with dark brown, reddish, and pale markings. Head brown, sutures pale and pale around compound eyes; occiput with sparse setae. Thoracic nota brown; pronotum without dorsal, median, posterior elevation; metanotum with barely discernible dorsal, median, posterior elevation; thoracic nota with sparse setae; thoracic sterna reddish with numerous pale dots; legs brown with pale markings; femora brown with pale median and basal maculae (Fig. 2); tibiae light brown to brown; tarsi pale, brown at apices; coxae with small finger-like gill; tarsal claws with 8 denticles. Abdominal terga brown with dark brown and reddish brown markings; abdominal terga 1–3 usually brown; terga 4–9 often brown with dark brown anterior margins; terga 6–9 usually brown with pale median longitudinal stripe; tergum 10 light brown; terga 1–3 each with barely discernible, median elevation; abdominal terga with sparse setae; abdominal gills pale; abdominal sterna pale to light brown with reddish brown lateral markings; sternum 1 reddish with paired large submedian white dots; sterna

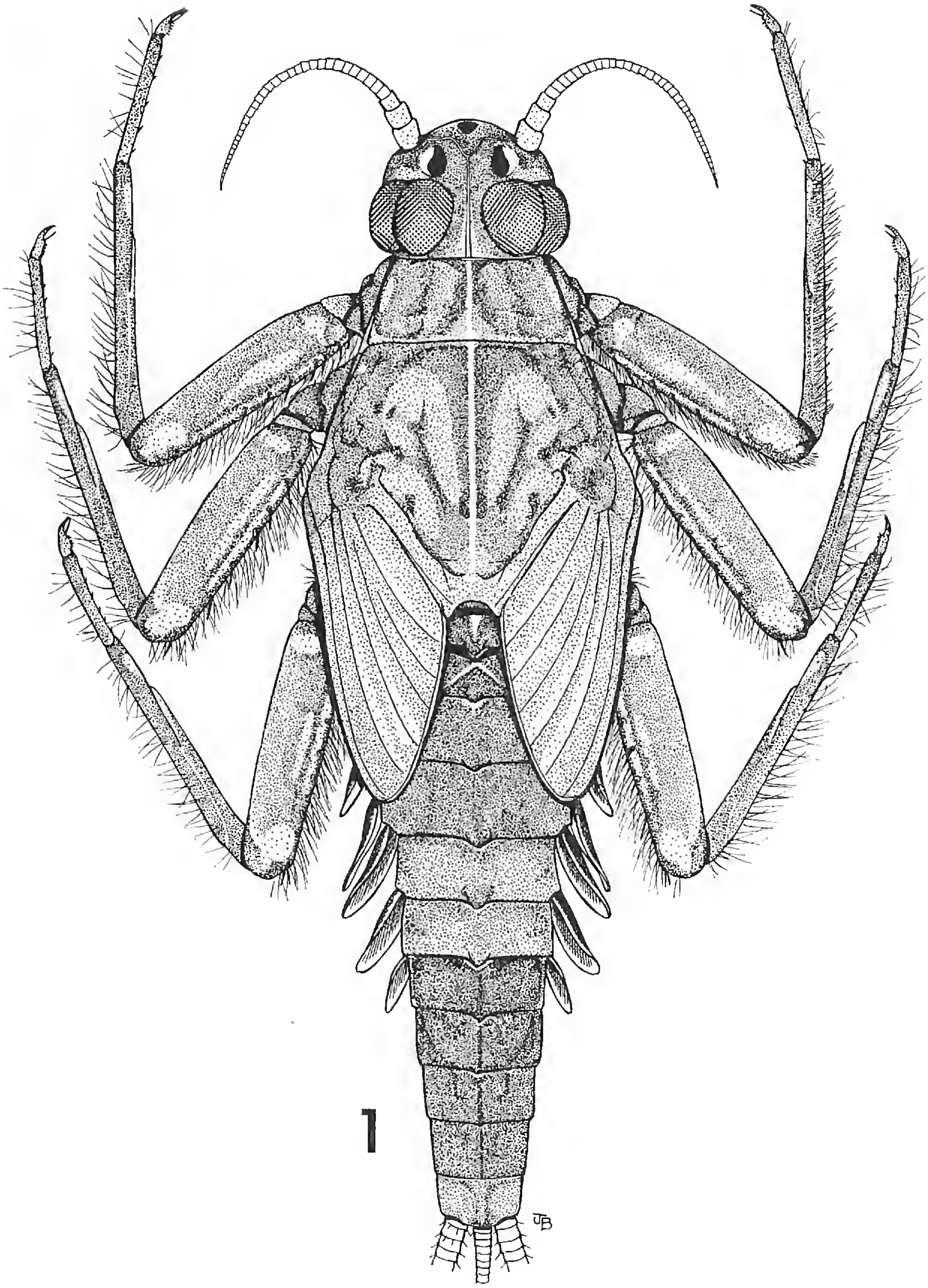


FIG. 1. *Baetodes adustus*, mature male nymph, dorsal view

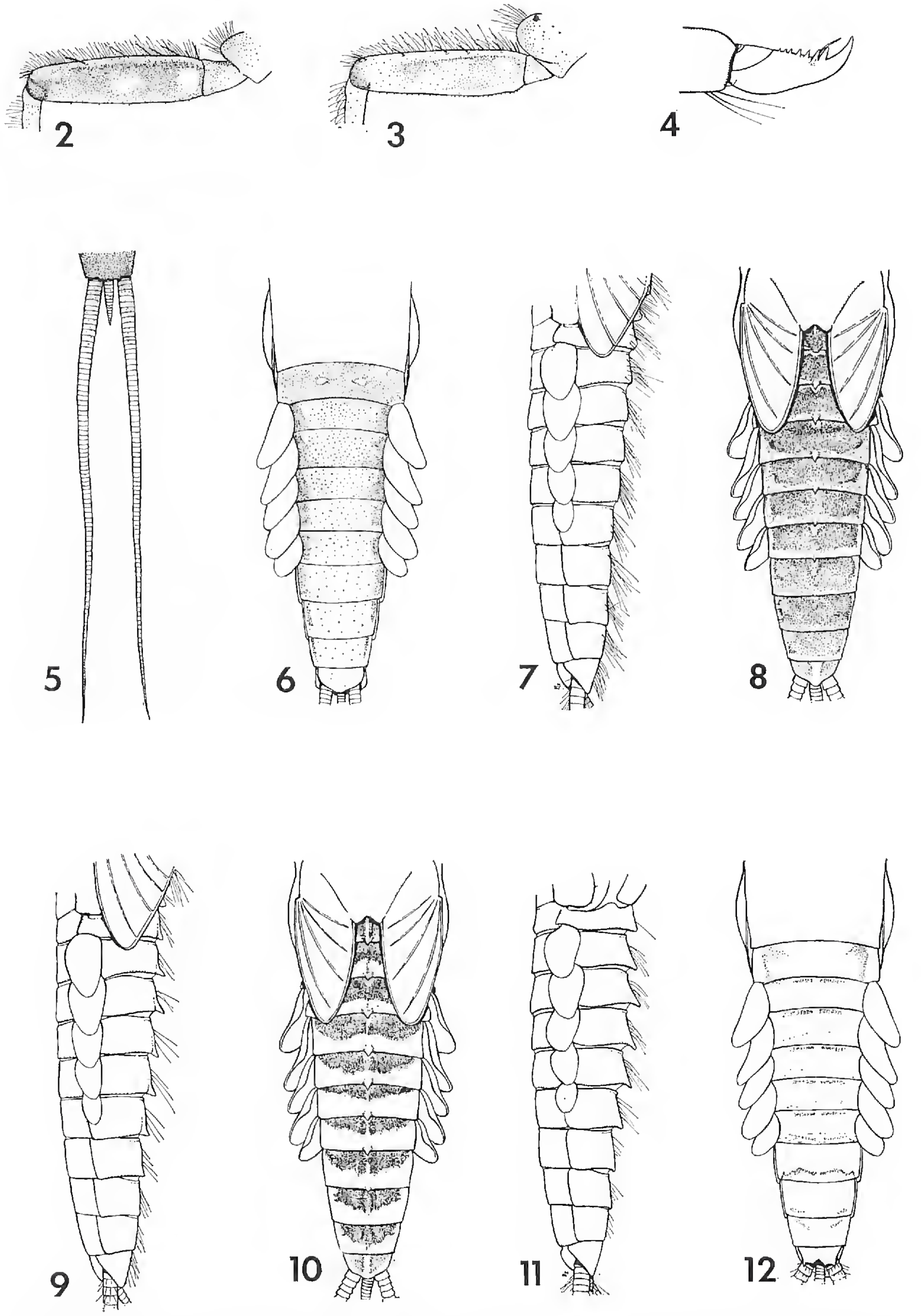
2–6 pale to light brown with lateral reddish brown markings, with white dots; sterna 7–10 light brown (Fig. 6). Caudad filaments light brown.

Holotype, mature female nymph, RIO LATOMA AT KM 181 ON HWY. 2, GUATEMALA, 24 October 1968, R. K. Allen. Paratopotype: 1 male nymph, same data as holotype, in collection California State College at Los Angeles. Paratypes: 1 female nymph, Rio Hondura at Ciudad Carrita, 5 mi. E. El Salvador/Honduras border, Honduras, 28 October 1968, R. K. Allen; 1 female nymph, Rio Mizata, 27 mi. W. La Libertad, El Salvador, 28 October 1968, R. K. Allen; 1 female nymph, Rio Sesecapa near Mapastepec on Hwy. 200, Chiapas, Mexico, 20 July 1966, R. K. Allen; 1 female nymph, Stream 7 mi. N. Arriago, on Hwy. 190, Chiapas, Mexico, 20 July 1966, R. K. Allen; 1 female nymph, Rio Papagayo on Hwy. 95, Guerro, Mexico, 16 November 1968, R. K. Allen; 1 male nymph, Rio Amacuzac at Huajintlan on Hwy. 95, Morelos, Mexico, 14 November 1968, R. K. Allen; 3 female nymphs, Rio San Antenco at Tonala, Chiapas, Mexico, 1 November 1968, R. K. Allen; 2 male and 1 female nymph, Rio Piedras Negras at Piedras Negras near Poza Rica, Vera Cruz, Mexico, 12 November 1968, R. K. Allen; 1 female nymph, Rio Hondura at Ciudad Carrita, ca. 5 mi. E. El Salvador, 28 October 1968, R. K. Allen; above paratypes in collection California State College at Los Angeles; 1 female nymph, Escula Agricola Panamericana, Dept. El Paraiso, Honduras, 26 October 1964, J. S. Packer; 1 male and 1 female nymph, Stream 8 km. E. Danli, El Paraiso, Honduras, 29 August 1964, J. S. Packer; above paratypes in collection University of Utah, Salt Lake City.

REMARKS.—*Baetodes caritus* appears to be most closely related to *B. deficiens* n. sp. Both species have reduced median abdominal tubercles, and similar dorsal abdominal color patterns. *Baetodes caritus* is distinguished from the latter species by the following characters: (1) femora brown with pale maculae (Fig. 2) and (2) thoracic sterna reddish with numerous pale spots (Fig. 6).

Baetodes deficiens Cohen and Allen, new species

NYMPH.—Length: body 3.5–4.5 mm; caudal filaments 5.0–6.0 mm. General color light brown to pale with dark brown markings. Head light brown, darker brown around median ocellus; occiput with sparse setae. Thoracic nota light brown with brown markings; mesonotum usually with brown transverse marking across anterior margin; pronotum without median posterior elevation or tubercle; metanotal tubercle barely discernible; thoracic nota with sparse setae; thoracic sterna pale; legs pale with brown markings; coxae usually with gills; femora pale with brown basal, median, and usually subapical maculae, and with dark brown to black marking at each apex (Fig. 3); tibiae and tarsi pale; tarsal claws with 7 denticles. Abdominal terga brown with dark brown, reddish brown, and pale markings; abdominal terga 1–3 reddish brown with pale to light brown posterior margins; terga 4–6 with dark brown to reddish brown markings at anterior margin; terga 7–9 brown, usually with dark brown anterior spots; tergum 10 pale; terga 1–3 each with barely discernible



FIGS. 2–3. Left femora of *Baetodes* nymphs. FIG. 2. *B. caritus*. FIG. 3. *B. deficiens*. FIG. 4, *Baetodes adustus*, tarsal claw. FIG. 5, *Baetodes adustus*, nymphal caudal filaments. FIGS. 6–12. Abdomens of *Baetodes* nymphs. FIG. 6. *B. caritus*, ventral view. FIG. 7. *B. deficiens*, lateral view. FIG. 8. *B. fuscipes*, dorsal view. FIG. 9. *B. fuscipes*, lateral view. FIG. 10. *B. inermis*, dorsal view. FIG. 11. *B. inermis*, lateral view. FIG. 12. *B. inermis*, ventral view.

median elevation (Fig. 7); terga with long setae; abdominal gills pale; abdominal sterna pale with brown markings; sterna 1–7 usually with submedian anterior transverse streaks; sterna 6–9 with sublateral longitudinal streaks; sternum 10 pale. Caudal filaments pale.

Holotype, mature female nymph, RIO CLARRITA AT SAN MORANO ON HWY. 4, DEPT. EL PARAISO, HONDURAS, 29 October 1968, R. K. Allen. Paratypes: 1 male and 4 female nymph, Rio Amacuzac at Huajintlan on Hwy. 95, Morelos, Mexico, 14 November 1968, R. K. Allen; 1 male and 2 female nymphs, Rio Choluteca, Tegucigalpa, Honduras, 29 October 1968, R. K. Allen; 1 female nymph, Rio San Marcos at Apapantilla 3 mi. S. E. Villa A. Camacho, Vera Cruz, Mexico, 12 November 1968, R. K. Allen; 2 male and 3 female nymphs, Rio Piedras Negras at Piedras Negras near Poza Rica, Vera Cruz, Mexico, 12 November 1968, R. K. Allen; 2 male and 1 female nymphs, Rio Papagpyo near Tierra Colorado, Guerrero, Mexico, 16 November 1968, R. K. Allen; 1 male and 1 female nymph, Stream 9 mi. S. Rio Grande de Santiago, Jalisco, Mexico, 17 October 1968, R. K. Allen; above paratypes in collection California State College at Los Angeles; 7 female nymphs, Dept. El Paraiso, Escula Agricola Panamericana, Rio Yeguace, Honduras, 26 October 1964, J. S. Packer; 1 female nymph, Dept. Choluteca, Stream near Choluteca on Pan Americana Hwy., Honduras, 10 October 1964, J. S. Packer, above paratypes in collection University of Utah, Salt Lake City.

REMARKS.—*Baetodes deficiens* is distinguished from *B. caritus*, an apparently closely related species, and all other described species of *Baetodes* by the following combination of characters: (1) abdominal terga without obvious tubercles, and with only raised elevations of segments 1–3; (2) femora pale with brown maculae (Fig. 3); and (3) thoracic sterna pale.

Baetodes fuscipes Cohen and Allen, new species

NYMPH.—Length: body 3.0–4.0 mm; caudal filaments 3.0–4.0 mm. General color brown and reddish brown with pale and reddish markings. Head brown with irregular dark brown markings; occiput with sparse setae. Thoracic nota brown with dark brown markings; pronotum with moderately well-developed median posterior elevation; metanotum with moderately developed median tubercle; thoracic nota with sparse setae; thoracic sterna reddish with numerous pale spots; coxae without gills; legs brown with pale and dark brown markings; femora brown with pale L-shaped marking, and dark brown at apices; tarsal claws with 7 denticles. Abdominal terga reddish brown with pale margins; terga 1–3 dark brown; terga 4–8 brown; terga 9–10 light brown (Fig. 8); terga 1–7 with median tubercles; terga 1–6 with moderately developed tubercles; terga 7 with poorly developed tubercles (Fig. 9); terga with sparse setae;

abdominal gills pale; abdominal sterna reddish with brown to pale markings and pale spots; sterna 1–4 reddish with numerous pale spots; sterna 5–9 reddish, brown to pale medially; sternum 10 pale. Caudal filaments light brown.

Holotype, male nymph, STREAM 5 MI. S. CIUDAD MENDOZA, VERA CRUZ, MEXICO, 7 November 1968, R. K. Allen. Paratypes: 2 female nymphs, Rio Jamapa 3 mi. N. E. Coscomatipec, Vera Cruz, Mexico, 8 November 1968, R. K. Allen, in collection California State College at Los Angeles; 1 female nymph, 10 mi. W. Juticalpa, Rio Julicalpa, Dept. Olancho, Honduras, 6 November 1964, J. S. Packer, in collection University of Utah, Salt Lake City.

REMARKS.—The nymph of *B. fuscipes* is similar to *B. adustus* and *B. pallidus* n. sp. in the number and development of the median, dorsal, abdominal tubercles, and in the development of the metanotal tubercle. The former species differs as the posterior pronotal tubercle is well developed and the coxae are without gills. This species is further distinguished by the color characters of the abdominal terga.

Baetodes inermis Cohen and Allen, new species

NYMPH.—Length 4.0–5.0 mm; caudal filaments 5.5–6.5 mm. General color light brown to brown with darker brown and reddish brown markings. Head light brown to brown with darker brown markings; head often with dark brown band between ocelli; occiput with sparse setae. Thoracic nota brown with dark brown markings; pronotum without posterior median elevation; metanotum with poorly developed median tubercle; thoracic nota with sparse setae; thoracic sterna pale usually with dark circular lines around bases of legs; legs pale with brown markings; femora pale with brown markings; tibiae and tarsi pale, often brown at apices; coxae with or without gills; tarsal claws with 7 denticles. Abdominal terga pale to brown with dark brown and reddish brown markings; terga 1–6 usually pale with brown to reddish brown anterior markings triangular in shape on posterior segments; terga 7–9 brown with dark brown anterior markings; terga 5–9 often with disjunct transverse reddish brown triangular marking; tergum 10 brown (Fig. 10); terga 1–7 with poorly developed median tubercle; tubercles of segments 1–6 small, tubercles barely discernible on segment 7 (Fig. 11); terga with sparse setae; abdominal gills pale; abdominal sterna pale with reddish brown markings; sterna 1–7 usually with thin transverse anterior reddish brown marking; sternum 8 often with faint transverse marking; sterna 9–10 usually pale (Fig. 12). Caudal filaments pale.

Holotype, mature female nymph, RIO SAN MARCOS NEAR CIUDAD VICTORIA, TAMAULIPAS, MEXICO, 24–25 November 1968, R. K. Allen. Paratopotypes: 12 male and 45 female nymphs, same data as holotype, 1 male and 3 female nymphs in collection of University of Utah, Salt Lake City; California Academy of Sciences; and Canadian National Collection, Ottawa; remainder in collection of California State College at Los Angeles. Paratypes: 20 male and 32 female nymphs, Rio

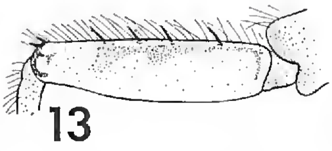
Amacuzac at Huajintlan on Hwy. 95, Morelos, Mexico, 14 November 1968, R. K. Allen; 1 female nymph Stream 15 mi. N. Ayoquezco, Oaxaca, Mexico, 20 October 1968, R. K. Allen; 1 male nymph, Rio Grande 3 mi. S. Gualatao, Oaxaca, Mexico, 6 November 1968, R. K. Allen; 14 male and 16 female nymphs, Rio La Pasion at Tizapan El Alto, Jalisco, Mexico, 16 October 1968, R. K. Allen; 1 female nymph, Rio Atoyac at Ayoquezco, Oaxaca, Mexico, 22 October 1968, R. K. Allen; 1 female nymph, stream at Hacienda Guadalupe, Jalisco, Mexico, 17 October 1968, R. K. Allen; 1 female nymph, Rio Papagayo on Hwy. 95, Guerrero, Mexico, 16 November 1968, R. K. Allen, above paratypes in collection California State College at Los Angeles.

REMARKS.—*Baetodes inermis* is readily distinguished from all described species of the genus by the distinctive color pattern on the abdominal terga, and by the thin transverse lines across the anterior margin of the abdominal sterna.

Baetodes noventus Cohen and Allen, new species

NYMPH.—Length: body 3.5–4.5 mm; (caudal filaments broken). General color brown to reddish brown with dark brown and reddish markings. Head unicolorous brown; occiput without setae. Thoracic nota brown with dark brown markings; pronotum with well developed dorsal, median tubercle; metanotum with a well developed dorsal median tubercle (Fig. 17); thoracic nota without setae; thoracic sterna light brown, suffused with red; legs light brown with pale and dark brown markings; femora brown with pale basal and apical maculae, and dorsal margin and apices dark brown; tibiae and tarsi light brown, apices of tarsi brown; coxae with finger-like gills; tarsal claws with 6 denticles. Abdominal terga brown to reddish brown, middle segments often pale with brown markings; abdominal terga 1–9 with median tubercle; terga 1–7 with well developed tubercles, tubercles moderately developed on terga 8–9 (Fig. 16–17); abdominal terga without setae; abdominal gills pale, often suffused with red; abdominal sterna pale, suffused with red and with brown markings; sterna 1–5 pale, suffused with red; sterna 6–9 pale with sublateral brown markings; sternum 10 pale. (Caudal filaments broken).

Holotype, mature female nymph, RIO MIZATA, 27 MI. W. LA LIBERTAD, EL SALVADOR, 28 October 1968, R. K. Allen. Paratypes: 1 female nymph, Rio Clarrita at San Morano on Hwy. 4, Dept. El Paraiso, Honduras, 29 October 1968, R. K. Allen; 1 female nymph, Rio Latoma at km. 182 on Hwy. 2, Guatemala, 24 October 1968, R. K. Allen, above paratypes in collection California State College at Los Angeles; 1 female nymph, Campamento Galera at bridge on Hwy. 3, Dept. Olancho, Honduras, 7 November 1964, J. S. Packer; 1 male and 1 female nymph, 38 km E. Zamorana on Hwy. 4, Dept. El Paraiso, Honduras, 31 October 1964, J. S. Packer; 1 male nymph, Stream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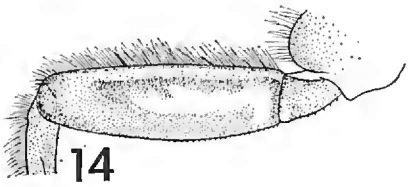
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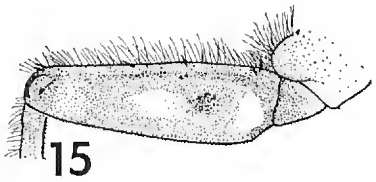
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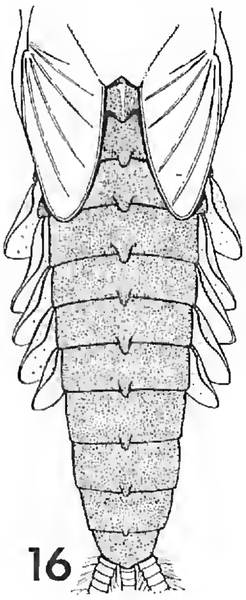
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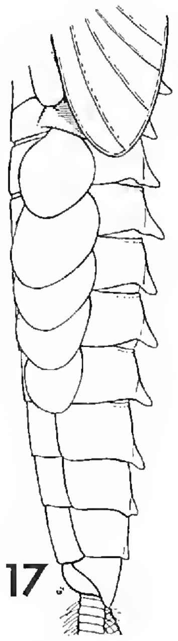
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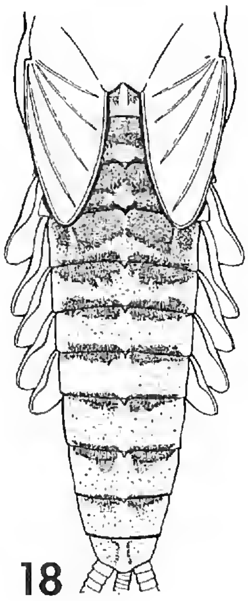
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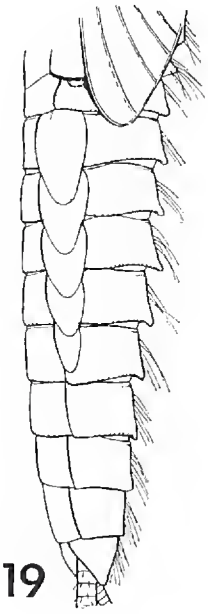
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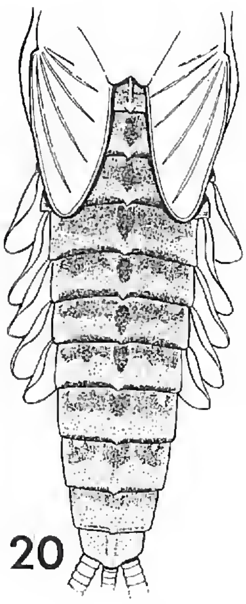
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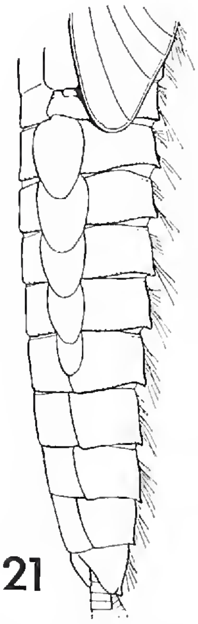
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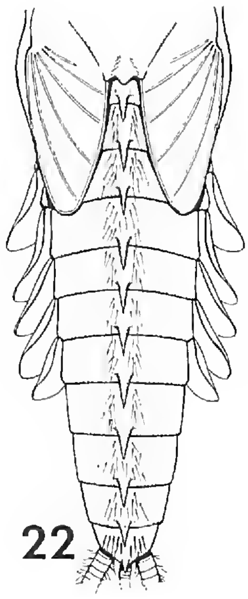
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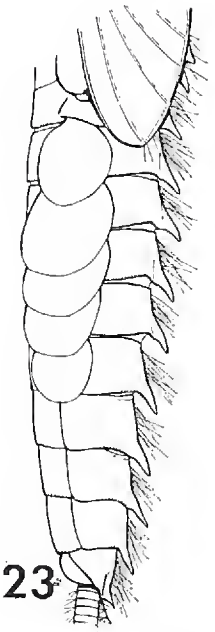
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FIGS. 13–15. Left femora of *Baetodes* nymphs. FIG. 13. *B. pallidus*. FIG. 14. *B. pictus*. FIG. 15. *B. tritus*. FIGS. 16–23. Abdomens of *Baetodes* nymphs. FIG. 16. *B. noventus*, dorsal view. FIG. 17. *B. noventus*, lateral view. FIG. 18. *B. pallidus*, dorsal view. FIG. 19. *B. pallidus*, lateral view. FIG. 20. *B. pictus*, dorsal view. FIG. 21. *B. pictus*, lateral view. FIG. 22. *B. tritus*, dorsal view. FIG. 23. *B. tritus*, lateral view.

E. Guaimaca on Hwy. 3, Dept. Francisco Morazan, Honduras, 6 November 1964, J. S. Packer, above paratypes in collection University of Utah, Salt Lake City.

REMARKS.—The nymph of *Baetodes noventus* is distinguished from all described species of *Baetodes* by the following combination of characters; (1) abdominal terga with median tubercles on segments 1–9; (2) well developed median, dorsal, tubercles on the pronotum, metanotum, and abdominal segments 1–7; and (3) coxae with gills.

Baetodes pallidus Cohen and Allen, new species

NYMPH.—Length: body 3.5–4.5 mm; (caudal filaments broken). General color light brown and reddish brown and black markings. Head light brown with pale transverse band between compound eyes and reddish brown transverse band between lateral ocelli; occiput with sparse setae. Thoracic nota light brown with brown markings; pronotum with small dorsal, median elevation; mesonotum with reddish brown transverse marking across anterior margin; metanotum with moderately developed dorsal, median tubercle; thoracic nota with setae; thoracic sterna pale; legs light brown with pale and brown markings; femora light brown with pale basal macula, elongate median macula, and apical dark brown mark (Fig. 13); tibiae and tarsi light brown, apices of tarsi brown; coxae usually with finger-like gills; tarsal claws with 6 denticles. Abdominal terga reddish brown with black and pale markings; terga 1–3 reddish brown with pale median macula, and darker reddish brown to black posterior margin; terga 4–9 pale with black transverse markings along anterior and posterior margins; tergum 10 usually pale (Fig. 18); abdominal terga 1–8 with a median tubercle; terga 1–7 with moderately developed tubercles; tubercle barely discernible on tergum 8 (Fig. 19); abdominal terga with sparse setae; abdominal gills pale; abdominal sterna light brown. (Caudal filaments broken).

Holotype, mature male nymph, RIO CLARRITA AT SAN MORANO ON HWY. 4, DEPT. EL PARAISO, HONDURAS, 29 October 1968, R. K. Allen. Paratypes: 1 male nymph, Stream 7 mi. N. Arriaga on Hwy. 190, Chiapas, Mexico, 20 July 1966, R. K. Allen; 1 female nymph, Stream 9 mi. S. Rio Grande de Santiago, Jalisco, Mexico, 17 October 1968, R. K. Allen, above paratypes in collection California State College at Los Angeles; 1 female nymph, Stream 10 mi. E. Guainaca on Hwy. 3, Dept. Fransico Morazan, Honduras, 6 November 1964, J. S. Packer; 1 female nymph, Stream 38 km E. Zamorano on Hwy. 4, Dept. El Paraiso, Honduras, 29 August 1964, J. S. Packer; 1 female nymph, Escula Agricola Panamericana, El Paraiso, Honduras, 26 October 1964, J. S. Packer, above paratypes in collection University of Utah, Salt Lake City.

REMARKS.—This species has many characters in common with *Baetodes adustus* but is distinguished from it by size and color.

Mature nymphs of *B. pallidus* are small (3.5–4.5 mm in length), and the abdominal terga have distinctive reddish brown, black and pale markings.

Baetodes pictus Cohen and Allen, new species

NYMPH.—Length: body 5.5–6.5 mm; caudal filaments 6.0–7.0 mm. General color brown with dark brown, yellow, and reddish brown markings. Head brown, frontoclypeal area pale; occiput with sparse setae. Thoracic nota brown with dark brown markings; pronotum with a posterior median elevation; metanotal tubercle small; thoracic nota with dense setae; thoracic sterna pale; coxae without gills; legs brown with pale markings; femora brown with large pale median marking (Fig. 14); tibiae and tarsi brown, tarsi brown at apices; tarsal claws with 6 denticles. Abdominal terga brown with reddish brown markings; terga 1–9 brown with broad reddish brown anterior transverse band, narrow reddish brown posterior transverse band, and reddish brown median macula; tergum 10 brown (Fig. 20); abdominal terga 1–7 with poorly developed median tubercle; tubercles barely discernible on terga 8–9 (Fig. 21); setae moderately dense; abdominal gills pale; abdominal sterna yellow with pale markings; sternum 1 pale; sterna 2–9 yellow with pale margins, posterior segments often with pale median longitudinal stripe; sternum 10 pale. Caudal filaments yellowish.

Holotype, nearly mature female nymph, STREAM 5 MI. S. CIUDAD MENDOZA, VERA CRUZ, Mexico, 7 November 1968, R. K. Allen.

REMARKS.—*Baetodes pictus* nymphs are superficially similar to those of *B. noventus* and *B. pallidus.* They are distinguished from *B. noventus* as the body tubercles are smaller in size, and the coxae are without gills. They are distinguished from *B. pallidus* as the middle abdominal terga bear a dark median macula, and the abdominal sterna are yellow.

Baetodes tritus Cohen and Allen, new species

NYMPH.—Length: body 6.0–8.0 mm; caudal filaments 8.0–10.0 mm. General color light brown with brown and reddish brown markings. Head light brown with irregular brown markings; frontoclypeal area pale; occiput with setae. Thoracic nota light brown with brown and pale markings; pronotum without dorsal, median, posterior elevation or tubercle; mesonotum with moderately developed dorsal, median, posterior elevation; metanotum with well developed tubercle (Fig. 23); thoracic nota with setae; thoracic sterna pale to light brown; legs light brown with reddish brown markings; femora light brown with variable reddish brown markings; femora often with large subbasal reddish brown macula and submarginal reddish brown streak near dorsal margin (Fig. 15); tibiae and tarsi light brown and suffused with reddish brown; coxae without gills; claws with 7–8 marginal denticles. Abdominal terga light brown to brown with reddish brown markings; terga 1–9 each with reddish brown marking across anterior margin of segment; abdominal marking often absent on posterior segments, and marking often disjunct in young specimens; abdominal terga 1–10 with a well developed median tubercle (Fig. 22–23); abdominal terga with setae; abdominal gills reddish with pale margins; abdominal sterna light brown with dark brown paired sublateral longitudinal streaks. Caudal filaments brown.

Holotype, male nymph, RIO TECOLAPAN NEAR SANTIAGO TUXTLA ON HWY. 180, VERA CRUZ, MEXICO, 16 July 1966, R. K. Allen. Paratypes: 17 male and 16 female nymphs, Rio San Marcos near Ciudad Victoria, Tamaulipas, Mexico, 24–25 November 1968, R. K. Allen, 1 male and 1 female nymph in each of the following collections: University of Utah, Salt Lake City; California Academy of Sciences; Canadian National Collection, Ottawa; V. K. Mayo, Tucson, Arizona; remainder in collection of California State College at Los Angeles. 1 male nymph, Stream at Santa Isabel, 12 mi. above Arriaga on Hwy. 190, Chiapas, Mexico, 23 October 1968, R. K. Allen; 4 female nymphs, Rio Latoma at km 182 on Hwy. 2, Guatemala, 24 October 1968, R. K. Allen; 2 female nymphs, Rio Amacuzac at Huajintlan on Hwy. 95, Morelos, Mexico, 14 November 1968, R. K. Allen; 1 male nymph, Stream at Hacienda Guadalupe, Jalisco, Mexico, 17 October 1968, R. K. Allen, 1 male and 1 female nymphs, Rio Sesecapa near Mapastepec on Hwy. 200, Chiapas, Mexico, 20 July 1966, R. K. Allen; 11 male and 14 female nymphs, Stream 9 mi. S. Rio Grande de Santiago, Jalisco, Mexico, 17 October 1968, R. K. Allen, above paratypes in collection California State College at Los Angeles; 1 female nymph, Stream 8 km El Paraiso, Honduras, 29 August 1964, J. S. Packer, in collection University of Utah, Salt Lake City.

REMARKS.—*Baetodes tritus* appears to be the most widely distributed Mexican *Baetodes* as it is known from central Mexico to Honduras. This species is also the most easily recognized as the abdominal terga bear well developed median tubercles on segments 1–10.

ACKNOWLEDGMENTS

We thank G. F. Edmunds, Jr., University of Utah, for the loan of the J. S. Packer collection, and Jerry Battagliotti, California State College, Los Angeles, for preparing the included illustrations. Type specimens are deposited in the California Academy of Sciences.

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A Review of the Acanthametropodinae with a Description of a New Genus

(Ephemeroptera: Siphlonuridae)

GEORGE F. EDMUNDS, JR. AND RICHARD W. KOSS[1]
University of Utah, Salt Lake City, 84112, and Johns Hopkins University, Baltimore

The subfamily Acanthametropodinae is one of the least known mayfly groups and a reasonable understanding of the taxon is available now for the first time. The subfamily was established by Edmunds (in Edmunds, Allen and Peters, 1963) for *Acanthametropus* and an undescribed genus. These forms were known only as nymphs. *Siphluriscus chinensis* Ulmer (1920) was the first acanthametropodine to be described, and it remains known only from the six adult specimens from China used in the original description. *Acanthametropus nikolskyi* Tshernova (1948) was described from an immature nymph from the Amur River. Burks (1953) described *Acanthametropus pecatonica* (as *Metreturus*) from two nymphs collected in Illinois in 1926 and 1927. *Metreturus* was erected as a new genus only because Tshernova's paper was then unknown to American mayfly workers. Edmunds and Allen (1957) synonymized *Metreturus* Burks with *Acanthametropus* Tshernova. Both Tshernova and Burks placed *Acanthametropus* as allied to *Ametropus*, but Edmunds and Traver (1954) and Edmunds and Allen (1957) placed the genus in the Siphlonuridae. Edmunds, Allen and Peters (1963) recorded *Acanthametropus* from the Savannah River, Georgia-South Carolina, based on three nymphs. Comparison of the three Savannah River and two Illinois specimens does not allow a decision as to whether or not there is more than one species in the United States.

Tshernova (1967) described the Lower Jurassic *Stackelbergisca* from a well preserved nymph from Siberia and an associated wing fragment. Both have characters of the extant acanthametropodines. The fossil nymph indicates that the legs are all directed posteriorly and the mouthparts are for carnivorous feeding. The fork of MP is deep and asymmetrical in the wing fragment; this is a character of Acanthametropodinae, but it is not exclusive to that subfamily.

The genus *Analetris*, described below, was found first in 1947 as a partial nymph in the stomach of a fish collected from the Green River at Hideout Canyon (Edmunds, 1957). One nymph subsequently

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was collected by G. R. Smith and G. G. Musser from the Green River at Buckboard Flats, Sweetwater Co., Wyoming in July 1959. Since 1947 many hours were expended in an effort to collect additional specimens from the Green River and its larger tributaries. In 1962–63 the Green River was inundated with water stored behind Flaming Gorge Dam and hope for additional specimens dimmed. In 1968 the junior author was successful in locating a population in a stretch of the Blacks Fork River from near Granger, Wyoming, to the crossing of the Blacks Fork River at Interstate Highway 80, about 7 miles east of Little America. He was able to rear one subimago ♂ which enabled us to recognize that *Siphluriscus* was an Acanthametropodinae. It is not known how many miles of the Blacks Fork River support *Analetris*, but it is relatively short because in many summers the river is almost dry before it reaches Flaming Gorge Reservoir. Most of the river is not readily accessible, but it is in increasing danger from oil well drilling, agricultural development, dam building and pollution. In fact, five additional collecting attempts have produced no more specimens. Lehmkuhl (1970) collected a series of nymphs of the same species in the South Saskatchewan River. This river is also in danger from pollution.

In the Acanthametropodinae, then, there are about 55 known specimens of 4 genera, of which 7 are imagos and subimagos. *Analetris* is the best represented genus but its known habitats are endangered. More than 40 miles of the Green River where *Analetris* presumably occurred have already been submerged behind Flaming Gorge Dam. The failure to collect more specimens is a result of a habitat in which it is difficult to collect, the shy and extremely fast swimming behavior of the nymphs, and inadequate collecting techniques.

Subfamily ACANTHAMETROPODINAE

ADULT.—Tornus of forewings near mid length; vein MP deeply forked; anal field elongate. Hind wings ½ or more as long as fore wings; vein MP deeply forked, base less than ¼ as long as fork. Fore tarsi of ♂ 2½ to 3 times as long as tibiae. Subgenital plate of ♂ deeply excavated medially. Terminal filament at least 2 mm long.

NYMPH.—Mouthparts of carnivorous type; mandibles with long sharp incisors; maxillae with fang-like spines; third segment of labial palpi reduced. Legs directed posteriorly when dead (or when swimming). Fore and middle pairs of legs with femora broadest in basal one-third; tarsi ca. ½ as long as tibiae; claws long, varying from ½ to 1½ times as long as tarsi; hind legs with margins of femora subparallel, femora ⅙ or less as wide as long; claws longer than tibiae and tarsi combined; tibiae, tarsi and claws bowed inward. Posterolateral projections present on abdominal segments 1–9. Cerci with long setae on mesal margins; terminal filament with long setae on both lateral margins.

Keys to the two genera known as adults and two known as nymphs are not necessary. Adults of *Analetris* have the three caudal filaments subequal in length while in *Siphluriscus* the terminal filament is much shorter than the cerci. *Acanthametropus* nymphs have conspicuous lateral projections on the head, prothorax and metathorax and a median tubercle on each abdominal tergum; these are not found in *Analetris*. It is possible that *Siphluriscus*, known only from adults, and *Acanthametropus*, known only as nymphs, represent a single genus.

Analetris Edmunds, new genus

SUBIMAGO ♂.—Eyes with ommatidia of fairly uniform size. Fore wings (Fig. 2) with fork of MA about ¾ as long as base; vein MP deeply forked, the fork over 4 times as long as the base; CuA connected to hind margin by 5 to 7 short crossveins (one forked on one wing, additional intercalary on one wing not attached basally). Hind wings (Fig. 3) more than 50% as long as forewings; MP deeply forked. Tarsi more than twice as long as tibiae; claws of each pair dissimilar, one rounded apically, one sharply hooked. Penes fused, rounded apically; forceps base deeply V-shaped (Fig. 7). Terminal filament subequal in length to cerci.

NYMPH (Fig. 1).—Head without lateral or frontal projections; maxillary palpi present. Fore femora broadest about ⅓ distance from base. Abdomen without median tubercles on terga. Caudal filaments subequal in length. Gills with margins entire, and with two ventral (posterior) smaller lobes (Fig. 4).

TYPE SPECIES.—*Analetris eximia* Edmunds, n. sp.

Etymology. From Greek, without a molar (grinder).

Analetris eximia Edmunds, new species

Genus et species incertus, Edmunds, 1954:64
Genus et species novum, Edmunds and Musser, 1960:113
Undescribed genus, Edmunds, 1957:23; Edmunds, Allen and Peters, 1963:10; Lehmkuhl, 1970:183.

SUBIMAGO ♂.—Length: body 12; wings 12 mm. Head pale, with pair of brown stripes between eyes; lower portion of eyes gray, upper portion orange. Prothorax yellowish brown, notum slightly darker. Mesothorax yellowish brown, with light brown stripe on each side between median line and inner parapsidal furrows of the notum, continuing to scutellum; medium brown along outer parapsidal furrows to wing bases, thin darker brown stripe along anterolateral margins of mesocutellum; medium brown marks at base of wings. Metathorax yellowish brown, dark brown streak on each side near apex of scutellum; medium brown marks at wing bases. Wings pale, longitudinal veins light brown,

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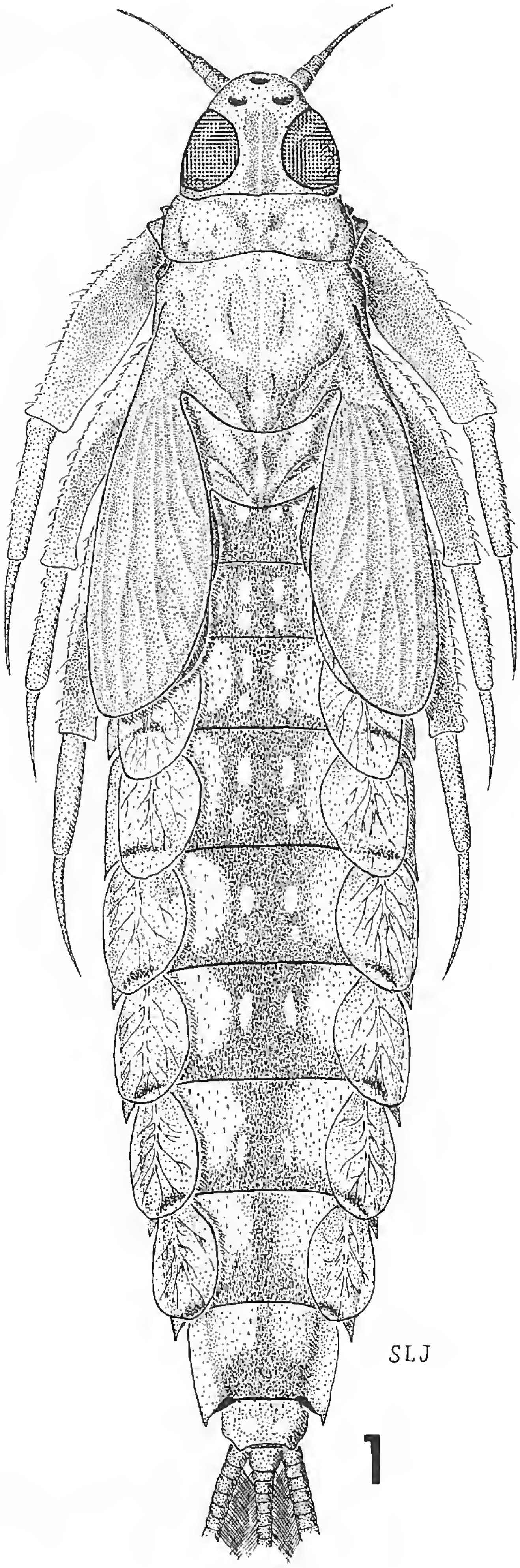
FIG. 1. *Analetris eximia*, nearly mature nymph, dorsal view.



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cross veins pale brown. Fore and hind tibiae and tarsi (Figs. 5 and 6). Legs yellowish brown; tibiae, tarsi and apex of fore femora medium brown; middle and hind legs with tibiae and tarsi darker than femora. Apex of each tarsomere narrowly ringed in brown.

Abdomen largely pale yellowish brown except for tergum one; tergum one largely medium brown, lateral margins pale, pale transverse lunar mark on anterior margin each side of midline, and pale spot in middle area of tergum on each side of midline; markings on terga 2 to 10 rather similar to those same segments of nymphs (Fig. 1), but more diffuse; median brown band bounded laterally by darker streaks; diffuse brown triangles lateral of median stripe, bases on posterior margins, triangles not reaching lateral margins of terga; darker line along posterior margin of each tergum. Sterna pale. Male genitalia (Fig. 7). Caudal filaments light brown at base, becoming paler apically.

Mature nymph.—Length: body 15, caudal filaments 4 mm. Color pale with markings generally light brown (Fig. 1). Head pale with pair of brown stripes between eyes from hind margin to ocelli; ocelli gray; apices of mandibles and maxillae brown. Pronotum with narrow transverse brown stripe near front margin, interrupted at midline; broader transverse stripe near middle of segment, interrupted at midline and reaching halfway to margin; smaller brown spot near margin on each side; sternum pale. Mesonotum pale with longitudinal brown stripe laterad of inner parapsidal furrow on each side; stripes on each side laterad of outer parapsidal furrow, extending to wing pad base; wing pad bases largely pale; apex of scutellum brown; pleura and sternum pale. Metathorax pale except for complex brown markings on metascutellum. Legs pale with diffuse brown band near apex of femur; this band very pale on middle and hind pair of legs.

Each abdominal tergum with wide brown median stripe containing four pale dots, and with brown triangles on each side, their bases on hind margin; dark brown streak near posterolateral corner of each tergum and dark brown spot near each gill insertion. Sterna pale. Gills pale, washed with brown dorsally on inner half. Caudal filaments pale basally, becoming increasingly darker brown toward apices.

Holotype subimago ♂ and nymphal exuvium of same, Blacks Fork River at Interstate Hwy. 80, 7 mi. E. of Little America, Sweetwater County, Wyoming, collected 3 August 1968, emerged 9 August 1968, R. W. Koss and W. P. McCafferty, in collection of University of Utah. Paratopotypes: 5 nymphs, 6 July 1968, R. W. and D. Koss; 3 nymphs, 3 August 1968, R. W. Koss and W. P. McCafferty; 20 nymphs, 18 July 1968, R. W. Koss. Paratypes: Wyoming: Sweetwater Co.; Blacks Fork River at Granger, 4 nymphs, 3 August 1968,

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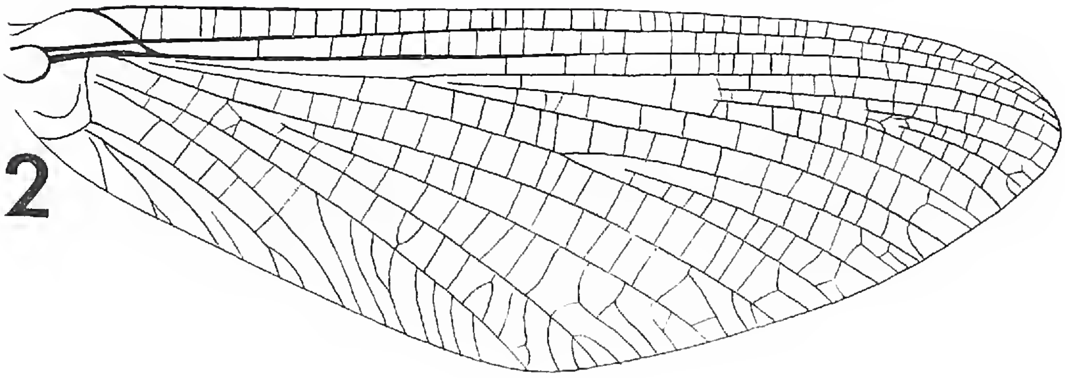
Figs. 2–7. *Analetris eximia.* (Figs. 2,3 and 5 to 7. subimago ♂; Fig. 4. nymph). Fig. 2. Fore wing. Fig. 3. Hind wing. Fig. 4. Gill 4, dorsal view. Fig. 5. Fore tibia, tarsus and claws. Fig. 6. Hind tibia, tarsus, and claws. Fig. 7. Genitalia, dorsal view.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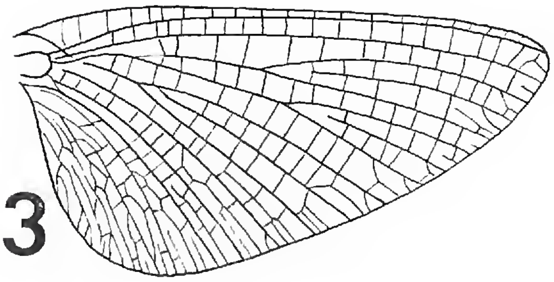
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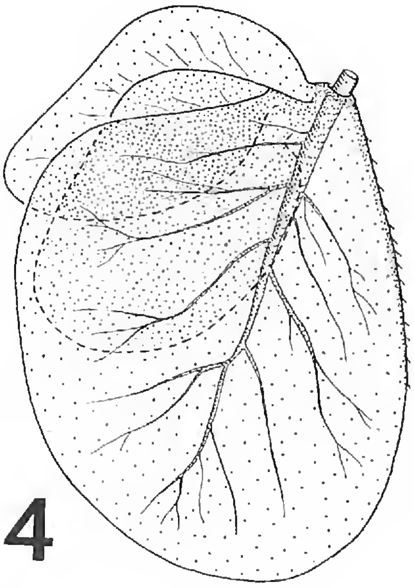
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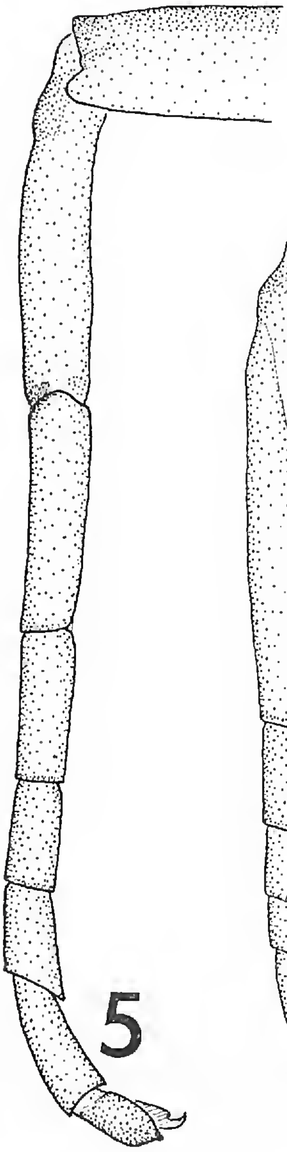
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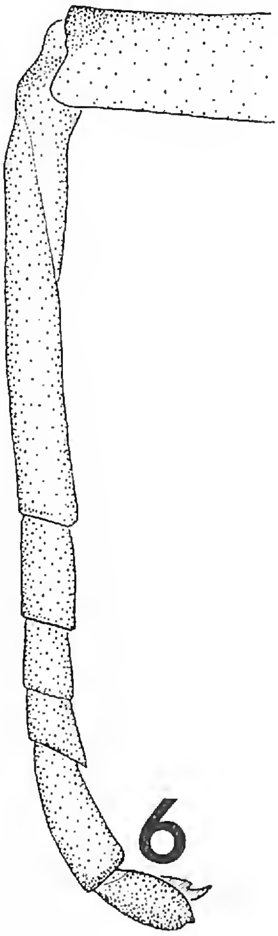
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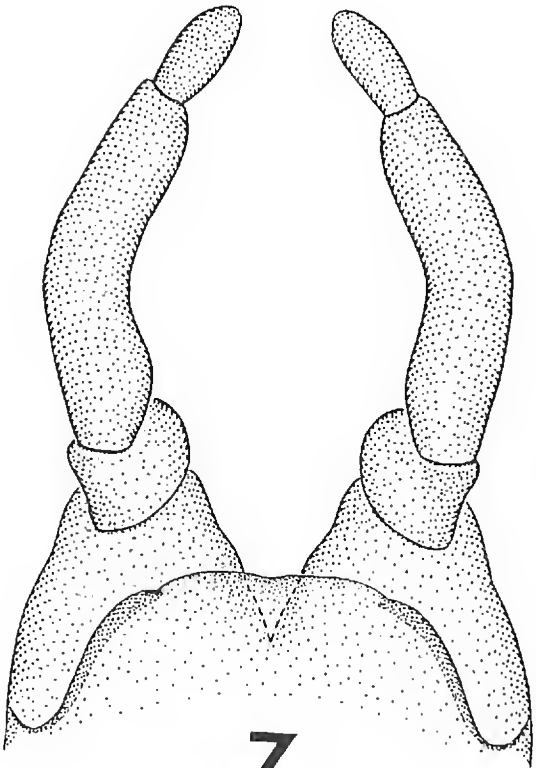
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R. W. Koss and W. P. McCafferty; Green River at Buckboard Flats, 1 nymph, 16 July 1959, G. W. Smith and G. G. Musser. Utah: Daggett Co.; Green River at Hideout Canyon, 1 nymph, 3 September 1947, G. F. Edmunds, Jr. Saskatchewan: South Saskatchewan River at Lemsford Ferry, 12 July 1970, D. M. Lehmkuhl, 10 nymphs, one in Canadian National Collection, one in University of Utah collection, others at University of Saskatchewan.

One or more paratypes in collections of R. W. Koss, Florida A & M University, California Academy of Sciences, Purdue University and Institute Royal des Sciences Naturelles, Brussells; others at University of Utah.

Notes on the Habitat and Biology of Nymphs

Analetris nymphs are known only from warm rivers having a constantly shifting sand substrate. Other insects found in this habitat are the nymphs of the mayflies *Pseudiron* and *Ametropus* and the dragonflies *Ophiogomphus* and *Gomphus*. The type locality in the Blacks Fork River is slow-moving (approximately 0.5 ft./sec. on the surface), shallow and alkaline. The river is mostly 1–2 feet deep in mid-July and fairly clear. Following rains and in the spring it is milky to muddy and several times the summer volume. At mid-day 17 July 1968 the water temperature was 21° C (71° F). The water temperatures at the Green River collecting sites varied from 19° to 23° C (66° to 74° F) in summer and fall.

The nymphs were most abundant in the fine-grained sand deposits on the downstream end of deposition zones on the inside curves of the meandering river. They anchor themselves on the shifting sand substrate by burying the legs in the sand nearly to the base of the tibiae by rapidly shifting the body forward and backward. The front legs are positioned slightly laterigrade in a somewhat anteriorly directed "pinching" position, while the middle and hind legs are perpendicular to the substrate surface. Frequently the nymphs rapidly fan the gills, excavating sand from below and around the body to create a slight depression in the sand. In nature sand probably buries the nymphs, and they were observed to remain buried in a laboratory aquarium with circulating water. When the water was circulating slowly they were observed to do a "push-up" movement, undulate the abdomen, free themselves of sand, and fan the gills, after being buried for 2–4 minutes. These reactions are presumed to be a response to inadequate oxygen available to the nymphs. In nature such movements may be necessary during low nighttime oxygen concentrations.

Nymphs survived longer in circulating water than in continually aerated standing water.

The nymphs often move over the sand searching the surface, perhaps for suitable substrate or for food, with the maxillary palpi. The mouthparts are obviously adapted for carnivorous habits and in the lab they fed on red-blooded Chironomidae, eating them whole.

The nymphs swim rapidly, and they readily avoided hand screens, rapidly dragged dip nets and a rapidly moved deep-bag net. The most effective collecting device proved to be a net with an opening 3 feet wide by 1 foot high, and a bag 4 to 5 feet deep. The net was used in shallow water, and it was hand held on the substrate. The collector's foot was used to "herd" or direct the specimens downstream into the net. This was best accomplished by dragging the foot along the bottom from an upstream position to a downstream one, starting from one side of the net opening and gradually moving over the other side. The net was then raised and shifted over to a new, undisturbed area, and the process repeated.

When the same net was staked out in the river overnight as a driftnet, it proved ineffective for collecting nymphs of *Analetris* and *Ametropus,* but an excellent collecion of *Pseudiron* nymphs was made.

Lehmkuhl (1970, and personal communication) was able to collect *Analetris* by rapidly moving a drag net upstream over the substrate surface.

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SCIENTIFIC NOTE

Mass movements of *Nymphalis californica* (Boisduval) in the San Francisco Bay area during 1971 (Lepidoptera: Nymphalidae).—The California Tortoise Shell butterfly undergoes periodic or sporadic population outbreaks and mass movements which have been called migrations in the literature. The last time such an event took place in the San Francisco Bay area was in 1959–1960 when several aggregations of the butterflies were observed flying in spring and under bark in winter in Marin County, followed by tremendous populations developed in June the following season. During intervening years the species is scarce and may not be a continuous breeding resident here.

During October 1971, I observed movements of *N. californica* in the Berkeley Hills, Alameda County, at a site above the Caldecott Tunnel (about 1,400 feet elevation). On 5 October, a smoggy day with temperatures in the 80's °F., the butterflies passed to the southeast (along the axis of the hills) at a steady 2/minute on a 50 foot sighting line, between 11:45 and 12:05 p.m. (P.S.T.). Most flew 3–8 feet above the ground over the roadway which forms a corridor through the trees at this point; a few flew circuitously or eastward through the trees. However, on the open ridge east of the trees none could be seen heading eastward, that is off the ridge axis. 7 October was cooler (77° maximum in Oakland) with an easterly breeze. The *Nymphalis* were less numerous and less directional in their activities, with 45 sighted in aggregated 30 minutes surveillance beween 11:50 and 12:40 p.m., and only 75% moved in a southeasterly or easterly direction. On 12 October, another warm, smoggy day (90° in Oakland), the flight was greatly increased, with a census of 392 during periods totaling 35 minutes (11/minute) between 11:30 and 12:15 p.m. Counts were made on the road and on open ridge knolls to the east and all individuals moved southeasterly despite a stiff northeasterly breeze. The site was revisited between 11:30 to 1:00 p.m. on 14 and 28 October, which were clear but much cooler days, and no *N. californica* were present.

Ten specimens were taken on 12 October and eight proved to be females, the ratio perhaps in part the result of sampling error if males are faster, more erratic fliers. Other butterflies flying in the vicinity included *Precis coenia* (Hübner), *Adelpha bredowi* (Geyer), *Vanessa carye* (Hübner), *Danaus plexippus* (L.), and *Colias eurytheme* (Boisduval). All but *P. coenia* were present in low numbers and none showed any tendency for directional movement.

Sightings of individual *N. californica* were made in Walnut Creek, Contra Costa County and in Berkeley on the University of California campus, during the period of 5–12 October, by John Hafernik. Both localities are non-resident sites for this species.—J. A. POWELL, *University of California, Berkeley, 94720.*

Nesting Habits and Larva of *Pulverro monticola*

(Hymenoptera: Sphecidae)

R. M. BOHART AND E. E. GRISSELL
Department of Entomology, University of California, Davis, 95616

Pulverro Pate is a nearctic genus with seven described species. Nothing has been published about its biology and very little about that of related genera such as *Ammoplanops* and *Ammoplanus*. No doubt the small size of these wasps has helped them avoid observation. The somewhat related genus *Microstigmus* is known to take Collembola or Thysanoptera as prey, so it is not surprising that thrips are used by *Pulverro*.

The nesting site of *Pulverro monticola* Eighme was first observed in July 1968. A detailed study was made in July 1970 and some additional work was done in the summer of 1971. Many nest entrances were found in the side banks along 400 m of dirt logging road near the Sagehen Creek Biological Station of the University of California at an altitude of about 6,500 feet in Nevada County, California. To some extent the nests were grouped, with 15 to 20 in a square meter area, and the entrances were sometimes only a few mm apart. On the other hand some nests were rather isolated or scattered along the roadside. The following description of our primary study area will serve to characterize other sites used by *P. monticola*. The roadside mound was about 0.5 m high and covered nearly 2.0 m^2. The soil was fine grained intermixed with many small pebbles and a few stones up to 15 or 20 cm in length. Surface features included several larger rocks, a few broken branches, and the remains of a small stump. The mound was sparsely clothed in *Lepidium* about 15 cm tall. From 1 to 24 July 1970 we located 32 nests in the mound some of which were started as late as 24 July. The season was considerably retarded by cold weather in 1971 and the nesting period was advanced to the approximate period of 15 July to 7 August.

During the middle of the nesting season, nest activity began about 8:45 a.m. Pacific Standard Time as the sun struck the east slope of the mound and ceased about 4:00 p.m. as sunlight left the west slope. Female *Pulverro* nesting on the east slope were active about an hour earlier in the morning and stopped about an hour earlier in the afternoon than those on the west slope.

Daily activity began as the female wasp emerged head first and remained for a few minutes in the sunlight near the entrance. A

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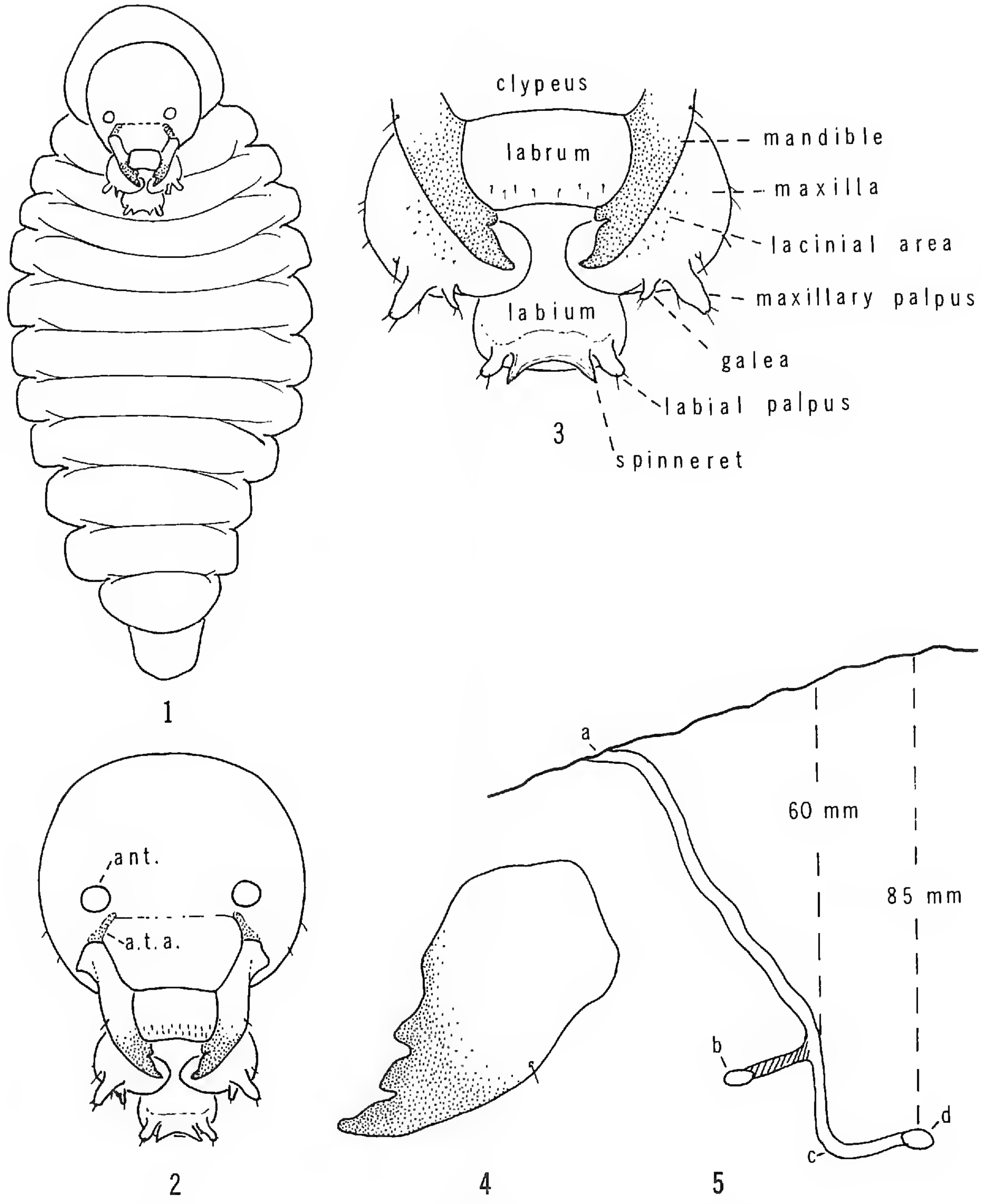

FIGS. 1–4. Prepupal larva of *Pulverro monticola* Eigme, ventral views. FIG. 1. Whole larva. FIG. 2. Head enlarged; ant. = antennal orbit, a.t.a. = anterior tentorial arm. FIG. 3. Mouthpart area enlarged. FIG. 4. Mandible. FIG. 5. Vertical section through a nest of *P. monticola*; a, entrance on ground slope; b, completed cell sealed off by a dirt plug; c, bend in burrow where loose thrips were found; d, nearly complete cell.

vigorous cleaning activity then began in which the wasp went head first into the nest, kicked out small dirt particles with her legs and dragged out larger particles in her mandibles. This material accumulated on the slope immediately beneath the entrance and was sometimes distributed somewhat by the wasp. This tumulus served as a convenient marker for the nest entrance just above it.

Underground morphology of the burrows was determined by excavation of about 20 of them. This process was extremely difficult and often unsuccessful because of the small burrow diameter (about 2 mm) and the rock and stick inclusions in the soil. Plaster of Paris, both dry and in dilute suspension, was pipetted into the burrows to aid in tracing them. This helped considerably but the uneven soil texture still created problems. Finally, earth at several sites was sifted before the nesting season in June 1971. The resulting fine and even grained soil was used by several *Pulverro* in July of the same year. Excavation of these nests in early August 1971 was fairly successful. One nest followed in its entirety appeared to be typical. Its directions and dimensions are shown in Figure 5. The burrow was briefly horizontal, then curved downward to a depth of about 85 mm. At the 60 mm level a short side burrow, plugged with dirt, led to an indistinct cell containing 21 thrips, the agglutinated remains of about 12 more thrips, and a half-grown wasp larva (Fig. 5b). At the 85 mm level four thrips were lodged loosely in a bend of the burrow (Fig. 5c). A cell at the end of the short unplugged side burrow which followed contained 28 thrips but no egg or larva (Fig. 5d). Judging from several excavations, the wasp may deposit thrips temporarily at a bend opposite the cell, and move them to the cell later. This idea fits well with the provisioning observations described below.

Prior to provisioning, wasps of both sexes were abundant on flowers of several sorts, particularly those with a short corolla. Examples were *Potentilla gracilis* Dougl. ex Hook., *Calyptridium umbellatum* (Torr.) Greene, *Nama lobbii* Gray, *Phacelia* species, *Chamaesaracha nana* (Gray) Gray, and *Ligusticum* species. Males could be found at flowers for about two weeks after the onset of nesting, but copulation was not observed. Provisioning females presumably collected their prey on the same flowers. Furthermore, they were observed to crawl down the corollas of *Penstemon gracilentus* Gray, apparently in search of prey. Female wasps were first seen provisioning on 4 July 1970. Thrips were carried singly, venter uppermost and held in the mandibles of the wasp. Each thrips was grasped by the thorax with its head projecting anteriorly from the wasp's mandibles, and the rest of the thrips lying under the thorax of the wasp. When a wasp was captured in an aspirator, it walked readily about the tube without using its legs to hold the prey. The provisioning female hovers briefly about its nest and then enters directly without alighting.

Ordinarily the wasp deposits its prey and emerges in 10 to 40 seconds. However, several timings were as short as three to five seconds. We presume that in these instances the female merely dropped her thrips at a bend in the burrow, as suggested above. On leaving the burrow a female waits momentarily with her head at the entrance, then walks back and forth in front of the entrance, pauses, and flies around in several erratic circles before disappearing. Time recorded for searching during mid day varied from 40 seconds to six minutes, with about two minutes on the average, based on 30 observations and five wasps.

Prey of *Pulverro monticola* appears to be mostly adult thrips but occasionally a few large immatures are included in the provisions. Observed Thysanoptera were *Frankliniella moultoni* Hood and a few specimens of *Aeolothrips fasciatus* (Linnaeus). Both of these were abundant on flowers in the vicinity.

Judging from the observation of many nests, the entrances are never closed by the wasp while she is absent in search of thrips or after the nest is complete. This is in agreement with the fact that female *Pulverro* have the tarsal rake undeveloped. The entrance is thus frequently exposed to predators and parasites. Ants of various sizes have been seen in fair numbers on the nesting site but even those small enough to enter the burrows have not done so. No sarcophagid flies have been noted. All of the nyssonine parasites and most of the chrysidids which visited the site were too large to enter the burrows. One minute species of *Hedychridium* was seen to inspect the nests and could conceivably be a parasite of *Pulverro*. Soon after nesting is completed, the burrow entrances are partially blocked by wind blown dust and doubtless they are eventually sealed off by rains.

In one of the excavations a prepupa was found. It was in a silken cocoon at a depth of about 80 mm. The cocoon was egg-shaped, 2.75 mm long and 0.85 mm at its greatest breadth. The outer surface of the cocoon was covered with sand grains and parts of thrips. The prepupa was 2.5 mm long and 0.8 mm wide. It was subsequently sketched while still alive, then partially cleared and mounted on a slide for microscopic examination. Details are given in Figures 1–4. Essential features of the larva are as follows: (1) body fusiform rather than cylindrical, largely smooth, a few scattered microsetae including some on mouthparts; (2) head capsule 0.40 mm long, 0.44 mm wide; (3) antennal orbits and frontoclypeal suture not distinct, mouthparts pigmented only toward apex of mandible; (4) labrum weakly emarginate apically, bearing about 10 scattered microsetae; (5) mandible with four teeth including a weak basal one, a single bristle near middle of outer margin; (6) maxilla largely asetose but with scattered spicules in lacinial area, maxillary palpus stout and much larger than galea; (7) spinnerets acute apically, not connected by a membrane and not exceeding labial palpi.

SCIENTIFIC NOTE

A host record for *Fedtschenkia* (Hymenoptera: Sapygidae).—The genus *Fedtschenkia* occurs in both western North America and in palearctic Asia. There has been some question as to its affinities since it resembles certain Scoliidae, such as *Cosila*, but male genitalia and other features place it in the Sapygidae. There has long been speculation about the identity of its host. All other known hosts of sapygids are bees, particularly megachilids but also xylocopids.

In 1956 at Tanbark Flat in the San Gabriel mountains of California the senior author observed a female *Fedtschenkia anthracina* (Ashmead) entering a ground burrow which was found to contain a cell with a dead adult of the eumenid wasp, *Pterocheilus trichogaster* R. Bohart. Evidence of a relationship seemed flimsy until D. J. Horning and the junior author excavated a number of burrows of *P. trichogaster* on Santa Cruz Island, California late in April of 1969. *Fedtschenkia* were abundant and active as parasites in the nesting area. Finally, the senior author at Arroyo Seco, Monterey County, California in May 1971 observed *F. anthracina* females entering and staying for considerable periods in burrows of *P. trichogaster* which were provisioning with geometrids of the genus *Hydriomena* Hübner (det. M. R. Gardner).—R. M. BOHART AND R. O. SCHUSTER, *Department of Entomology, University of California, Davis, 95616.*

A New Seed Inhabiting Cerambycid from Costa Rica
(Coleoptera)

JOHN A. CHEMSAK
Division of Entomology, University of California, Berkeley, 94720

The number of known seed-infesting Cerambycidae is relatively small considering the great potential for larval development this habitat provides. In North America, *Paratimia conicola* Fisher lives in the cones of *Pinus attenuata* and *P. bolanderi* (Craighead, 1923; Linsley, 1962); *Ataxia sulcata* Fall and *Leptostylus terraecolor* Horn in the seeds of *Rhizophora mangle* (Craighead, 1923); *Leptostylus gibbulosus* Bates in seeds of *Sapindus* (Vogt, 1949). In Latin America, seed-infestors include *Lepturges spermophagus* Fisher in Cowpea, *Vigna* (Fisher, 1917); *Baryssinus leguminicola* Linell in *Enterolobium* (Gilmour, 1965 has synonymized this species under *Lophopoeum timbouvae* Lameere which is known to infest seeds of various legumes as listed by Duffy, 1960); *Leptostylus gundlachi* Fisher in pods of coralbean, *Erythrina glauca* (Wolcott, 1948); and *Lepturges guadeloupensis* Fleutiaux and Sallé has been reported from pods of *Acacia* by Wolcott (1948).

The following new species, reared from *Diospyros* fruits by P. A. Opler, was made available by D. H. Janzen and is described at this time to make the name available for other studies. The illustration was prepared by Celeste Green. This study was conducted during the course of National Science Foundation Grant GB-31120X.

Leptostylus spermovoratis Chemsak, new species
(Fig. 1)

MALE.—Form moderate sized, robust, convex above; ground color reddish brown, apex of abdomen dark; pubescence dense, short, appressed, mottled whitish-brown and black; elytra with a broadly triangular black chevron behind middle. Head with front shallowly convex, subquadrate, deeply impressed between antennal tubercles; antennal tubercles elevated, divergent; punctation obscured by pubescence; pubescence mottled, front mostly dark; eyes moderately coarsely faceted, deeply emarginate, separated above by more than diameter of antennal scape; mouthparts and base of labrum with a few long erect hairs; antennae a little longer than body, basal segments mottled with dark brown, segments from fifth pale, dark annulate at apices, scape extending to about middle of pronotum, third segment slightly arcuate, longer than first, fourth slightly shorter than first, remaining segments gradually decreasing in length. Pronotum broader than long, sides slightly inflated; base broadly impressed, apex more narrowly impressed; disk with five prominent tubercles, punctures around

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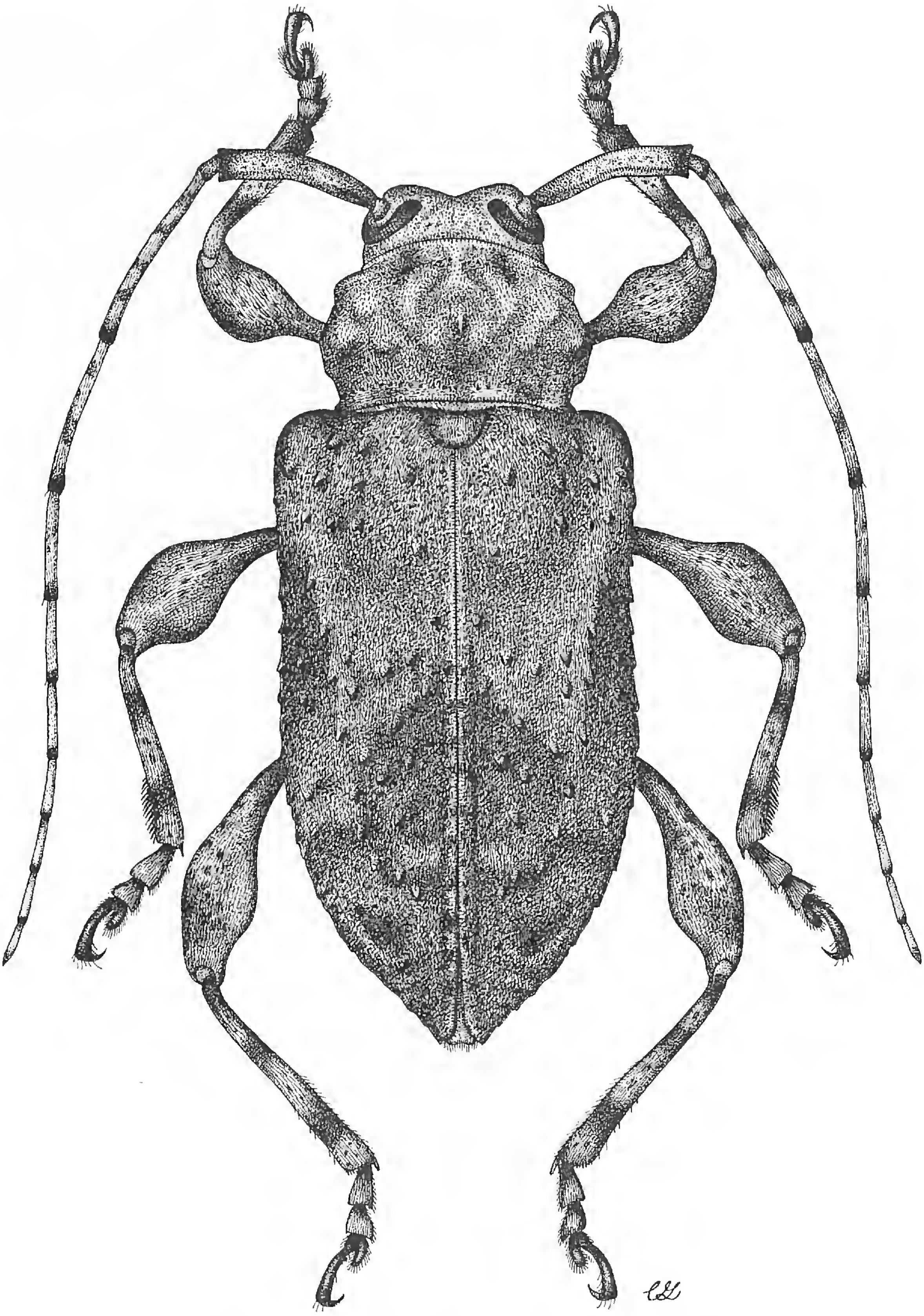

FIG. 1. *Leptostylus spermovoratis* Chemsak, ♂.

tubercles irregular, base with a line of coarse punctures; pubescence gray-brown, appressed, black basally at sides and middle and at apex on each side of middle; prosternum narrow, intercoxal process narrower than width of coxa, expanded behind, coxal cavities closed; mesosternal process broad, abruptly declivous in front, middle coxae with small tubercles internally; scutellum black, triangular, rounded behind, sparsely pubescent. Elytra less than twice as long as broad, tapering apically, broader than pronotum; disk with semicircular elevated ridges at base on each side of scutellum, ridges bearing elevated black pubescent tubercles, dark pubescent tubercles scattered over surface but forming a broad triangle behind middle; pubescence mottled, sides with a dark band extending down humeri to middle; apices narrow, truncate. Legs robust, femora clavate, pale and brown mottled; tibiae each with two dark bands. Abdomen densely pale pubescent at sides, sparsely pubescent at middle; last sternite dark, sparsely pubescent, truncate at apex. Length, 10 mm.

FEMALE.—Form similar. Antennae slightly shorter. Abdomen with last sternite rounded at apex. Length, 10–12 mm.

Holotype male, allotype and two paratypes (1 male, 1 female) from COMELCO, BAGACES, GUANACASTE, COSTA RICA, emerged from *Diospyros* fruits on 8 January 1971 (P. A. Opler).

The type series varies little in coloration and the elytral pattern of all the specimens is quite similar.

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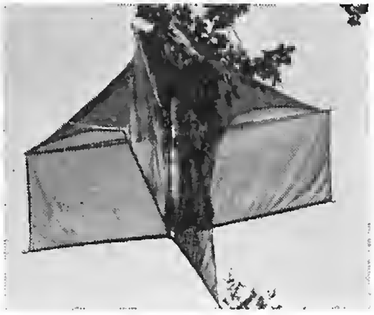

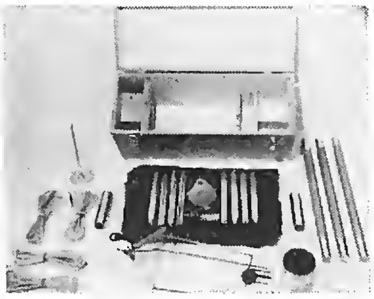

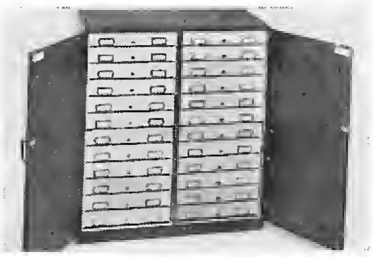

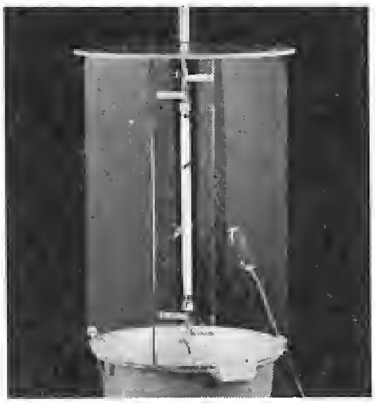

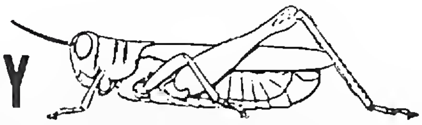

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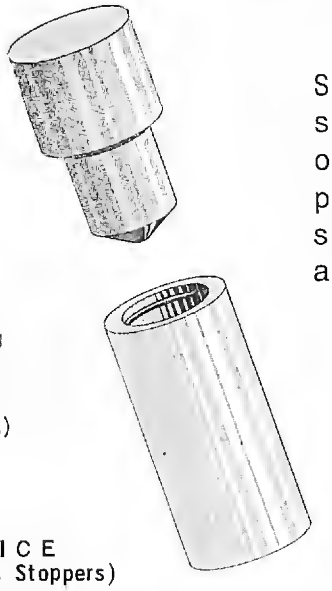

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Bumble Bees Collected by the California Academy—Lingnan Dawn-Redwood Expedition to Central West China, 1948

(Hymenoptera: Apidae)

Shôichi F. Sakagami
Zoological Institute, Hokkaido University, Sapporo

The present paper is a report on the taxonomic study of the bumble bees collected by the California Academy—Lingnan Dawn-redwood Expedition to Central West China (1948), or more familiarly known as the Metasequoia Expedition. The main purpose of the expedition was "to collect insects and other animals in the hope of finding some ancient faunal elements of possible North American affinity which might have survived with *Metasequoia* and the other ancient trees associated with it" (Gressitt, 1953). Bumble bees are not suitable material to trace such a relation, yet the collected specimens are valuable because of insufficient information on this group in Eastern Asia. Numerous names have been published for the Chinese bumble bees (Wu, 1941), and a zoogeographical consideration was given by Panfilov (1957). Most descriptions of Chinese forms published prior to 1940 were incomplete. The resulting misinterpretations of taxa were serious for any further studies on this difficult group. Only recently various "forms" are being restudied accurately by the examination of type specimens (Tkalců, 1960, 1961a,b, 1968a,b). For the time being, however, we need more effort to clarify each taxon inhabiting this vast area. For this purpose, the present study may serve as a milestone for future synthesis.

Except for a few specimens collected in 1950 from Luichow Peninsula, Kwangtung Prov. by Dr. J. L. Gressitt, most specimens were collected by him and Mr. Y. W. Djon during July to September 1948 from the localities as shown in Fig. 1. The map is based upon a sketch prepared by Dr. Gressitt.

The subgeneric system mainly follows that by Richards (1968). The synonymic lists include only the original description and important papers.

The Pan-Pacific Entomologist 48: 153–174. July 1972

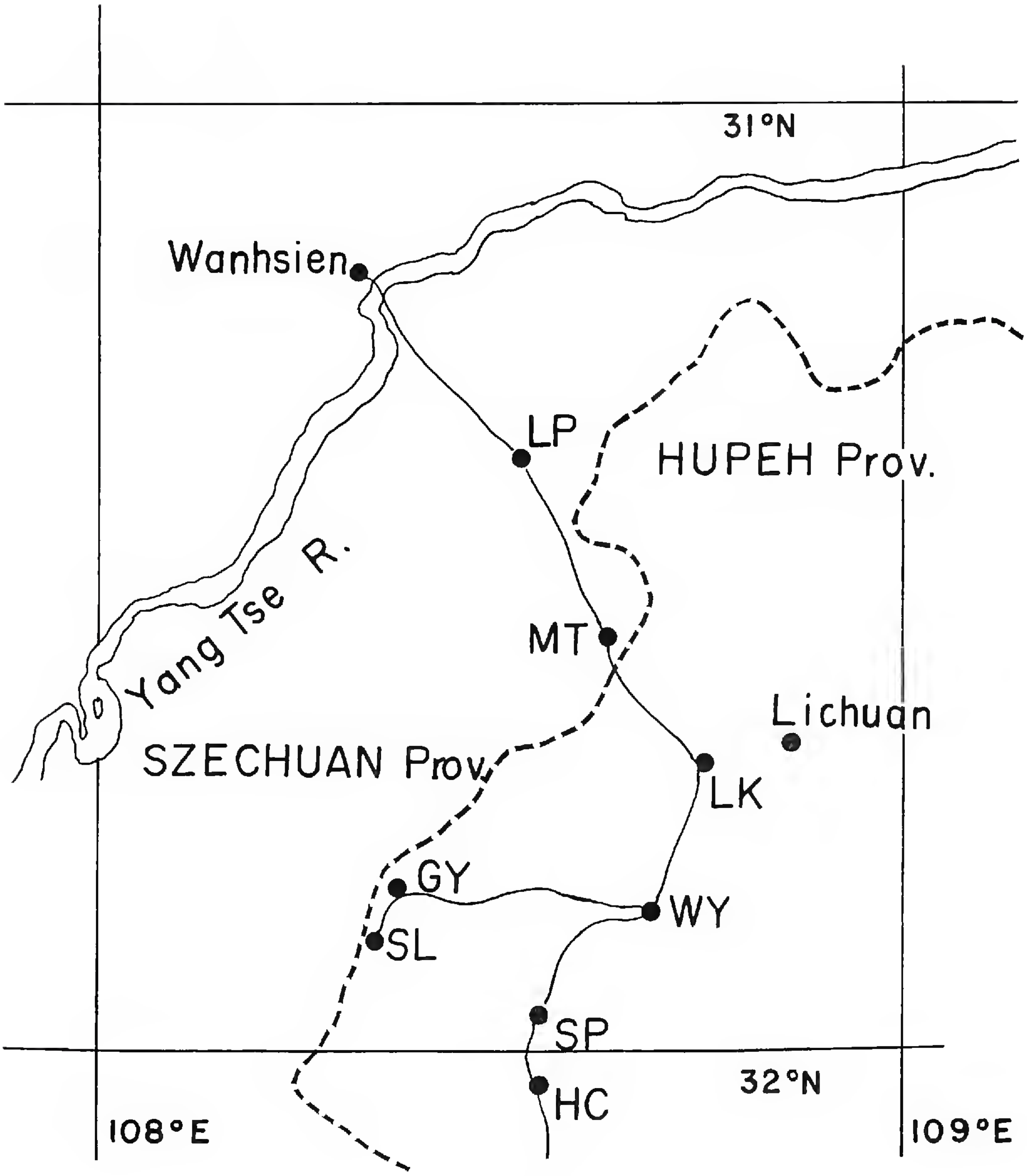

FIG. 1. Map showing localities where the specimens were collected. Hupeh Province (Lichuan District): Sui-hsa-pa (= Suisapa, 1,000 m, SP), Hsao-ho (= Hsiacho, HC), Wang-chia-ying (Wang-ga-ying, WY), Gan-yu-yai (GY), Song-lung-chi (SL), Leung-ho-keo (Leung-ho-kow, LK), Szechuan Province (Wanhsien District): Mo-tau-chi (MT), Lung-chiu-pa (Lunchepa, LP).

Before going further, I would like to express my heartiest thanks to Dr. Paul H. Arnaud, Jr. and Mr. Hugh B. Leech, California Academy of Sciences, San Francisco, and Dr. Yoshihiro Hirashima, Kyushu University, Fukuoka, who gave me the opportunity to study valuable materials, Dr. J. L. Gressitt, Bernice P. Bishop Museum, Honolulu, who informed me through Mr. Leech of details about the localities where the specimens were collected, and Dr. Robbin W. Thorp, University of California, Davis, who read the manuscript and helped me publish it. My sincere gratitude is also expressed to Dr. Borěk Tkalců, Praha, whose expert knowledge based upon examinations of many type specimens and whose unselfish answers to my questions were indispensable to complete the work.

BOMBUS (TRICORNIBOMBUS) ATRIPES Smith

Bombus atripes Smith, 1852: 44, ☿, ♂.
Megabombus (Tricornibombus) atripes, Tkalců, 1968b: 83, ♀, ☿, ♂.
SPECIMENS EXAMINED.—WY, 22–23 September, 3 ☿; SL-GY-WY, 19 September, 2☿, 1♂.

Recently this and the next species were thoroughly redescribed by Tkalců (1968b). The hair coat coloration, bright orange brown above, blackish below, is constant for all specimens examined.

BOMBUS (TRICORNIBOMBUS) IMITATOR Pittioni

Bombus (Tricornibombus) imitator Pittioni, 1949: 251, ♀.
B. (T.) imitator var. *flavescens* Pittioni, 1949: 254, ☿.
Megabombus (Tricornibombus) imitator, Tkalců, 1968b: 90, ♀, ☿, ♂.
SPECIMENS EXAMINED.—SP, 26 July, 2 ☿, 2–3 August, 2 ☿, 16 August, 1 ☿, 1♂, 22–30 August, 11☿, 1♂, 12–17 September, 8☿, 3♂; HC, August, 1☿; LK, August, 1☿, 31 August, 2♂, 7 September, 1☿, 9 September, 1♂.

These specimens were seemingly already examined by Tkalců (cf. Tkalců, 1968b, p.93). In most specimens the apical half of metasomal tergum III bears pale ochre orange hairs, occasionally black hairs are confined to the anterior lateral corners (=*flavescens* Pittioni, cf. also Tkalců, 1968b). Terga III and IV of one male are tawny yellow orange with sparse admixture of black hairs anteriorly. Black interalaris of most specimens is poorly defined, and in small workers often represented by an obscure dark patch.

BOMBUS (THORACOBOMBUS) OPULENTUS Smith

Bombus opulentus Smith, 1861: 153, ♀.
Megabombus (Agrobombus) opulentus, Tkalců, 1968a: brief note.
SPECIMENS EXAMINED:—WY, 23 September, 1☿, 22 September, 1♂; GY-WY, 20 September, 1♂.

The identification of these specimens as *B. opulentus*, a long forgotten taxon, was based upon a brief note by Tkalců given in the description of *Bombus honshuensis* (Tkalců) and confirmed by himself (*in litt.*). Because Dr. Tkalců is preparing the descriptions of three castes of this species, only some remarks on hair color and some male characters are given here.

HAIR COLOR.—*Worker.*—Mesosomal disc, upper half of mesosomal side and metasomal terga I～II orange brown. Head excluding sparse orange brown

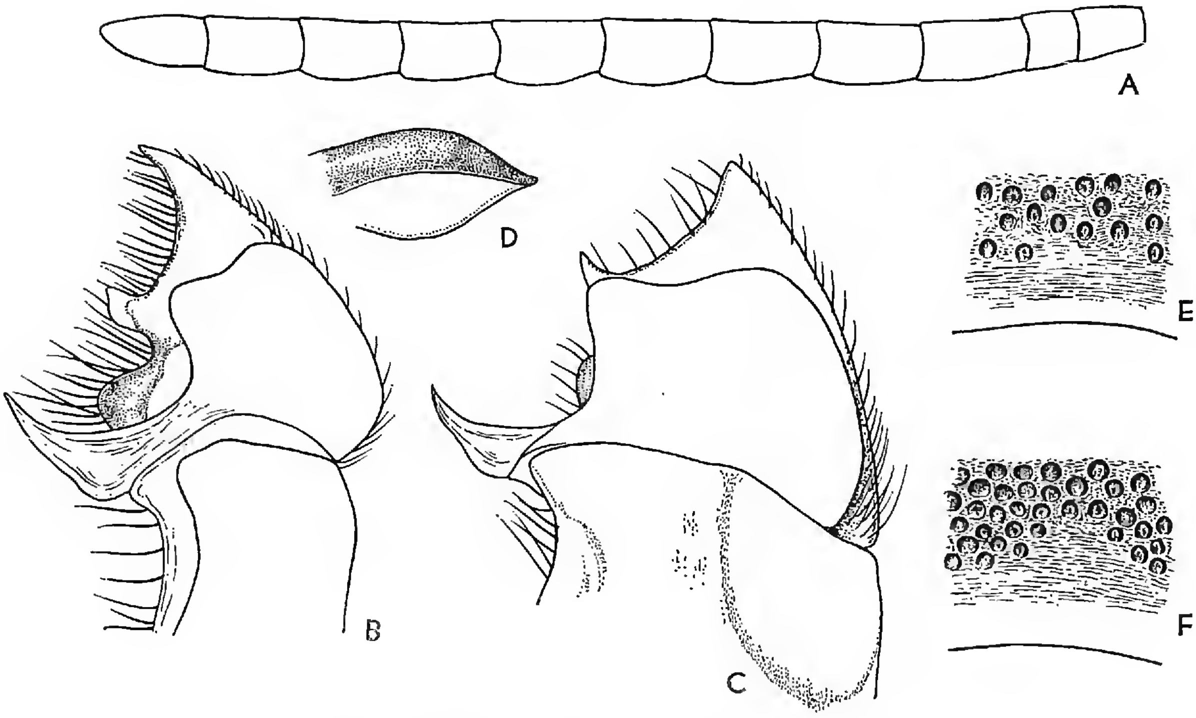

FIG. 2. Comparison of males of *B. opulentus* (A ~ D, F) and *B. schrencki* (E). A. Antenna; B. Apex of genitalia dorsal view; C. Same dorsolateral view; D. Lower membrane of basal process of gonostylus; E and F. Sculpture of posterior part of metasomal tergum IV.

hairs on vertex, lower half of mesosoma, terga IV ~ VI, sterna and legs blackish to chocolate brown, tergum II laterally broadly blackish. *Male.*—Generally as worker but differing in following points: Short plumose hairs on face and gena pale fulvous; vertex mostly pale orange brown with sparse black hairs; lower half of mesosoma with more extensive orange brown hairs, leaving narrow dark chocolate band on venter; coxae and trochanters below with pale brownish hairs; hairs of tergum II entirely orange brown, slightly paler apically, forming obscure marginal ciliation; hairs of tergum III entirely blackish in one specimen, basal half blackish and apically orange brown in another, both with obscure ciliation; sterna with obscure marginal ciliation.

MALE CHARACTERS.—(cf. Synoptic table of *B. unicolor* (Friese) $= U$, *B. schrencki* (Morawitz) $= S$ and *B. honshuensis* $= H$ in Tkalců 1968a, p.48) : 1) Flagellar segments IV ~ X moderately swollen below (Fig. 2 A, $= U$, $\neq S,H$). 2) Punctures bearing hairs on hind tibia dense and homogenous ($= S,U$, $\neq H$). 3) Forewing darker than in *S.* and *U*, with slight iridescence. 4) Penis valve below with short rectangular denticule ($= U,S$, $\neq H$). 5) Lateral depression of gonocoxite basally not distinctly demarcated (Fig. 2 C, $= U,S$, $\neq H$). 6) Apical contour of gonostylus similar to that of *U*, inner angle slightly more pointed though not so conspicuously as in *S* (Fig. 2 B,C). 7) Lower membrane of inner process of gonostylus as in *S* (Fig. 2 D). 8) Basal process of lacinia dorsolaterally well visible (Fig. 2 C, $= S,H$). 9) Barba mandibularis honey yellow ($= U,H$, $\neq S$). 10) Erect hairs of scape blackish brown ($= U,S$, $\neq H$).

Thus, *B. opulentus* is more closely related to *B. schrencki* and *B. unicolor* than to *B. honshuensis*. Besides the characters noted above, the punctures on tergum IV, especially marginally, are better defined

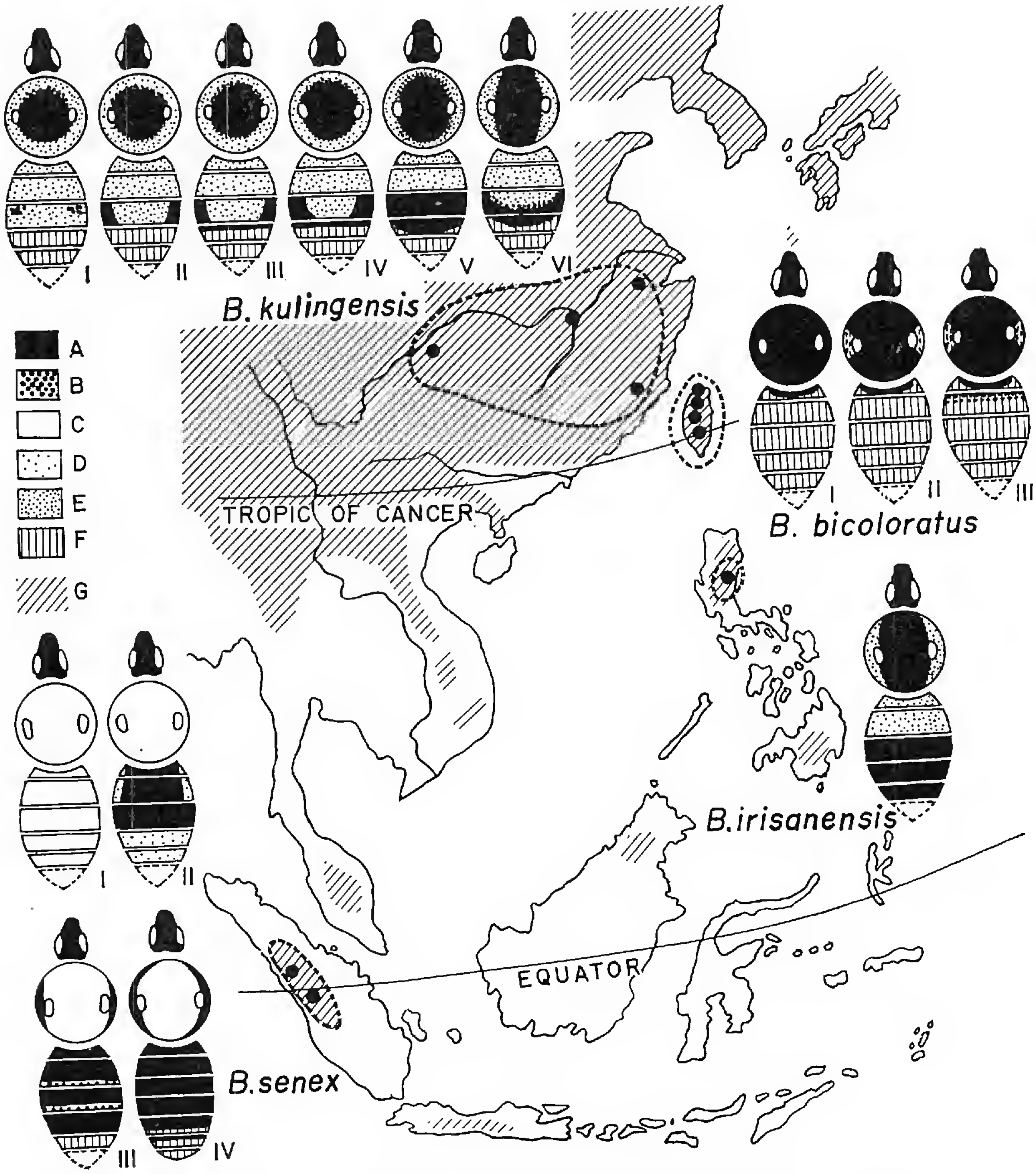

FIG. 3. Distribution and color patterns of the four species of the subgenus *Senexibombus* Frison. All color patterns shown are of females, except *B. senex* f. *pallidithorax* (IV) known by male only. *Bombus kulingensis* Cockerell (Central West China) I. Typical form, II. "*tajushanensis*" Pittioni, III. *k.* f. *quasiflavior* Tkalců and "*t.*" f. *flavior* Pittioni, IV. "*t.*" f. *nigrofasciatus* Pittioni, V and VI a worker and queen described in text; *B. bicoloratus* Smith (Formosa) I. Typical form, II. f. *fulvolateralis* Cockerell, III. f. *intermedius* Chiu; *B. irisanensis* (Philippines, in variation recorded) ; *B. senex* Vollenhoven (Sumatra) I. Typical form, II. f. *sumatrensis* Cockcrell, III. f. *ardentior* Cockerell, IV, f. *pallidithorax* (Frison) (♂). Color codes: A. Black, B. Admixture of blackish hairs, C. Whitish, D ∼ E. Pale to deep yellowish or ochraceous, F. ferruginous. G. Distribution of bumble bees in E. and SE. Asia.

and denser in *B. opulentus* than in *B. schrencki* (Fig. 2E, F). Certainly *B. opulentus* may be regarded as the Southernmost representative of the *B. schrencki*-group.

BOMBUS (SENEXIBOMBUS) KULINGENSIS Cockerell

Bombus kulingensis Cockerell, 1917: 266, ♀.

Bombus (*Senexibombus*) *tajushanensis* Pittioni, 1949: 244, ♀, ☿; f. *nigrofasciatus*, 246, ♀, ☿; f. *flavior*, 247, ♀, ☿.

Bombus (*Senexibombus*) *kulingensis*, Tkalců, 1961a: 46, ♀; f. *quasiflavior*, 52, ♀.

SPECIMENS EXAMINED.—SP, 26 August, 1☿ (in very poor condition), 27 August, 1♀, 29 August, 1☿.

By the synoptic table of *B. tajushanensis* and *B. kulingensis* by Tkalců (1961a), the specimens examined straightly go to the latter. But Dr. Tkalců recently informed me that *B. kulingensis* and *B. tajushanensis* are conspecific. Two specimens examined are characterized by their melanism, a queen without pale hairs on mesosomal dorsum, and a worker with tergum III completely, IV nearly entirely black. Figure 3 shows the distribution and color patterns of the four species forming *Senexibombus*, a small subgenus endemic to Eastern and Southeastern Asia at the S.E. Asiatic boundary of bumble bee distribution. The record of *B. kulingensis* from Western Hupeh represents, for the time being, the northwestern limit of the subgenus.

BOMBUS (DIVERSOBOMBUS) TRIFASCIATUS Smith

Bombus trifasciatus Smith, 1852: 43, ♀, ☿.

Bombus ningpoensis Friese, 1909: 675, ♀ (cf. Tkalců, 1961b, 367).

Bombus (*Diversobombus*) *ningpoensis*, Pittioni, 1949: 251, ♀, ☿; Tkalců, 1960: 4, ☿.

Bombus (*Diversobombus*) *ningpoensis* subsp. *minshanicus* Bischoff, 1936: 19, ☿.

SPECIMENS EXAMINED.—SP, 22–31 July, 23☿, 1–10 August, 22☿, 11–20 August, 68☿, 1♂, 21–31 August, 77☿, 1–10 September, 1☿, 2♂, 11–18 September, 20☿, 1♂; LK, 12 August, 1☿, 28–31 August, 5☿, 1–10 September, 87☿, 1♂; LK-SP, 21 August, 1☿, 18 September, 2♂; HC, 4 August, 1☿, 12–16 August, 8☿; WY-SP, 21 July, 1☿; WY, 22 September, 2☿; SL-GY-WY, 19 September, 3☿; LP, 29 September, 1☿; MT, 25–26 September, 4☿; Kwangtung Prov., Luichow Peninsula, 8 September, 1☿.

This is apparently one of the most abundant and widespread bumble bee species in Western China. Some structural differences from *B. diversus* Smith, the type species of the subgenus, are as follows: 1) Punctures on ocellocular area above (☿, ♂) more well defined, contrasting with interspaces smoother, showing less marked undulations

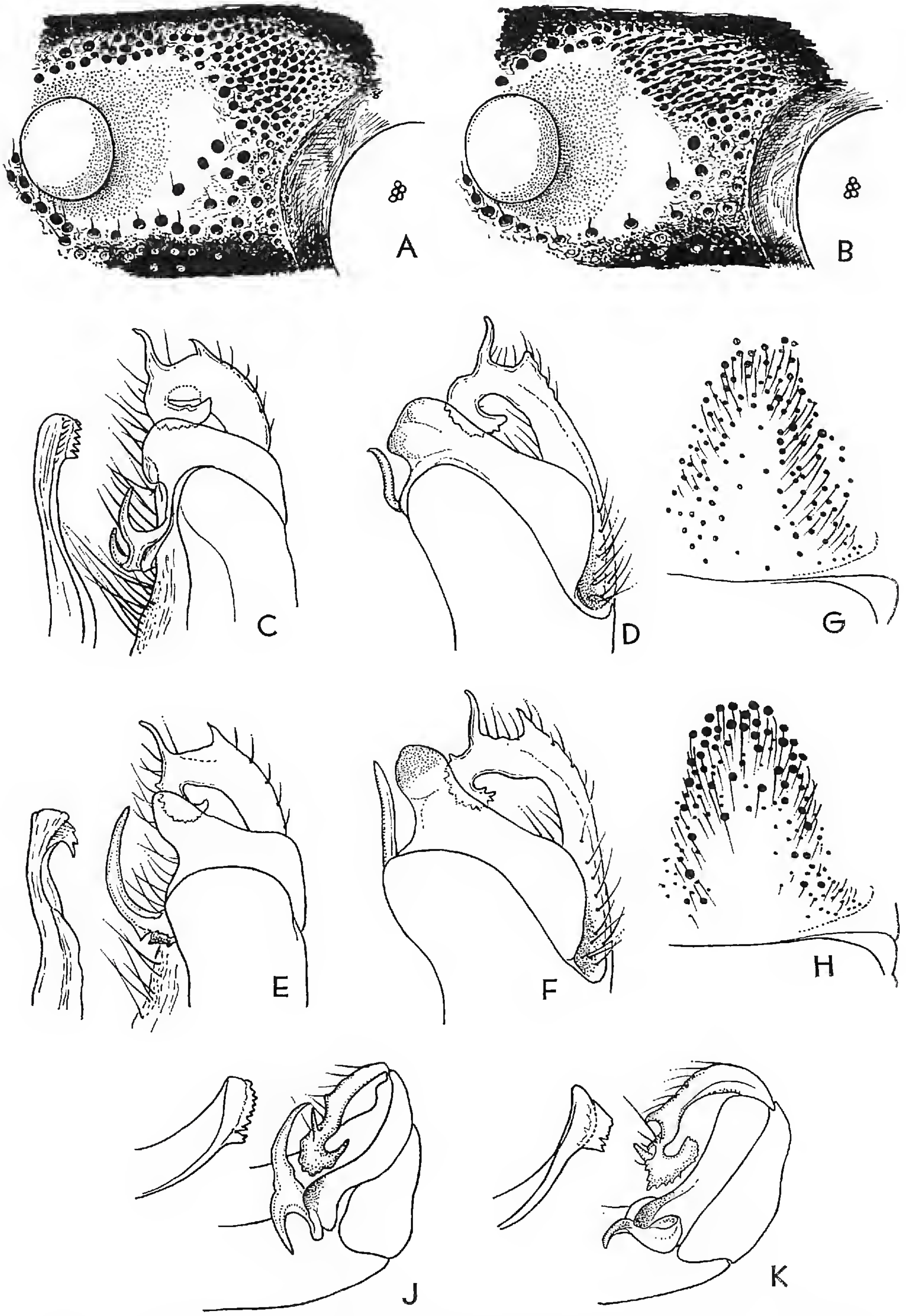

FIG. 4. Comparison of *B. trifasciatus* (A,C,D,G,J) and *B. diversus* (B,E,F,H,K). A,B. Sculpture on ocellocular area (worker); C,E. Apex of male genitalia, dorsal view; D,F. Same, dorsolateral view; J,K. Same, apical view; G,H. Punctation of male clypeus.

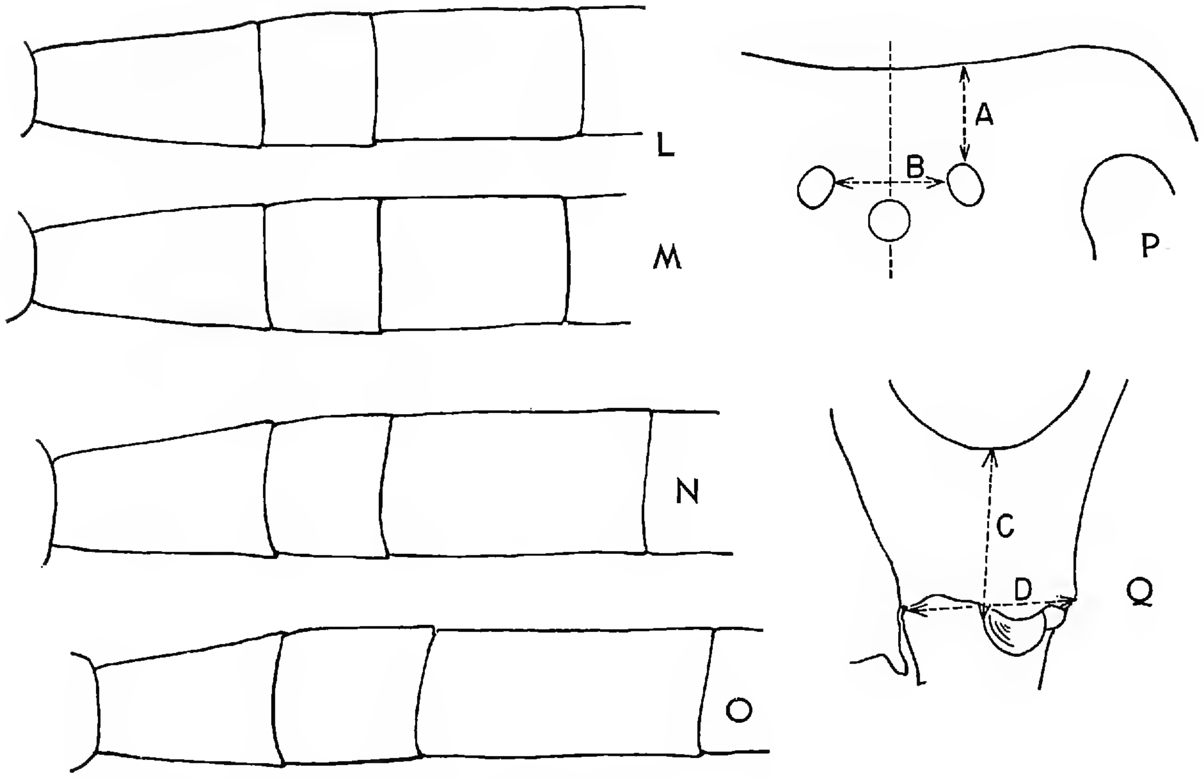

FIG. 5. Comparison of *B. trifasciatus* (M,N) and *B. diversus* (L,O), continued. L,M. Basal flagellar segments (worker); N, O. Ditto (males); P, Q. Parts used for relative size measurements (cf. in text).

(Fig. 4A, B). 2) Punctures on metasomal terga (☿, ♂), especially IV and V, denser, submarginally punctures often nearly as wide as interspaces. 3) Male clypeus with less coarse punctures and medio-apical smooth area less contrasting (Fig. 4G, H). 4) Male antennal flagellum I slightly longer and II slightly shorter (Fig. 5N, O). 5) Inner apex of male gonocoxite relatively well projecting (Fig. 4C–F, J, K). 6) Inner angle of male gonostylus more angulate apically (Fig. 4C–F, J, K). 7) Inner process of male gonostylus shorter and bifurcate (Fig. 4C, E, J, K). 8) Outward serration of head of penis valve less projecting but more continuous (Fig. 4C, E, J, K).

The shape of the inner process of the gonostylus is most critical. On this character, *B. diversus*, (Japan), *B. ussurensis* Radoszkowski (Japan, Korea, Ussuri) and *B. hummeli* Bischoff (North China, cf. Bischoff 1936, p. 19) form one group and *B. trifasciatus* another, together with *B. wilmani* Cockerell (Formosa), *B. montivagus* Smith (S.E. Asia, cf. Tkalců, 1968c), and *B. albidopleuralis* Friese (Nepal), suggesting the segregation of two species groups between northern and southern areas of the range of the subgenus *Diversobombus* endemic to East and S.E. Asia.

Using the rich material some variation studies were executed as

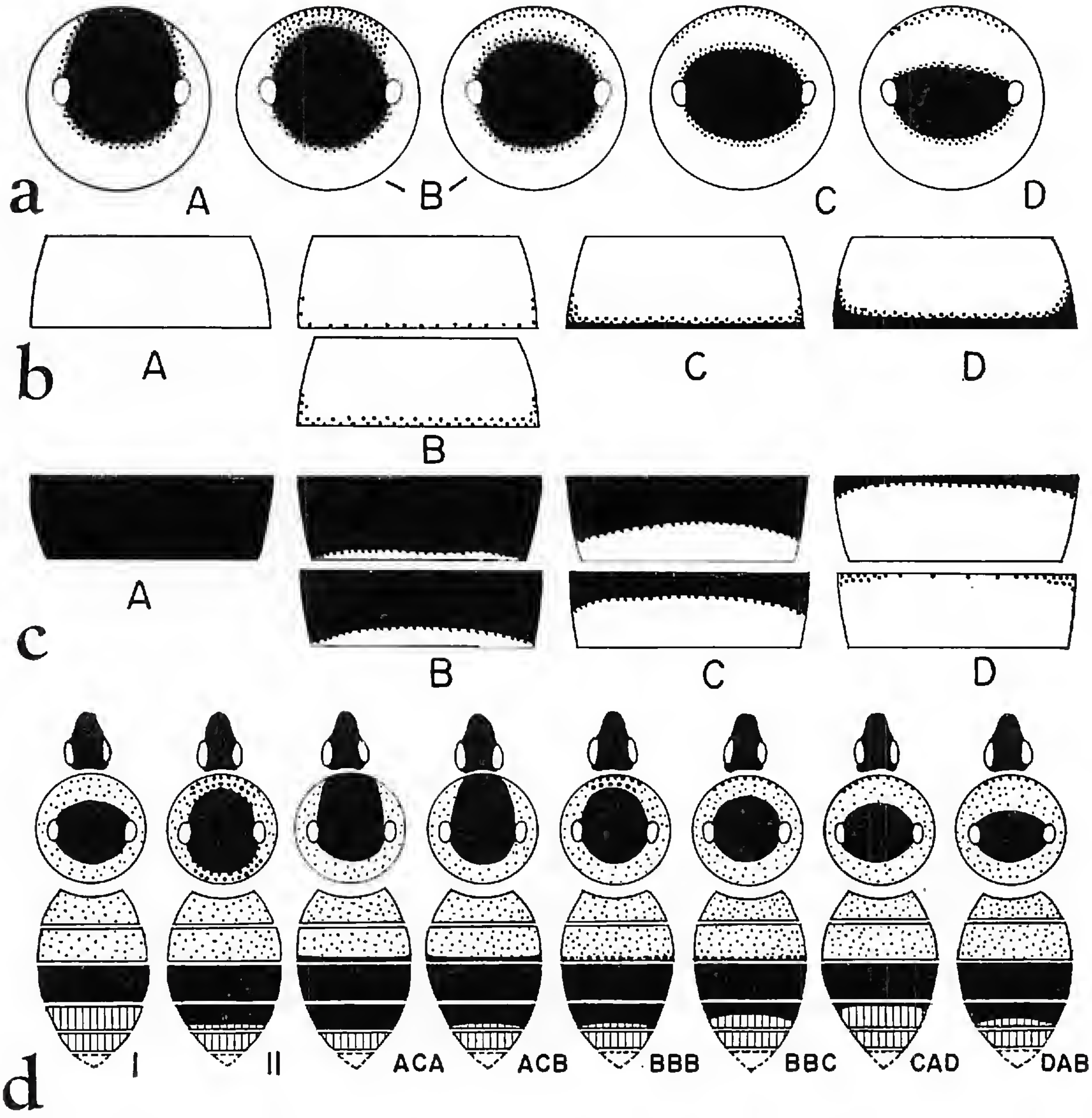

FIG. 6. Color variation in *B. trifasciatus.* a. Mesosomal dorsum; b,c. Metasomal terga II and IV; d. Selected color patterns, I. *trifasciatus* from original description; II. f. *minshanicus*; Others showing representative patterns described in text.

follows: HAIR COLOR.—The variation was studied with respect to the following three parts, which were most variable, of workers with relatively intact hair coat. 1) Mesosomal dorsum. Extent of black interalaris is variable. In most melanic specimens, pale collaris completely disappears. In the flavinic extreme, interalaris remains as a relatively narrow band (Fig. 6a, A–D). 2) Metasomal tergum II varies from completely yellowish to distinctly black banded posteriorly (Fig. 6b, A–D). 3) Tergum IV varies from completely black to nearly entirely ferruginous, leaving sparse black hairs anterolaterally (Fig. 6c, A–B).

The frequency distribution of various combinations of color patterns

(Fig. 3) is as follows: BBB 116, BBC 49, CBB 18, BBD 17, CBC 15, BCB 14, BAB 9, ABC, DBB each 7, ABB 6, BCC 5, BBA, BDB, CAB, CBD, ABD, DAC each 2, AAB, ABA, ABD, ACA, ACB, ACC, BAA, BAC, BAD, BCD, CAA, CAD, CBA, CDD, DAB, DBC each 1. For each body part, the frequency distribution is as follows: Mesosomal dorsum, A 20, B 222, C 43, D 11; tergum II, A 23, B 248, C 24, D 2; tergum IV, A 13, B 193, C 72, D 23, E 4. Pittioni (1949) referred to the relatively constant color pattern of this species with variability exhibited mostly in the extent of interalaris. The chromatic constancy of this species was also suggested by Tkalců (1960). The population studied by me seems to be more variable, though not so obviously as to be called polytypic. The prevalence of type B in mesosomal dorsum corresponds to subsp. *minshanicus* described from S. Kansu, characterized by the extension of interalaris and resulting diminution of both collaris and scutellaris, together with the appearance of narrow reddish band at the posterior margin of tergum IV in some specimens. In the specimens examined the decrease of collaris often reaches the extreme (type A, complete absence, and the invasion of reddish hairs on tergum IV is often greater (more advanced), whereas the diminution of scutellaris was never observed. Apparently the population studied shows a tendency to subsp. *minshanicus*-type but it is open to the question whether the species is divided into more than one distinct subspecies within the range. A single worker from Luichow Peninsula, Kwangtung Prov. showed type ABB, and four males with intact coat respectively BBB, BAC, CAA and DBD.

The variability of mesosomal disc correlates to the body size as follows:

Head width	(mm)	3.75 ≥	3.81 ~ 3.94	4.00 ~ 4.13	4.18 ~ 4.32	≥ 4.37	Total bees
Color pattern	A		2	5	10	3	20
	B	15	40	71	79	17	222
	C	9	12	9	12	1	43
	D	3	1	3	4		11

Melanism appears more frequently in larger specimens. No such correlation was detected for terga II and IV.

ALLOMETRIC TENDENCY.—Moure and Sakagami (1962) enumerated morphological differences between queen and worker bumble bees. Some of them, especially those of the head, are similar to the allometric tendency of other bees (cf. Sakagami and Moure, 1965). This feature was studied by using the specimens of *B. trifasciatus*, with respect to malar index (length/width of malar space, cf. Fig. 5 Q, C/D) and occipital index (interocellar distance/ocelloccipital distance, cf. Fig. 5P, B/A). The result is given as follows:

Head width (mm)	Malar index	Number of (specimens) measured	Occipital index	Number of (specimens) measured
3.25 ~ 3.57	1.21	(12)	1.10	(14)
3.62 ~ 3.75	1.18	(14)	1.15	(13)
3.81 ~ 3.88	1.23	(10)	1.21	(9)
3.94	1.22	(14)	1.23	(13)
4.00	1.27	(16)	1.29	(16)
4.06	1.26	(12)	1.30	(11)
4.13	1.28	(17)	1.31	(20)
4.19	1.27	(17)	1.34	(13)
4.25	1.28	(17)	1.40	(18)
4.31	1.30	(17)	1.40	(15)
4.38	1.31	(12)	1.43	(11)
4.43 ~ 4.50	1.29	(10)	1.46	(12)

The gradual increase of the ratio is conspicuous for the occipital index and, though less remarkable, is also traced in the malar index. The latter is of particular importance because this index is often adopted as a useful distinctive character. This allometric tendency is more conspicuous when queens and small workers are compared. For instance, the ranges and means of ratios in *B. diversus tersatus* Smith, measured each in five queens and five dwarf workers are as follows:

	Head width (mm)	Malar index	Occipital index
Queens	4.87 ~ 5.13 (5.04)	1.20 ~ 1.26 (1.24)	1.55 ~ 1.66 (1.62)
Workers	2.56 ~ 2.82 (2.66)	0.95 ~ 1.16 (1.04)	0.65 ~ 0.88 (0.79)

BOMBUS (ALPIGENOBOMBUS) BREVICEPS CHANNICUS Gribodo

Bombus channicus Gribodo, 1891: 116, ☿, ♀.
Alpigenobombus breviceps channicus, Tkalců, 1968c: 16, ♀, ☿, ♂.

SPECIMENS EXAMINED.—MT-LP, 28 September, 1☿; LP, 29 September, 1☿, 1♂.

Hind tibia and basitarsus are bright chestnut, not yellowish ochre as in *B. b. vicinus* (Tkalců).

BOMBUS (BOMBUS) IGNITUS Smith

Bombus ignitus Smith, 1869: 207, ♀, Tkalců, 1962: 17, ♀, ♂.
Bombus (*Bombus*) *ignitus*, Sakagami & Ishikawa, 1969: 185.

SPECIMENS EXAMINED.—GY-WY, 20 September, 1☿; SL-GY-WY, 19 September,

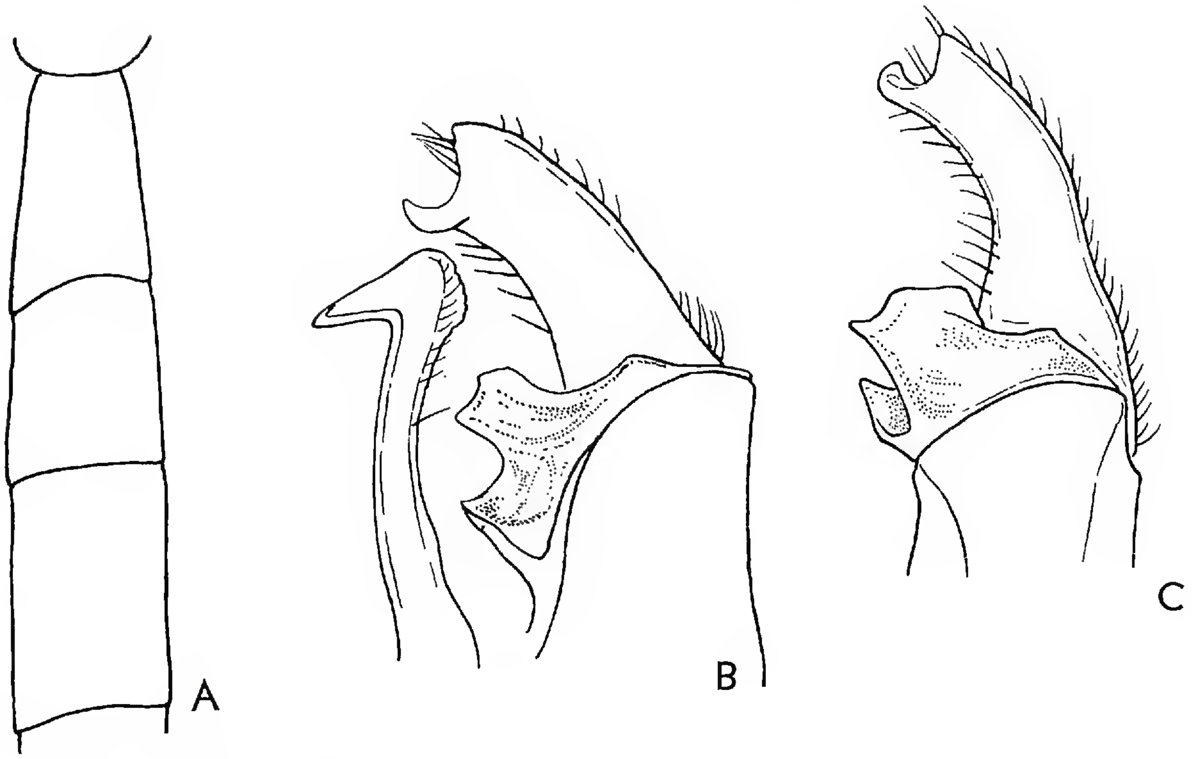

FIG. 7. *Bombus pyrosoma* (male). A. Basal flagellar segments; B and C. Apex of genitalia dorsal and dorsolateral views.

2☿; HC, 8–10 August, 2☿, 13–15 August, 3☿; LK, 9 September, 1☿; SP, 3 August, 3☿.

All specimens have sparse ochraceous hairs on metasomal tergum II (= var. *balteatus* Skorikov, 1933 or var. *cancellatus* Frison, 1935), and some specimens have similar hairs on tergum I, either anteriorly or posteriorly or mesosoma anteriorly (= var. *subcollaris* Skorikov, 1914).

Bombus (Melanobombus) pyrosoma F. Morawitz

Bombus pyrosoma F. Morawitz, 1890: 349, ♀.
Bombus (*Lapidariobombus*) *pyrrhosoma pyrrhosoma*, Bischoff, 1936: 9, ♀, ☿, ♂.
Bombus (*Lapidariobombus*) *pyrrhosoma*, Tkalců, 1961b: 353, ☿.

SPECIMENS EXAMINED.—WY, 22 September, 1☿; LK, 7–9 September, 9☿; SP, 30 July, 6 August, 2☿; WY-SP, 21 July, 1☿; SL-GY-WY, 19 September, 1☿; MT, 26 September, 1♂; Kwangtung Prov., Luichow Peninsula, 8 September, 1☿.

The sculpture on ocellocular area agrees with the figure shown by Tkalců (1968a, Fig. 70). Male antenna and genitalia are illustrated in Fig. 7. The hair color of both sexes agrees with that given by Bishoff (1936):

WORKER.—Head, mesosoma and legs dark chocolate brown. Ill-defined collaris and scutellaris, coxa II below, trochanters, femora basally (to apex in femur III), tergum I, sterna whitish; other terga orange red (probably bright ferruginous when fresh). Mesosomal side below broadly whitish with admixture of dark hairs. Tergum I with sparse admixture of dark hairs.

Variation is seen in the degree of admixture of dark hairs to whitish parts, resulting in different contrasts of collaris, scutellaris and pleuralis though collaris is mostly separated from head by a narrow obscure dark band. A single worker from Luichow Peninsula possesses pleura nearly whitish with admixture of dark hairs only medially, otherwise not markedly differing from the other specimens, that is, not showing color pattern of *B. p. hönei* (Bischoff, 1936) and without structural difference from the other specimens.

MALE.—Head, mesosoma, legs and tergum I ochraceous yellow, other terga orange red. Sparse dark hairs on vertex, gena, face especially along eyes, and on interalar areas. Metasoma in poor condition, so that admixture of dark hairs not precisely examined. Mandibular beard blackish brown, partly with honey yellow hairs.

BOMBUS (PYROBOMBUS) FLAVESCENS Smith

Bombus flavescens Smith, 1852: 45, ♂.
Bombus (*Pratobombus*) *flavescens*, Pittioni, 1949: 259, ♀, ☿, ♂.
SPECIMENS EXAMINED.—HS, 9 August, 1♂.

A single specimen of this extremely polytypic species goes to *B. f.* f. *geei* Cockerell in the key by Pittioni.

HAIR COLOR.—Chocolate brown; tergum IV except anterior margin, and following terga, legs and sterna dirty orange yellow. Mandibular beard pale orange yellow, short hairs of face whitish to grayish yellow above antenna, more yellowish below, long facial hairs mostly dark, with admixture of yellowish hairs, clypeus with yellowish long hairs; small patches of fulvous hairs on terga I and II laterally and on tergum II medioposteriorly.

BOMBUS (PYROBOMBUS) FLAVUS Friese

Bombus pratorum ssp. *flavus* Friese, 1904: 517, ♂; Friese & v. Wagner 1909: 52, ♂.
Bombus parthenius var. *picipes* Richards, 1934: 90, ☿ (Tkalců *in litt.*).
Bombus (*Pratobombus*) *klapperichi* Pittioni, 1949: 266, ♀; f. *intermedius*: 268, ♀; f. *flavescentiformis*: 269, ☿.

SPECIMENS EXAMINED.—SP, 20–29 August, 7☿, 2♂, 17 September, 1☿; HS, 9–10 August, 2☿, 12–16 August, 6☿; LK, 31 August, 2☿, 4–10 September, 1♀, 5☿, 2♂; MT-LP, 28 September, 1☿; Kwangtung Prov., Luichow Peninsula, 8 September, 2☿.

The specimens examined were identified as *B. flavus*, a long forgotten taxon. The species is close to *B. modestus* Eversmann and *B. beaticola* (Tkalců). Three castes are redescribed below to avoid any further confusion.

ALL CASTES.—Integument black, hind tibia and all tarsi dark chestnut brown. Wings pale brown and hyaline, veins dark brown. Hair coat relatively long, erect and rather uneven.

QUEEN.—Body 16 mm, forewing 14 mm. *Hair color* (Fig. 10d, I).—Head dark to chocolate brown, with short hairs on face and sparsely on occiput fulvo-testaceous. Interalaris broad and dark to blackish brown. Collaris virtually absent, represented only by sparse admixture of yellowish hairs. Scutellaris narrow but distinct, ochraceous yellow as mesosomal side. Metasomal tergum I entirely and anterior half of tergum II, broadly at middle, narrowly at side, ochraceous yellow, with sparse admixture of dark brown hairs; remainder of tergum II, III and anterior two thirds of IV blackish brown; tergum IV posteriorly, V, and sparse hairs on VI faded ochraceous orange. Sterna I ~ III marginally pale fulvous, IV ~ V as tergum V, all sterna with admixture of dark hairs, denser laterally. Legs dark brown, coxae, trochanters and femora basally below ochraceous yellow.

Structure.—Upper, maximum and lower interorbital distances, 36:46:42. Supraorbital punctures (Fig. 8M) 1.0 ~ 1.5 times larger than diameter of facets, slightly larger than, but essentially similar to those of *B. beaticola*, dense and rather irregular; interspaces weakly coriaceous and moderately shining, as wide as to two times wider than punctures; punctures on paraorbital corridor sparse, interspaces smooth and shining; postsupraorbital punctures dense, as large as or smaller than facets, interspaces average narrower than punctures, not becoming wider along postorbital margin; dorsal furrow distinct; suprafrontal punctures coarse and sparse, 2.0 ~ 2.5 times larger than facets. Relative measurements of vertex: Ocellocular distance 22, postocellar distance 25, ocelloccipital distance (cf. Fig. 5P) 25, distance between mid and lateral ocelli 6, diameters of mid and lateral ocelli 13, 12. Malar space nearly as long as wide, smooth except sparse, minute and ill-defined punctures on area slightly above mandibular base. Clypeus below with punctures slightly denser than in *B. beaticola* (Fig. 8E, F). Labrum as in *B. beaticola*; tubercles flat, shining but moderately coriaceous, with ill-defined punctures except coarser ones on lower slope; median furrow well depressed, granulate with fine and dense punctures; lamella distinctly curved, about one-third as wide as labrum. Mandible with basal punctures much denser than in *B. beaticola* (Fig. 8A–D), incisura lateralis distinct. Length : width ratios of flagellar segments : I (23:13.5), II (16:14), III (18:13.5), III slightly longer than in *B. beaticola* (III nearly l = w) (Fig. 9N, P). Median impunctate area of mesoscutum smooth and shining, maximum width about one-third distance between end of median line and posterior margin of sclerite. Metasomal terga finely tesselate but rather shining especially on IV and V, where punctures equal or slightly exceed size of facets, well defined and rather sparse with interspaces about 3 ~ 4 times puncture diameter except marginally where punctures denser and interspaces 2.0 ~ 3.5 times puncture diameter. Epipygium flat, granulate and weakly elevated, coriaceous with fine

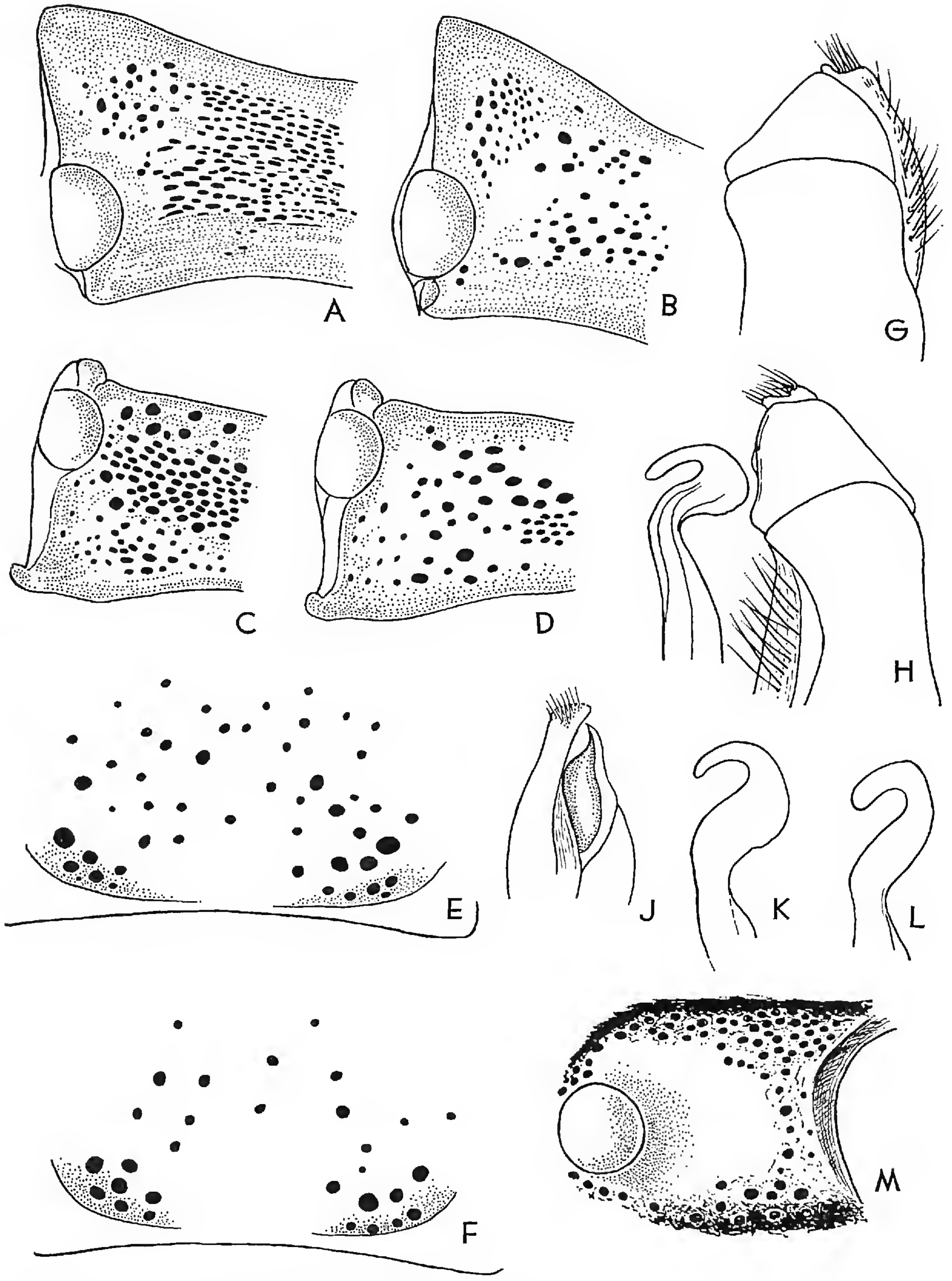

FIG. 8. Comparison of *B. flavus* (A,C,E,G,H,J,K,M) and *B. beaticola* (B,D,F,L). A,B. Base of right mandible (queen); C,D. Base of left mandible (worker); E, F. Punctation on lower part of worker clypeus; G,H. Apex of male genitalia dorsolateral and dorsal views; J. Inner depression of gonostylus; K,L. Apex of penis valve; M. Sculpture of ocellocular area (queen).

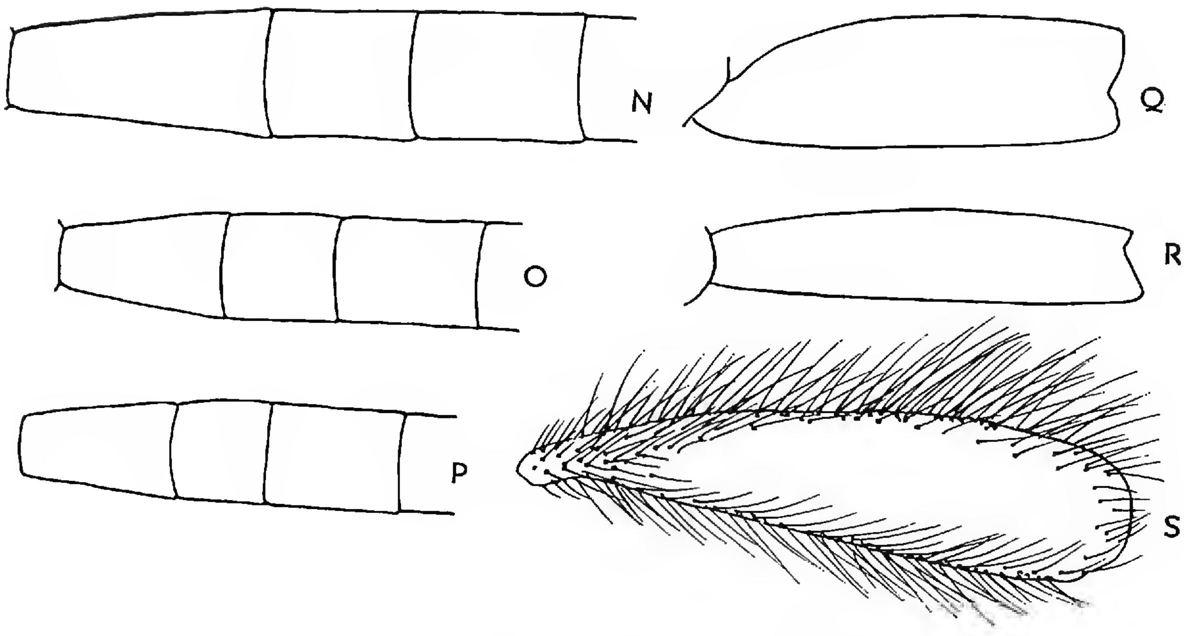

Fig. 9. *Bombus flavus*, continued. N,O,P. Basal flagellar segments (queen, male, worker); Q, R. Male hind and mid basitarsi; S. Male hind tibia.

and dense punctures. Hypopygium weakly ridged but nor carinate. Hind tibia shining but microscopically alutaceous except marginally and basally. Mid basitarsus shagreened but shining, posterior margin nearly straight. Hind basitarsus shagreened even basally, though less conspicuously than mid basitarsus, posterior margin gently curved.

Worker.—Body 11 ∼ 13 mm, forewing 9.5 ∼ 10.5 mm. *Structure.*—Similar to queen except certain caste-linked reductions of sculpture. *Hair color.*—Head as in queen but short hairs paler, occiput and gena behind with more ochraceous or yellowish long hairs. Other body parts ochraceous to yellow, with admixture of dark brown hairs in variable degrees on mesosomal disc and metasomal terga as shown later; terga IV ∼ V often more or less with dull orange tone in parallel with increased admixture of dark hairs on tergum III. Tibiae and tarsi dark brown; corbicular fringes ochraceous with admixture of dark brown hairs, especially posteriorly (Fig. 10d).

Male.—Body 11 ∼ 13 mm, forewing 9.5 ∼ 10.5 mm. *Hair color.*—Uniformly pale ochraceous to citron yellow. Mandibular beard orange yellow. Sparse dark brown hairs on vertex, gena, face along inner orbit and mesosomal disc, slightly denser centrally but rather uniformly distributed (Fig. 10d, III). Terga apically slightly paler, with no admixture of dark hairs.

Structure.—Upper, maximum and lower interorbital distances, 30:36:32. Supraorbital area essentially as in females, punctures slightly larger than facets, rather ill-defined though slightly more distinct than in *B. beaticola*; parafacettal corridor only sparsely punctured. Relative measurements on vertex : Ocellocular distance 18, postocellar distance 20, distance between mid and lateral ocelli 5, diameters of mid and lateral ocelli 10, 9. Malar space as in females but punctures finer, length : width as 25:21. Length : width ratios of flagellar segments : I (17:11, basal width 6), II (12:11), III (15:11) (Fig. 9O). Median impunctate area of mesoscutum smooth and very narrow, with sparse punctures along median line. Terga as in *B. beaticola*. Hind tibia well corbiculated (Fig.

9S), fringes longer than width of segment, upper surface slightly convex basally, flat apically, smooth and shining, slightly shagreened at base and posterior margin; apical bristles exceeding apex. Mid basitarsus (Fig. 9R) shining but shagreened, with hind margin slightly tapering apically. Hind basitarsus (Fig. 9Q) finely shagreened but more shining than mid basitarsus; posterior margin slightly tapering apically. Stipes wider than in *B. beaticola*, curvature of inner margin as in *B. modestus*, not *B. beaticola*, outer apical angle more distinctly curved than in *B. beaticola* (Fig. 8G, H). Penis valve rather parallel sided, apical hook with outer margin distinctly rounded and basally rather widened, tapering apically (Fig. 8H, K, L).

The identification of this species was possible by the courtesy of Dr. B. Tkalců. The original description is very short, only, "Asia centr., einfarbig gelb behaart." The males are structurally identical to the type as defined by a note and pencil sketches which Dr. Tkalců made from the type, and sent to me years ago for a different purpose, and by another more detailed note sent by him according to my request. The unique difference is the presence of sparse dark hairs in my specimens, which could be interpreted as an extreme of variation range. According to Dr. Tkalců, the specimen which he labelled as lectotype as preserved in the collection of the Zoologisches Museum der Humboldt Universität Berlins, with the following four labels: 1) Turkestan Kashgar 22. 7. 1900. 2) *Bombus pratorum* v. *flavus* Fr. ♂ 1904 Friese det. 3) *Bombus pratorum* v. *flavus* Fr. 4) Red label printed "type." The genitalia is separately pinned with a label as in 2) shown above. Dr. Tkalců informed me that the locality was false, the real locality being probably Szechuan or adjacent territories (cf. Tkalců, 1968a, p. 49, footnote). He also examined another nearly identical specimen from Tíen-mu-shan, China. Meanwhile, a single queen examined by me agrees well with the description of *B. klapperichi* Pittioni described from Fukien Province both in coloration and structure, except for: 1) Smaller size ($17 \sim 18$ mm in *B. klapperichi*). 2) Inner orbits slightly convergent below (parallel in *B. klapperichi*). 3) Distance between mid and lateral ocelli slightly longer (ratio to diameter of lateral ocellus 12:6 in *B. flavus*, $12: > 6$ in *B. klapperichi*). 4) Flagellum I $2w > 1$ in *B. flavus* $2w =$ ca.1 in *B. klapperichi*. These differences are regarded as lying within the variation range and 2) and 3) could be interpreted as an outcome of allometric change as shown in *B. trifasciatus*. Further the worker coloration is variable but approximately corresponds to *B. f. flavescentiformis*. Consequently it is concluded that *B. flavus*, so far known from the male alone, is conspecific with *B. klapperichi*, known only from

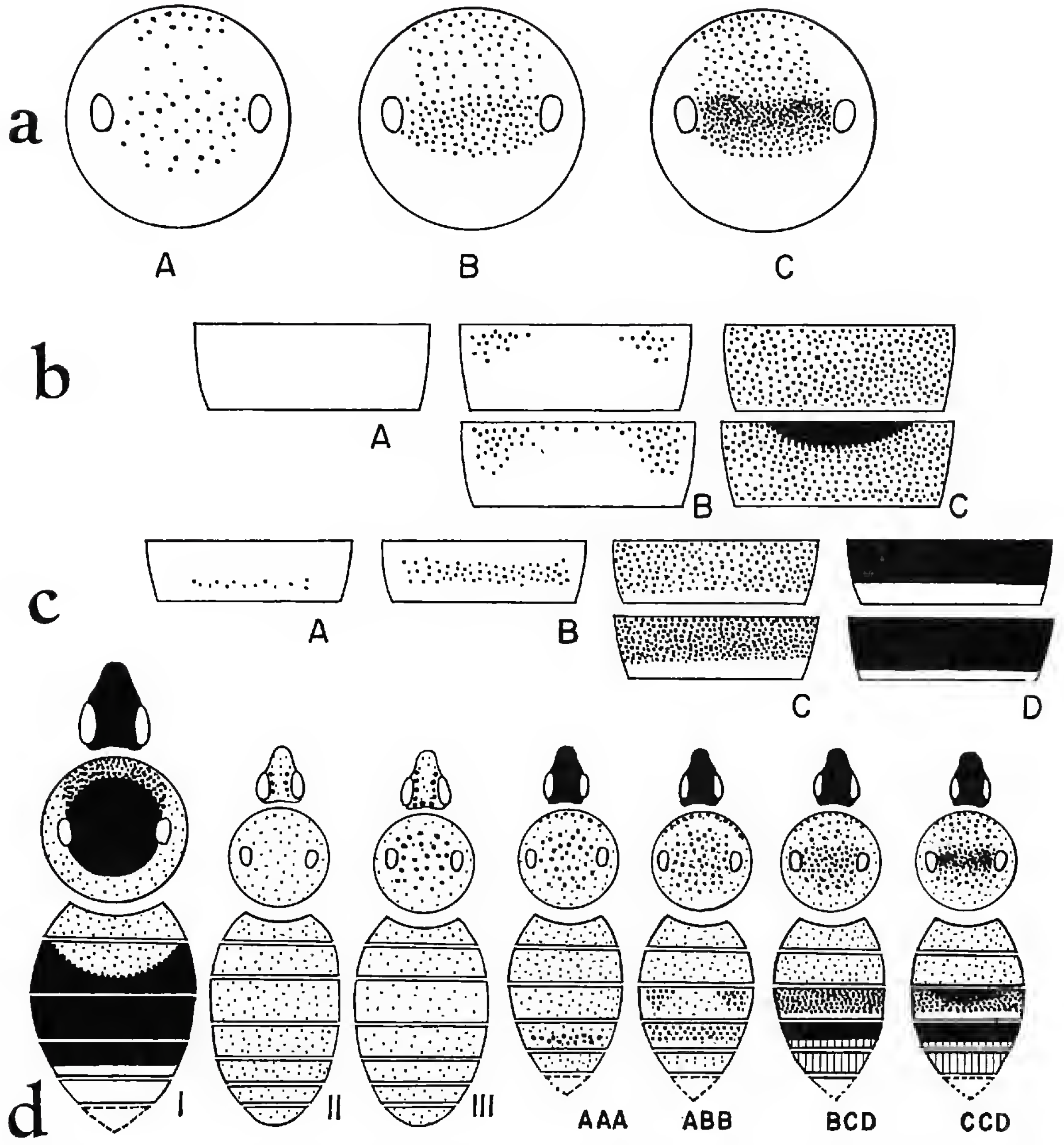

Fig. 10. Color variation in *B. flavus*. a. Mesosomal dorsum; b,c. Metasomal terga III and IV; d. Selected color patterns. I. Queen, II. Male type specimens (from note by Dr. Tkalců), III. Male recorded in text; Other showing representative patterns in worker.

the female, and the species has a wide distribution from Kwangtung to Szechuan, probably throughout Central and Southern parts of China, forming a southern and continental vicariant of *B. modestus* in Siberia and *B. beaticola* in Japan. Comparing with the synoptic table of the latter two species by Tkalců (1968a, p. 33), *B. flavus* is closer to *B. modestus* in relative lengths of flagellar segments and shape of stipes, but closer to *B. beaticola* in the less shagreened hind basitarsus.

In coloration the queen is comparable to *B. beaticola moshkarareppus* Sakagami et Ishikawa from Hokkaido, Northern Japan, by the prevalence of dark hairs on the face and mesosomal disc, but the pleura are broadly pale as in *B. b. beaticola* (Tkalců) from Central Japan (Sakagami and Ishikawa, 1969). The variation in workers is mainly caused by the degree of admixture of dark hairs on the mesosomal disc and metasomal terga III and IV, which positively correlates with an increase of dark hairs on head and corbicular fringes, as well as intensified orange tone on apical terga. The variability in mesosomal disc and metasomal terga III and IV, shown in Fig. 10a ~ c, results in various types of combinations, the frequency distribution of which in the specimens in good condition is: AAA (6 specimens), ABA (2), BAA (1), AAB (2), ABC (1), ABD (1), BCD (4), CCD (5), showing the presence of two dominant types, a paler type (AAA) and a queen like type (BCD, CCD). Thus the variation trend is precisely similar to that of *B. beaticola* (Sakagami and Ishikawa, 1969).

PSITHYRUS (METAPSITHYRUS) PIELI Maa

Psithyrus (*Metapsithyrus*) *pieli* Maa, 1948: 29, ♂, ♀.

SPECIMENS EXAMINED.—LK, 9 September, 1♀, 1♂.

Dr. B. Tkalců suggested this possible identification. Both specimens were in poor condition.

DISCUSSION

Excluding *Psithyrus* and the specimens collected in Luichow Peninsula, Kwangtung Province, all specimens examined are tabulated according to relative abundance and seasonal distribution as follows:

Number of specimens (♀-☿-♂)

	July	August			September			Total	
	late	early	mid	late	early	mid	late	(444)	
B. trifasciatus	0–25–0	0–27–0	0–77–1	0–83–0	0–88–3	0–23–3	0–7–1	0–330–7	337
B. imitator	0—2–0	0—1–0	0—1–1	0–11–3	0—1–1	0—8–3		0—27–8	35
B. flavus		0—2–0	0—6–0	0—7–2	1—5–2	0—1–0	0–1–0	1—24–4	29
B. pyrosoma	0—2–0	0—1–0			0—9–1	0—1–0	0–1–0	0—14–1	15
B. ignitus		0—5–0	0—3–0		0—1–0	0—3–0		0—12–0	12
B. atripes						0—2–1	0–3–0	0——5–1	6
B. breviceps							0–2–1	0——2–1	3
B. opulentus						0—0–1	0–1–1	0——1–2	3
B. kulingensis				1—2–0				0——2–0	3
B. flavescens		0—0–1						0——0–1	1

The relative abundance is strongly influenced by the overwhelming predominance of *B. trifasciatus* (75.5 % of all specimens), followed by *B. imitator* (7.8 %) and *B. flavus* (6.5 %). Although the collecting was limited to late summer to early fall, the relative abundance may reflect the quantitative makeup of the local fauna because of the long annual cycle of most bumble bees. Exceptions are expected in *Pyrobombus.* It is likely that some short-cycle species of this subgenus were not collected. The capture of males of *B. flavus* in late August and early September suggests that this species possesses a life cycle relatively longer than other *Pyrobombus.* But the capture records of males of an allied species, *B. beaticola* in Japan (Honshu, records at altitudes less than 2,000 m) show a remarkable variation: late May (1), late June (1), early July (1), mid July (12), late July (18), early August (18), late August (6), early September (17), mid September (2). Recently Meidell (1968) asserts that *Bombus* (*Pyrobombus*) *jonellus* (Kirby) possesses two generations per year in Norway. Naturally such opinion cannot uncritically be generalized to other species showing a wide variation of male appearance. But it is interesting to pursue this problem in various species of *Pyrobombus,* many of which are characterized by an ephemeral colony life which can be studied in part by checking the records of preserved specimens.

It is still premature to discuss the zoogeographical position of the bumble bee fauna of the area considered, which belongs, in the system by Panfilov (1957), to the Central Chinese Province in the Japan-China-Himalayan Subregion. He comments that the few studies in this province indicate only *B. atripes, B.* (*Adventribombus*) *unicolor* Friese and *B.* (*Hortobombus*) *supremus* F. Morawitz as typical of the area. Most species examined by me are those endemic to China Proper including: *B. trifasciatus, B. atripes, B. imitator, B. opulentus, B. flavus, B. pyrosoma, B. kulingensis* and *P. pieli.* One species, *B. ignitus,* reaches Japan and two, *B. breviceps* and *B. flavescens* South East Asia. On the other hand, no Euro-Siberian elements in the broadest sense are recognized, though some species are regarded "secondarily" as belonging to northern groups (*B. flavus* and *B. opulentus*).

Among the bumble bees studied, there is no instance of strict sympatric isochromy as recorded in South East Asia (e.g. Tkalců 1968c). The patterns recognized in the area studied are divided as follows:

1) Pale mesosoma with dark interalaris and trichromatic (pale, dark, reddish) metasoma. To this pattern belong the following

species with deviations from the model as given parenthetically: *B. trifasciatus* (♀, ☿, ♂. Interalaris often expanded), *B. kulingensis* (♀, ☿, ♂ unknown. Interalaris expanded), *B. flavus* (♀ and some ☿), *B. imitator* (♀, ☿, ♂. Interalaris often weakened). *B. ignitus* (♂, though not collected), *B. breviceps* (♀, ☿, ♂. Pale hairs distinctly darker), *B. pyrosoma* (☿, ♂. Considerably deviated from the model by weakening of interalaris, absence of dark metasomal band and in workers pale hairs nearly whitish).

2) Black with red tail. Widespread in the Palaearctics, isolately appearing in some Andean species. *B. ignitus* (♀, ☿), *B. flavescens* (partly).

3) Predominantly pale. *B. flavus* (♂, some ☿), *B. flavescens* (partly, though not captured from the area).

4) Bright orange fore body with dark venter, with or without dark apical terga. *B. opulentus*, *B. atripes*.

From this tabulation, it is easily recognized that the first mentioned pattern prevails in the area studied.

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Foraging and Nest Provisioning Behavior of the Oligolectic Bee, *Diadasia bituberculata*

(Hymenoptera: Anthophoridae)

ROBERT A. SCHLISING
Pasadena, California 91101

Among bees, oligolecty—a type of flower constancy in which the females of a species restrict their pollen-food foraging to a narrow range of plant types—is receiving considerable attention and is becoming fairly well known (Linsley and MacSwain, 1958; Stephen, Bohart and Torchio, 1969). Bees in the anthophorid genus *Diadasia* Patton are oligolectic (Linsley and MacSwain, 1957, 1958), most species restricting their pollen foraging to plants in the Malvaceae (*Sphaeralcea*, *Callirhoe*, *Sidalcea*, or *Sida*). Other species in this genus are oligolectic on *Opuntia* (Cactaceae), *Helianthus* (Compositae), *Clarkia* (Onagraceae), and *Convolvulus* (Convolvulaceae). One species, *Diadasia bituberculata* (Cresson), is known to be oligolectic on *Convolvulus* Linnaeus (many species of which have recently been transferred to the genus *Calystegia* Robert Brown). The purpose of the present study was to observe details of the pollen foraging and nest provisioning of this one bee species on one species of *Calystegia* (formerly *Convolvulus*).

Oligolectic bees commonly show inherited morphological and behavioral features which adapt these species for existence on a restricted number of food plants (Linsley, 1958). In *Diadasia bituberculata* these include elongated, specialized mouthparts that permit extraction of nectar from flowers with deep tubular corollas (Linsley and MacSwain, 1958), as well as seasonal and diurnal synchronization with flowering of its host plants. Michener (1951) lists the range of *D. bituberculata* as "California," an area in which several species of *Convolvulus* and *Calystegia* occur (Munz and Keck, 1959; Munz, 1968). Although different populations of *D. bituberculata* throughout its range utilize different species of *Convolvulus* or *Calystegia* as their pollen source, this report is limited to observations of these bees at flowers of *Calystegia fulcrata* (Gray) Brummitt at one locality.

This study was conducted in 1971, along Mineral King Road, 3.9 miles southeast of the junction with State Highway 198, near Three Rivers, Tulare County, California. This locality, in the hot dry foothills of the Sierra Nevada, at an elevation of 610 m, is covered

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by chaparral with dense shrubs often up to 3 or 4 m tall and trees considerably taller. The commonest woody plants on the steep slopes and in the draws here include: *Adenostoma fasciculatum* Hooker and Arnott, *Aesculus californica* (Spach) Nuttall, *Ceanothus cuneatus* (Hooker) Nuttall, *Eriodictyon californicum* (Hooker and Arnott) Torrey, *Fremontodendron californicum* Coville, *Mimulus longiflorus* (Nuttall) Grant, *Quercus chrysolepis* Liebmann, *Rhus diversiloba* Torrey and Gray, and *Umbellularia californica* (Hooker and Arnott) Nuttall. Both the bees and their "wild morning glory" food plants occur throughout the area—usually along rock outcroppings or other open and grassy spots in the chaparral, or along roadsides and fire trails.

The main pollen source of the bees here was a *Calystegia* population that occupied nearly 50 m of a narrow strip of east-facing roadbank, and grew with very few annual grasses and native herbs (Fig. 1). The creamy-white, nearly scentless flowers of *C. fulcrata* are tubular at the base, and flared or trumpet shaped at the top (Fig. 2). Nectar is secreted at the very base of the corolla tube in five nectary areas; pollen is located on anthers near the top of the tube. These two insect foods are available to foragers only from the early morning opening of the flowers to their wilting and closing by afternoon or earlier. The flowers last but one day (new flowers open each morning), so the total sequence of flower visitors during an individual flower's life can be rather easily studied. The flowering peak was in late May (Table 1), and flowering lasted about seven weeks in 1971, with a few flowers open on 6 May and none remaining on 5 July. Flowers were rather uniformly spread out over the population, but in several areas where the vines were particularly dense, there were as many as 25 to 30 flowers per m^2.

The nesting site of the bees was located about 200 m northwestward, around a corner and out of sight of the *Calystegia* food plants. Nests

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FIG. 1. Location of *Calystegia fulcrata* population, on lower chaparral-facing slopes of roadside bank, from foreground to curve of road in distance. FIG. 2. Stems and flowers of *C. fulcrata* (× 0.25). FIG. 3. *Diadasia bituberculata* nest site, with most burrows in three areas to left of arrows. FIG. 4. *D. bituberculata* female, with full scopal loads of *C. fulcrata* pollen (× 3). FIG. 5. *D. bituberculata* female from rear, showing dense plumose hairs of scopae, with very few pollen grains to left of arrow (× 4). FIG. 6. Two turrets, amid dried annuals at top of bank in Fig. 3, with turret entrance and top of tumulus to left of arrows (× 0.25). FIG. 7. Typical position (posed specimen), of *D. bituberculata* male in *C. fulcrata* flower, witth tongue reaching nectaries and dorsum of abdomen brushing stamens and (outlined) stigma (× 2).


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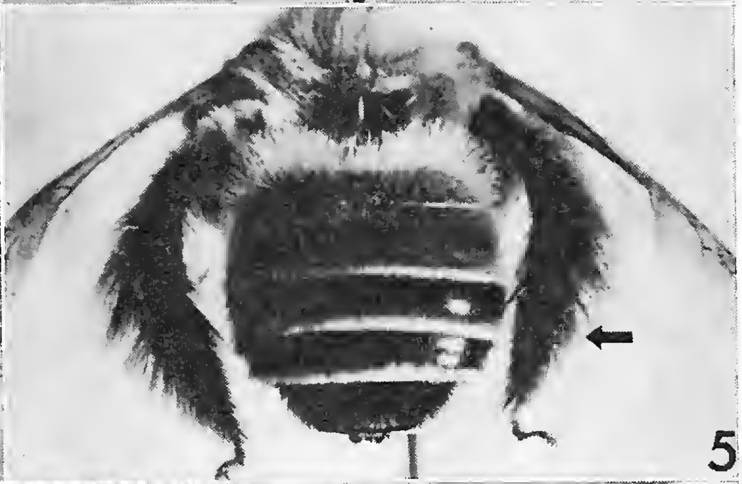
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TABLE 1. Dates and number of hours of observation in 1971, noon air temperatures (°C in shade 0.5 m above flowers and nests), and number of open *Calystegia* flowers in the main population.

Date		Total hours	Temperature	Open flowers
May	12	2.5	–	121
	13	5.0	22.5	235
	15	7.0	22.0	360
	16	7.25	17.0	375
	24	7.5	27.5	392
	25	6.0	28.5	373
June	4	6.25	24.0	285
	5	8.75	27.5	279
	10	2.0	–	–
	11	8.75	28.5	226
	12	6.0	32.5	223

were located in an exposed southeast-facing bank of the roadcut that was 3 m from the road and nearly devoid of vegetation (Fig. 3). A few plants of *C. fulcrata* grew on this bank, and several more occurred 50 m away on a fire trail, but it is believed that the nesting bees observed here primarily utilized the large population 200 m to the southeast.

The dates and numbers of observation hours here are listed in Table 1, along with noon air temperatures. No measurable precipitation occurred during the hours of observation, but weather records (U. S. Dep. Commer., 1971) for Three Rivers (elevation 290 m) show that the 7.37 cm of precipitation that occurred in May was 5.13 cm above the normal (based on a 30-year average) for the month; June precipitation was zero, or 0.53 cm below normal. Total annual precipitation averages 53.90 cm here. Most study days were sunny, with moderate breezes in the afternoons. The bees, particularly at the nest site, were very docile and could be watched at very close range. They appeared to be totally unaffected by observers sitting only decimeters away.

FEMALE FORAGING BEHAVIOR

Females of *Diadasia bituberculata* are completely reliant on *Calystegia fulcrata* for nest provisioning at this site, and emergence from nests and the beginning of foraging activity is synchronized with the frist availability of pollen. Anther dehiscence, which is regulated in some species by air temperature and relative humidity (Percival, 1965), was usually very early near Three Rivers. On 5 June the first female was seen at 5:10 a.m. (Pacific Standard Time), when some powdery, freshly dehisced pollen was available on the anthers, and in the next ten minutes visits by females became abundant. An overcast and humid morning inhibits both anther dehiscence and foraging activity of the bees. On 16 May, for example, flowers were fully open by 5:15 a.m. when it was light, but there was a heavy cloud cover and the air, at 10° C, was very moist with a gentle mist; female bees did not come to flowers that morning until 10:40, when the first anther dehiscence occurred. Nectar presentation seems to occur as or before the anthers dehisce.

A foraging female typically flies directly to, and "dives headlong" into a *Calystegia* flower, where she spends one to eight (rarely up to 30) seconds taking nectar by inserting her tongue into one to five of the nectaries at the base. Early in the morning the females may first probe the nectaries for a second or more in nearly each flower visited, but later in the day they may take nectar from fewer of the flowers visited (Table 2). Early in the morning each female spends an average of at least 2.5 times longer collecting pollen in individual flowers than she does later in the day. Mean pollen-collecting time for 6 bees was 23 seconds per flower at 5:30–6:30 a.m. and 9 seconds at 9:30–10:30 on 5 June (Table 2). Although Linsley and MacSwain (1957) noted that the elongated, specialized mouthparts of this species (Fig. 4) permit simultaneous gathering of pollen and nectar from *Convolvulus* flowers, females at this site very rarely took pollen from the anthers while also taking nectar. They consistently climb onto the anthers (which are well elevated above the nectar bearing areas) for pollen gathering *after* taking nectar—or they settle immediately on the anthers without taking nectar.

When collecting pollen, females usually position themselves on the outer surfaces of the anthers or slightly below them on the filaments, where they can rotate their bodies (sometimes buzzing loudly) inside the flower, one to three times around the cluster of five anthers. Pollen is removed with the forelegs and transferred to the scopae—the dense, plumose hairs on the hind legs (Figs. 4, 5). Occasionally a female sits *on top of* the five anthers a few seconds, grooming pollen from her face and thorax, but usually she flies from the flower immediately after taking pollen.

A female does not complete her pollen load with pollen from one flower only, but leaves a flower still bearing abundant pollen for other

TABLE 2. Representative timings (in seconds) of foraging by 4 females of *Diadasia bituberculata* in flowers of *Calystegia fulcrata* on the morning of 5 June.

Bee	Flowers visited	Nectar[a]	Pollen	Resting
1[b]	1	8	61	0
	2	0	20	0
	3	4	41	0
	4	0	47	0
	5	0	18	0
	6	0	28	8
		0	7[c]	0[d]
2[b]	1	7	45	4
	2	0	20	0
	3	3	10	0
	4	2	20	6
	5	1	19	0
	6	3	20	0
	7	3	43	0
	8	0	3	0
	9	3	4	0
	10	5	36	3
		0	6[c]	0
	11	2	32	9[d]
3[e]	1	0	8	0
	2	2	65	0
	3	0	9	0
	4	0	8	0
	5	0	6	0
	6	0	6	0
	7	0	5	0
	8	0	10	0
	9	0	2	0
	10	0	10	2
	11	0	8	0
4[e]	1	0	3	0
	2	0	3	0
	3	0	9	0
	4	0	5	0
	5	0	5	0
	6	0	13	0
	7	0	3	0
	8	0	3	0

[a] Nectar collection always preceded pollen collection in the same flower.

[b] Observed between 5:30–6:30. Bee started foraging with little or no pollen on scopae.

[c] Bee continued pollen collection after rest in same flower.

[d] Bee left flower (probably for nest) with full scopae.

[e] Observed between 9:30–10:30. It was possible to record only short series of uninterrupted flower-visit sequences at this time of day, due to the very fast and erratic flight patterns of the bees.

Calystegia flowers. To obtain "full" scopal loads of pollen (Fig. 4) a female may visit from five or six to perhaps 15 flowers early in the morning. When flowers are nearly depleted of pollen later in the day up to 30 or more flowers are visited to obtain loads, and some loads brought to nests later are much smaller. During the main pollen collecting period females may fly to, but immediately desert, flowers that still have pollen in them. Most flowers are frequently visited and foraged in—often by one bee a few seconds after another.

The times at which pollen foraging cease vary, apparently with weather conditions (and with times at which foraging starts) and with the number of females of *Diadasia* collecting from the limited number of flowers at one locality. In mid May, with lower air temperatures (Table 1), and possibly fewer females present, remaining pollen was still being collected at 3 p.m.—even if the flowers were already partially folded shut and wilted. But later in the season pollen supply was depleted and foraging was completed by about 12:30 p.m. on 24 May or even by 9:30 a.m. on 12 June. When the females cease pollen foraging (even as early as 9:30) they start nest construction, although visits to *Calystegia* flowers for nectar may continue through the afternoon. After pollen foraging was over for the day females were also seen utilizing three other herbaceous species for nectar (but not pollen) near the nest site: they were occasional in flowers of *Penstemon laetus* Gray and rare in flowers of *Clarkia speciosa* ssp. *polyantha* Lewis and Lewis and *Calochortus superbus* Purdy ex J. T. Howell.

All *Calystegia fulcrata* flowers examined at this site had the pollen removed by bees—probably by *D. bituberculata* in all cases—during study days, and there is no doubt that bees of both sexes, and particularly the females, bring about pollination of the flowers. During pollen collection, the style and stigma project above the parts grasped by the bees. But stigmas are frequently brushed as females enter, leave, or forage in flowers, and pollen is found lodged between the weakly appressed stigmatic lobes after *Diadasia* visits. These flowers, during their one-day life, commonly receive as many as 50 individual visits by the bees. Similar high numbers of bee visits per flower have been reported for tropical oligolectic bees closely related to *Diadasia,* to flowers related to *Calystegia* (Schlising, 1970). The situation at Three Rivers is remarkable however, because it is nearly individuals of one species alone—*D. bituberculata*—that exploit and pollinate the plants.

Female Nest Provisioning Behavior

At Three Rivers these bees utilized three areas of an eroded bank (Fig. 3) for their nests: 1) the nearly horizontal surface at the top, covered with short grasses and other low annuals (Fig. 6), 2) the exposed, nearly vertical, mineral soil surface, and 3) the nearly level deposits of soil washed down, sparsely covered with annual grasses. The densest aggregation of nests—27 per m^2—was on this flatter area only 2 m from the road edge. Most burrows had curving or straight horizontal turrets made of dried mud pellets covering the burrow entrances (Fig. 6); turrets varied from about 1.0 to 2.5 cm long, and entrances faced every direction.

Morning emergence of females from nests was observed on 5 June at 4:50 a.m., when the air temperature 20 cm above the nests was 10.5° C. The first bee seen to emerge flew in a small circle over the nests, then slowly to a *Calystegia* flower on a bank 2 m away, where she rested in the sun, took nectar, and finally pollen. During the next 15 minutes other females emerged, and by 5:15 were abundant at the main *Calystegia* population, collecting both nectar and pollen. Observations made during the night and also as these beees emerged indicate that surface plugs are not constructed to close burrow entrances when occupied by females at night.

When returning to her nest with a pollen load in the morning, a female typically enters her turret (or her burrow, if it has no turret), until she is barely but entirely within it (out of the sun), with her hind pollen-laden legs resting on the dorsum of her abdomen. Then, with a twitching of the hind tarsi the only visible motion of her body, she rests here for 0.25 to 7 (occasionally up to 15 or 17) minutes. Then she crawls down into the nest, and 4 to 8 squeaky buzzes, each about one second long, are heard as she removes the pollen from her scopae. After these buzzes, a female usually appears at the burrow entrance in a few seconds, and flies away immediately.

Such provisioning behavior is repeated throughout the foraging period. Variation in timing among different foragers is of interest, since all females were probably collecting pollen from the *Calystegia* 200 m from the nests. Representative provisioning timings are shown in Table 3 for four females followed over a 2-hour period on 5 June. Bee #1 averaged 8.0 minute trips in collecting apparently "full" loads of pollen (Fig. 4), while bees #2, #3 and #4 averaged 9.6, 14.2 and 21.0 minute trips in collecting similar loads. These same four bees averaged (respectively) periods of 5.3, 3.6, 2.2 and 1.0 minutes spent in the nest between foraging trips, so it appears that the faster

TABLE 3. Times of nest provisioning activities by 4 females of *Diadasia bituberculata* on 5 June, from 6:40–8:40 a.m.

Bee #1		Bee #2		Bee #3		Bee #4	
Return	Leaving	Return	Leaving	Return	Leaving	Return	Leaving
6:43	6:48	6:44	6:46	6:57	6:59	7:25	7:26
6:57	?[a]	6:59	7:00	7:14	7:16	8:04[b]	8:05
7:02	7:05	7:14	7:16	7:35	7:37	8:15	8:16
7:15	7:17	7:23	7:25	7:48	7:51	8:31	8:32
7:19	7:30	7:31	7:33	8:05	8:07		
7:35	7:37	7:41	7:47	8:25	8:27		
7:48	7:51	7:58	8:08	8:35			
8:02	8:11	8:16					
8:19	8:28						

[a] Flight from nest not seen.
[b] Longest (and highly atypical) foraging flight recorded during early morning.

foragers may spend longer periods in the nest. Foraging time periods later in the day became less uniform, for all individuals timed, as pollen became scarcer, and it commonly took 2 to 4 times longer for a forager to return with a pollen load. In-burrow periods also became longer and fluctuated more among individuals and within the population as a whole later in the day, until all bees ceased foraging and began new cell construction in the nests.

Later in the season, at least, foraging and cell provisioning are not alternated with new cell contruction while *Calystegia* pollen is still plentiful. On days when *Calystegia* pollen was being used up rather early, some bees were still collecting at 9:30–10:00 a.m., but others had turned to further cell excavation in their burrrows—not to return to foraging and provisioning of these cells until the next morning. Females of *D. consociata* Timberlake, on the other hand, may collect pollen throughout the day from *Sida hederacea* (Douglas) Torrey, and will make three or four pollen trips in succession (Linsley et al., 1952a), but apparently do not restrict their cell excavation activities only to times after pollen foraging is completed for the day.

During nest construction a female may alternate cell excavation with turret construction or repair. A few seconds after entering her burrow for excavation, a bee backs out, kicking pebbles of soil removed from below. Although the ground is very hard and dry where the nests are dug, these pebbles are moist; some are used to fashion the turret and the rest accumulate as a tumulus. Frequent flights away from the nest during construction serve in obtaining nectar as a source of energy and also in obtaining moisture used in wetting the hard soil. Bees in the genera *Ptilothrix* Smith (=*Emphor* Patton) and *Melitoma* Lepeletier and Serville, in the same tribe as *Diadasia*, are among the bees known to collect water used in moistening soil in nest construction (Grossbeck, 1911; Rau, 1930; Linsley et al., 1952a, 1956; Stephen et al., 1969). No species of *Diadasia* has been recorded as collecting water for nest construction, according to Linsley and MacSwain (1957), but these authors suggested the possibility of nectar being used in soil softening. Roy Snelling, of the Natural History Museum of Los Angeles County, Los Angeles, California, has observed females of *D. bituberculata* collecting nectar in *Penstemon* flowers in the San Gabriel Mountains of Los Angeles County, and feels that such nectar may the the liquid used to soften soil in nest construction (personal communication). The very short periods excavating bees spent away from their nests at Three Rivers suggest a source of liquid close by. Close freewater sources were examined during excavation periods, but no *Diadasia* individuals were seen taking water. Females were collected nearby taking nectar from the four species already listed; the use of nectar from these or other flowers in nest construction is very probable but has yet to be demonstrated with certainty here.

While observations were not made on below ground aspects of the nests, information is available for several species of *Diadasia*, including *D. bituberculata*, on various aspects of burrow and cell structure, nest contents, parasites, larval overwintering, and adult emergences (Linsley and MacSwain, 1952, 1957; Linsley et al., 1952a, 1952b). Although there is no published record on number of cells per nest for this species, Linsley and MacSwain (1957) listed anywhere from 1 to 42 cells per nest for other species of *Diadasia*, and noted that nesting habits for *D. bituberculata* are similar to those of *D. consociata*, which produces 1 to 15 (commonly 5 to 10) cells per burrow. Of the 10 females observed provisioning and then excavating on 5 June here, only one was still working at the same nest 6 days later. It is not known how long a female takes to completely provision one nest, but Linsley et al. (1952a) have recorded females of *D. consociata* taking as long as 5 or 6 weeks to construct and provision a burrow with 10 or more cells. They also noted that females of *D. consociata* may construct more than one burrow; this may be true of *D. bituberculata* as well, for between 25 May and 12 June at Three Rivers new nests were continually being initiated. After nests were provisioned, some females completely removed their turrets and filled the burrows to the surface with pieces of turret and soil from the tumulus.

Male Behavior and Mating

At Three Rivers males of *D. bituberculata* are found from about 6:30 a.m. to 3:30 p.m. or later visiting flowers of *C. fulcrata* during a characteristic cruising flight over the plants. They follow a low, zig-zag flight 10 to 30 cm above the flowers, as if searching for females, and enter only 5% of the open flowers. A male may fly directly into a flower, and while rotating his body in the corolla, take nectar from three to five of the nectaries. Nectar visits last from one or two (usually four or five) to 25 seconds, and while the tongue is inserted into the nectar, the abdomen and hind legs extend into the area of anthers and stigma (Fig. 7). Males often rest for up to 2.5 minutes, with legs on one side of the body on the anthers and stigma and legs of the other side on petals, or with the body curled around the stamens at the level of the anthers or lower. In either position, a male may sit quietly, or—often with considerable squirming—groom head and thorax with the front legs. These males usually have abundant pollen on abdomen and legs; they frequently brush the stigma when entering or leaving, or while in a flower, and undoubtedly promote pollination.

While most commonly observed cruising *Calystegia* flowers, males can also be found flying over the nest site. At Three Rivers males were also found in flowers of the three species of plants utilized for nectar by females. They were common in the deep tubular flowers of *Penstemon laetus* and in the cup-shaped flowers of *Clarkia speciosa* ssp. *polyantha*, and were rare in the cup-shaped flowers of *Calochortus superbus*. These flowers are utilized by males as nectar sources and as resting places, mostly, but not exclusively, later in the day when *Calystegia* flowers are partially or totally closed. *Penstemon* flowers as well as closed *Calystegia* flowers had sluggishly active males in them late in the afternoon, but numerous flowers pinched at night contained no sleeping males, and it is not known where males spend the night.

Mating of *D. bituberculata* bees was reported by Linsley et al. (1952a) as occurring in flowers of *Convolvulus*; at Three Rivers mating may occur in flowers of three species. Bee encounters thought to be matings were observed once only in flowers of both *Clarkia* and *Calochortus*. Mating was more clearly seen on two occasions (13 May at 10:00 a.m. and 5 June at 6:40 a.m.), commencing in flowers of *Calystegia fulcrata.* In each case a cruising male pounced on a pollen-collecting female, and with a loud buzzing fell from the flower to the ground with her. In the first encounter the bees remained in contact on the ground for eight or ten seconds before separating and flying off. The other encounter lasted about five seconds; the male then flew off, and the female flew to another flower and continued pollen collecting. The very few matings seen during the 67 hours of observations suggest that mating may mainly occur at the beginning of the foraging season here (which probably began one week or more before observations started on 12 May). Observations here do show agreement with the suggestion of Linsley et al. (1952a), that males persist throughout the nesting season.

DEPENDENCE OF DIADASIA BITUBERCULATA ON CALYSTEGIA

Linsley and MacSwain (1958) and Stephen et al. (1969) emphasized that the pollen food-plant restriction called oligolecty must be considered a *relative* phenomenon, with some species more highly oligolectic than others. Some bees that are typically highly oligolectic may turn to other plants in times of shortage of their "preferred" pollen sources. For example, *Diadasia australis californica* Timberlake, a desert cactus oligolege, has been found collecting pollen from nearby *Phacelia* flowers when the local cactus pollen supply was exhausted (Linsley and MacSwain, 1957, 1958). All females of *D. bituberculata* examined at Three Rivers had only *C. fulcrata* pollen on their scopae. Yet, the very beginning or end of the foraging season was not studied here and it may be interesting to see if these bees are less faithful in pollen collecting early in the season or during the final days of foraging when the preferred pollen sources are very scarce. Throughout its entire geographic range however, Linsley and MacSwain (1957) believe that none of the oligolectic species of *Diadasia* is restricted to a single species of a plant genus. They encountered *D. bituberculata* in several localities, but always taking pollen only from the introduced and weedy *Convolvulus arvensis* Linnaeus; they suspected that this species also visited native and less widely distributed species of plants in this group. This bee is able to utilize at least four plant species, for during the spring of 1971 pollen-taking females of *D. bituberculata* were collected on three native species of *Calystegia* in different localities in California: *C. fulcrata*, in Tulare, Kern and Los Angeles Counties; *C. longipes* (Watson) Brummitt, in Tulare and Kern Counties; and *C. purpurata* (Greene) Brummitt, in Ventura County.

Stephen et al. (1969) have noted that some bees that are highly oligolectic in collecting pollen also take nectar from a very limited number of species, and Linsley (1958) noted that in some cases male flower response may be as specific as that of the female. At Three Rivers in 1971 both sexes of *D. bituberculata* were found taking nectar from no more than the four species listed earlier (*Calystegia*, *Penstemon*, *Clarkia* and *Calochortus*), although flowers of many species were searched for the bees. The perennial *Calystegia fulcrata*, the preferred pollen source, probably also serves as the preferred nectar source each year; the same plants of *Penstemon* and *Calochortus*, also perennials, may be utilized each season as well. Compared with nectar sources listed for some other species of *Diadasia* (Linsley and MacSwain, 1957; Linsley et al., 1952a), the nectar plants known for *D. bituberculata* at Three Rivers are a restricted set.

Since these bees restrict their foraging to few plants it was of interest to record the possible competitors they have, and the total range of *C. fulcrata* flower visitors was sampled at Three Rivers. Other than a very occasional ant or clerid beetle, bees were the only flower visitors. Only a few instances of pollen collection were noted during the study period, by females of *Halictus farinosus* Smith and *Lasioglossum punctatoventre* (Crawford), so females of *D. bituberculata* had essentially no competition for pollen here. (Linsley et al., 1952a, similarly noted that the oligolectic *D. consociata* had no competition for pollen on *Sida hederacea.*) *Calystegia* nectar was taken by *Emphoropsis rugosissima* Cockerell, *Osmia gabrielis* Cockerell, *O. nemoris* Sandhouse, *O. subaustralis* Cockerell, and *Synhalonia stretchii* (Cresson), but it seems very unlikely that these nectar collectors were ever common enough to diminish the supply of nectar needed by *Diadasia* bees. Thus, in 1971 this population of *D. bituberculata* had very little competition for food—in spite of their flower visits being restricted to only one plant species for pollen and to only four species for nectar.

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Flower Visitation Records for Butterflies
(Lepidoptera)

OAKLEY SHIELDS
Department of Entomology, University of California, Davis, California 95616

Interrelationships of plants and insects are of great evolutionary importance. Recent evidence suggests that pollinators and flowers have largely coevolved through time. This paper presents some flower visitation records for butterflies and briefly discusses the interaction of adult butterflies and flower food sources.

Butterflies are an extremely well-known group of organisms. The sheer volume of literature on them staggers the imagination. To my knowledge, no one has collected together the flower-feeding records. No attempt is made here to undertake more than a modest overview, being a survey of sources readily available to me. However, it is apparent that strongly suggestive correlations emerge which are worth considering.

Recently three sources dealing with "intrafloral ecology" have reviewed much of the accumulated knowledge: Baker and Hurd (1968), Stebbins (1970), and Faegri and Pijl (1971). Grant and Grant (1965) give extensive records for insect pollinators of the Polemoniaceae, including 45 butterfly species; these were not duplicated in the records here. An important old paper that has apparently escaped the attention of recent reviewers is that of Robertson (1895). He says, "There are few evident butterfly-flowers. The best of them are commonly visited by long-tongued bees and flies." The field is young and open to speculation.

Other work of note includes Knuth (1906), Robertson (1928), Hingston (1930), Carpenter (1946), Hamm (1948), Clench (1955), Dronamraju (1960), Dronamraju and Spurway (1960), and Emmel (1971). This latter gives a detailed report on the symbiotic relationship of a large hesperine skipper and a *Maxillaria* orchid; it possesses a 43 mm proboscis flexed at several points to probe the coiled corolla tube of the orchid!

Since my knowledge of botany is nil, little attempt is made to interpret the data but rather it is presented in accessible form for botanists. The most striking fact, it seems to me, is that in four separate lines (Ranunculales, Theales, Violales, and Saxifragales), series of rather closely related groups are visited, indicating perhaps

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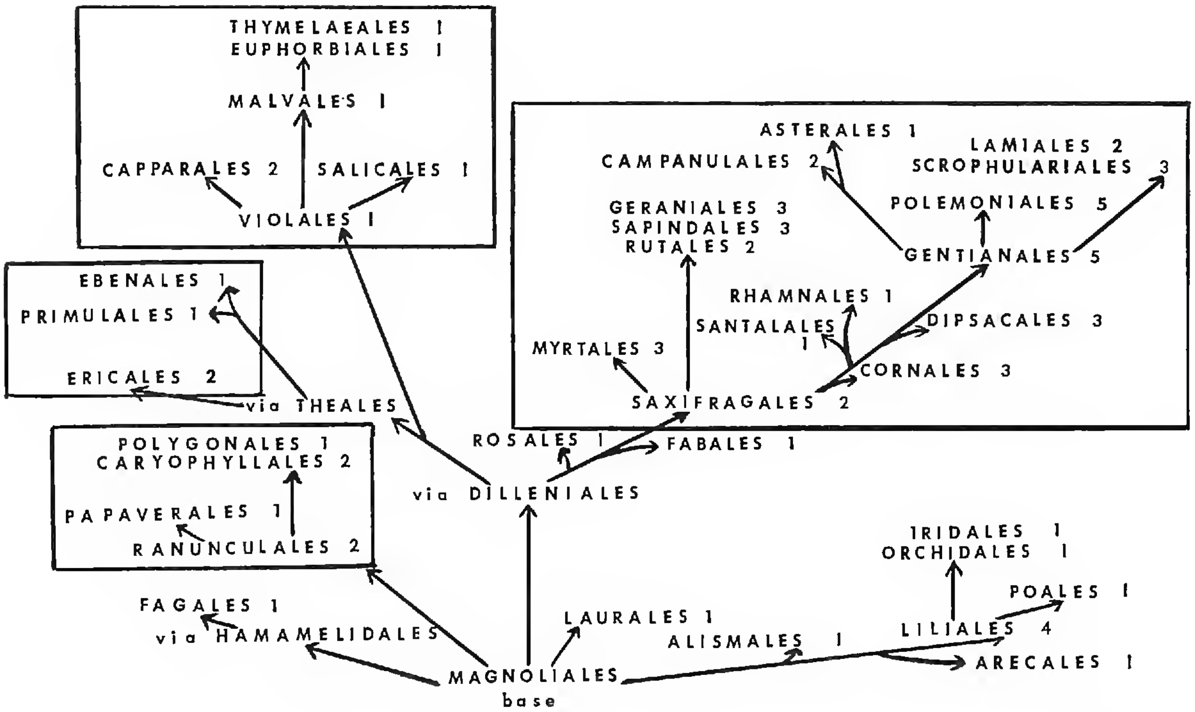

FIG. 1. Plant relationships for butterfly visitations, based on the classification of Takhtajan (1969: fig. 31) (number of plant families used given for each order)[1].

that those groups are interrelated, as the massive botanic evidence strongly suggests (Fig. 1). One would not expect such close similarities if the flower-preference habit developed at random. But 29 of the possible 94 orders are fairly linearly related (in four groups) and only 10 orders more "distantly" related are used. The most primitive dicot orders and the line from Magnoliales through Hamamelidales appear not to be used for the most part, and the monocots are only spottily visited (except Liliales). The flowers chosen by the widest variety of butterfly subfamilies (five or more) include Apocynaceae, Asclepiadaceae, Boraginaceae, Compositae, Cruciferae, Hippocastanaceae, Hydrophyllaceae, Labiatae, Leguminosae, Polygonaceae, Rubiaceae, and Verbenaceae. The commonest family used is Compositae, with 29 genera. The highest similarity in plant orders utilized by two butterfly subfamilies (44%) were the Lycaeninae-Nymphalinae and Hesperiinae-Pyrginae lines. More definitive conclusions must await further data. It has been my experience that butterflies do indeed have "preferred" flowers in a given habitat and usually fly past many flower species.

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[1] Those families reported in Robertson (1928; records therein are not listed here) that are in addition to those already recorded are Acanthaceae, Acearaceae, Alismaceae, Balsaminaceae, Campanulaceae, Caryophyllaceae, Convolvulaceae, Dipsaceae, Ebenaceae, Fumariaceae, Gentianaceae, Lobeliaceae, Lythraceae, Oxalidaceae, Polemoniaceae, Pontederiaceae, Primulaceae, Santalaceae, Staphyleaceae, and Valerianaceae.

An intriguing possibility exists here. The butterfly and flower may be evolving within the same habitat, so that a particular flower array may accompany a constellation of butterfly forms through time. Butterflies appear for the most part to be promiscuous in their feeding habits, visiting a variety of the "preferred" types.

According to Faegri and Pijl (1971), butterflies alight on a blossom margin to feed. They characterize the preferred butterfly flowers (psychophily) as being diurnal; no closing at night; weak, pleasant odor; vividly colored; blossom rim not very dissected; erect, radial blossom with flat, often narrow rim; ample nectar hidden in narrow tubes or spurs; and nectar or tongue guide present.

Butterflies often walk over a cluster of blossoms while feeding; thus, pollen could be carried by their legs (e.g., the pollinia of *Asclepias* are pulled out by the monarch butterfly's legs) and bodies. Many butterflies have hair trailing along the inner surface of the hind wing upperside, on the upper and undersurface of the thorax, and the face, which may be important in picking up pollen, as well as the proboscis itself, leg setae, and leg hooks. Hingston (1930) reports an instance where pollen from a *Gloriosa* lily is shaken on the visiting *Papilio* by the action of its wingbeat when feeding. However, the rather casual visitation of flowers by some species may not effect pollen transfer (Percival, 1965: 187). It remains a problem to discriminate between pollen transfer and casual visitation.

Flower feeding by butterflies is often in company with Hymenoptera (especially), Coleoptera, Diptera, and others, e.g. on *Chrysothamnus*, *Cirsium*, *Eriodictyon*, *Eriogonum*, *Melilotus*, *Monardella*, *Prunus*, *Rhus*, and *Solidago*. In the case of *Mimulus*, the pollinators are humming birds, bumble bees, sphingids, and *Papilio* butterflies. In a few instances, butterfly adults feed on the same plant species as their larvae do (*Colias eurytheme* on *Medicago sativa*, *Danaus plexippus* on *Asclepias*, and *Apodemia mormo* and *Philotes rita*, *battoides*, and *enoptes* on *Eriogonum*), but more usually the butterfly adult feeds on plants *other than* its larval foodplant (Faegri and Pijl, 1971: 133). Often the larval foodplant is not in bloom when the butterfly adult is on wing; or if it is, its flowers are usually not attractive to that species.

Many of the flower records given, as far as I can tell, constitute regular rather than casual visitation, but no attempt has been made to distinguish these from rare visits. I once noticed a worn male *Euphydryas chalcedona* avidly feeding on *Sambucus mexicana* blooms, 16 June 1971, Thompson Canyon, just NE of Monticello Dam, Yolo

Co., Calif., on a hot, humid day. *Sambucus* is almost never visited by butterflies, in my experience, but there were few other flowers in bloom on this date.

It may be of evolutionary significance that butterflies of the subfamily Megathyminae (larvae in Agavaceae), generally considered one of the most primitive groups of skippers, do not flower feed but do take moisture along creeks, damp sand, etc. Certain butterfly species with fresh (usually) to worn winged males and worn females will visit moisture. Other non-flower sources for butterflies include carrion, honey dew, rotting fruit, tree sap from wounds, dung, and urine. Thus, perhaps it would have been possible for butterflies to survive at a time when no flowers were available for food, i.e. before the advent of angiosperm flowers (e.g. some lycaenids in Africa feed on lichens as larvae).

Nocturnal feeding at flowers by moths must be extensive since there are about ten times as many moths as butterflies. Though certainly of great interest to evolutionists, this will be difficult data to acquire.

The butterfly *Eumaeus atala* in Florida feeds as an adult on *Serenoa* (Palmae) and *Bidens* (Compositae), while its larva eats *Zamea integrifolia* (Cycadaceae) (Klots, 1951). *Serenoa* being a small palm, and the relationship of Lycaeninae to the other butterflies at present being obscure and ancient, one wonders about a possible early Mesozoic association between *Serenoa*, *Zamea*, and *Eumaeus*.

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BUTTERFLY RECORDS FOR FLOWER VISITATION

AGAVACEAE
  Nolina microcarpa: *Erora quaderna* 45[2]
AMARYLLIDACEAE
  Allium douglasi: *Mitoura spinetorum* 54
  Brodiaea sp.: *Battus philenor hirsuta*, *Erynnis tristis*, *Papilio zelicaon* (all 69)
  Brodiaea pulchra: *Battus philenor hirsuta* 69
ANACARDIACEAE
  Rhus glabra: *Chlosyne nycteis* 25

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[2] Numbers refer to literature cited at the end of this article.

Rhus trilobata: *Callophrys apama homoperplexa* 71, *C. comstocki*, *Incisalia iroides*, *Mitoura johnsoni* (all 69), *M. spinetorum* 54

APOCYNACEAE

Apocynum sp.: *Apodemia nais* 3, *Chlosyne leanira* ssp., *C. palla*, *Emesis zela* (all 69), *Epargyreus clarus* 62, *Euphydryas anicia* 3, *Hesperia harpalus oregonia* 53, *Limenitis lorquini* 69, *Lycaena editha* 69, *Phyciodes campestris* 53, *Piruna pirus* 3, *Satyrium liparops* 62, *S. sylvinus* 69, *Speyeria egleis* ssp. 69, *S. hydaspe purpurascens* 53, *S. zerene conchyliatus* 53

Apocynum androsaemifolium: *Speyeria callippe juba* 71

Apocynum cannabinum: *Chlosyne nycteis* 25, *Lephelisca borealis* 57, *Limenitis archippus* 71, *Satyrium alcestis* 41, *S. falacer* 7 & 8, *S. liparops strigosum* 8, *S. ontario* 8

Trachelospermum sp.: *Atlides halesus* 29, *Papilio polydamas* 29

ARALIACEAE

Aralia hispida: *Colias interior* 29

ASCLEPIADACEAE

Asclepias incarnata: *Atrytone conspicua* 29, *Chlosyne nycteis* 25, *Danaus plexippus* 6, *Poanes massasoit* 29, *Speyeria cybele* 6, *S. idalia* 6

Asclepias syriaca: *Danaus plexippus* 6, *Epargyreus clarus* 8, *Satyrium acadica* 52, *S. falacer* 7, *S. liparops* 62, *S. titus mopsus* 6, *Speyeria cybele* 6 & 8

Asclepias tuberosa: *Chlosyne ismeria* 41, *C. nycteis* 25, *Colias philodice*, *Danaus plexippus*, *Everes comyntas* (all 6), *Nathalis iole* 41, *Phyciodes tharos* 6, *Satyrium falacer*, *S. ontario autolycus*, *S. titus mopsus* (all 41), *Speyeria cybele* 8, *Vanessa cardui* 41

BERBERIDACEAE

Berberis sp.: *Incisalia eryphon* 71, *Mitoura spinetorum* 54

BORAGINACEAE

Echium vulgare: *Achalarus lyciades*, *Thorybes bathyllus*, *T. pylades* (all 8)

Heliotropium sp.: *Cercyonis silvestris* 69, *Lycorea ceres atergatis* (to dried plant) 34, *Pseudocopaeodes eunus* 69

Heliotropium indicum (dried plants): *Danaus plexippus*, *Hymenitis andromica*, *Hypothyris euclea*, *Ithomia drymo*, *Lycorea ceres*, *Mechanitis isthmia*, *Melinaea lilis*, *Tithorea harmonia* (all 21)

Tournefortia argentia (dead twigs): *Danaus melissa* 21, *Euploea* ssp. 21

CAPPARIDACEAE

Cleome serrulata: *Papilio bairdii brucei* 69

CAPRIFOLIACEAE

Sambucus coerulea: *Mitoura spinetorum* 54

Triosteum perfoliatum: *Speyeria cybele* 6

COMPOSITAE

Achillea sp.: *Euphydryas editha baroni*, *Lycaena editha*, *Mitoura nelsoni* (all 69), *M. spinetorum* 54, *Satyrium californica* 53, *S. dryope* 69, *Speyeria atlantis nausicaa* 69

Achillea millefolium: *Lycaena nivalis* 35, *Satyrium falacer* 7

Ageratum sp.: *Papilio polydorus queenslandicus* 2

Anaphalis sp.: *Mitoura spinetorum* 54

Anaphalis margaritacea: *Callophrys apama homoperplexa*, *Mitoura siva*, *M. spinetorum* (all 71)

Antennaria sp.: *Incisalia augustinus* 6, *I. niphon* 6

Antennaria parvifolia: *Mitoura spinetorum* 54
Arnica alpina: *Colias nastes* 66
Arnica cordifolia: *Lycaena rubidus* 9
Aster sp.: *Colias croceus*, *Gonepteryx rhamni*, *Lycaena phlaeas*, *Maniola jurtina*, *Nymphalis io*, *N. urticae*, *Pieris brassicae*, *P. rapae*, *Polygonia c-album*, *Polyommatus icarus*, *Vanessa atalanta*, *V. cardui* (all 24)
Aster canescens: *Lycaena mariposa* 9
Baccharis sp.: *Libytheana bachmanii* 70
Baccharis sarothroides: *Hylephila phylaeus* 69
Bidens sp.: *Atlides halesus*, *Eumaeus atala*, *Hemiargus thomasi*, *Strymon maesites* (all 29)
Carduus californicus: *Speyeria nokomis apacheana* 9
Chrysanthemum leucanthemum var. *pinnatifidum*: *Satyrium falacer* 7
Chrysothamnus sp.: *Hesperia harpalus* 69, *H. h. leussleri* 3, *H. juba* 69, *Libytheana bachmanii* 71, *Satyrium acadica coolinensis* 50, *Speyeria callippe* ssp. 71
Chrysothamnus nauseosus: *Speyeria egleis tehachapina* 15
Cirsium sp.: *Hesperia columbia*, *H. harpalus dodgei*, *H. lindseyi* (all 33), *Satyrium falacer* 7
Cirsium arvense: *Danaus plexippus* 22
Cirsium vulgare: *Danaus plexippus* 22
Coreopsis sp.: *Zerene cesonia* 58
Coreopsis lanceolata: *Chlosyne gorgone* 32, *Lephelisca virginiensis* 32
Echinacea pallida: *Chlosyne nycteis* 25
Erigeron sp.: *Chlosyne damoetas malcolmi* 69, *Mitoura spinetorum* 54
Erigeron philadelphicus: *Boloria selene* 36
Erigeron ?strigosus: *Satyrium falacer* 7
Eriophyllum lanatum: *Lycaena nivalis* 35
Eupatorium sp.: *Limenitis archippus* 71
Eupatorium coelestinum: *Ancyloxypha numitor*, *Hylephila phylaeus*, *Precis lavinia coenia* (all 6)
Eupatorium purpureum: *Danaus plexippus* 6, *Hesperia leonardus* 6
Gaillardia sp.: *Mitoura spinetorum* 71
Gnaphalium sp.: *Incisalia niphon* 6, *Polygonia gracilis* 29
Grindelia sp., probably: *Ochlodes yuma* 71
Haplopappus sp.: *Mitoura siva* 71, *M. spinetorum* 54, *Speyeria callippe* 69
Haplopappus bloomeri: *Hesperia harpalus yosemite* 65
Haplopappus linearifolius: *Mitoura loki* 69
Helenium sp.: *Mitoura spinetorum* 54, *Speyeria atlantis nikias* 71
Helenium autumnale: *Euptoieta claudia* 40, *Phyciodes tharos* 40
Helianthus annuus: *Satyrium calanus* 32
Pluchea camphorata: *Chlosyne nycteis* 25
Rudbeckia sp.: *Atrytone arogos iowa* 3
Rudbeckia laciniata: *Speyeria zerene platina* 3
Senecio sp.: *Parnassius clodius baldur* 20, *Speyeria callippe* ssp. 3 & 71
Senecio douglasii monoensis: *Mitoura spinetorum* 54
Senecio longilobus: *Sandia macfarlandi* 28
Solidago sp.: *Cercyonis boopis*, *Danaus plexippus*, *Mitoura nelsoni*, *Neophasia*

menapia, *Pholisora libya*, *Satyrium dryope* (all 69), *S. saepium* 3, *Speyeria nokomis apacheana* 69

Solidago canadensis: *Danaus plexippus* 6

Solidago gigantea, probably: *Callipsyche behrii* 12, *Mitoura nelsoni* 12, *M. spinetorum* 12 & 54, *Satyrium californica* 12

Vernonia sp.: *Autochton cellus* 29

Wyethia, or *Balsamorhiza* sp.: *Parnassius clodius sol* 69, *Speyeria callippe juba* 69, *S. c. nevadensis* 20, *S. coronis* ssp., *S. cybele leto*, *S. hydaspe*, *S. zerene* (all 53 & 69)

Zinnia sp.: *Chlosyne nycteis* 25

CORNACEAE

Cornus canadensis: *Mitoura johnsoni* 54

CRASSULACEAE

Dudleya cymosa: *Papilio indra* 69

Sedum sp.: *Speyeria callippe* ssp. 3

CRUCIFERAE

Arabis blepharophylla: *Incisalia fotis bayensis* 69

Barbarea vulgaris: *Strymon melinus* 6

Brassica sp.: *Anthocaris cethura*, *Colias eurytheme*, *Erynnis tristis* (all 69), *Incisalia niphon* 6, *Leptotes marina* 69, *Speyeria callippe comstocki* 71, *Strymon melinus* 69, *Vanessa carye* 69

Brassica nigra: *Pieris rapae* 69

Cardamine bulbosa: *Incisalia niphon* 47

Erysimum sp.: *Speyeria callippe macaria* 51

Erysimum asperum: *Parnassius clodius baldur* 19, *Papilio zelicaon* 20

Rorippa sp.: *Emesis zela* 69, *Mitoura johnsoni* 54

Sisymbrium loeseli: *Lycaena rubidus*, *Polygonia zephyrus*, *Speyeria zerene cynna* (all 69)

ERICACEAE

Arctostaphylos sp.: *Mitoura spinetorum* 54

Arctostaphylos nevadensis: *Mitoura johnsoni* 54

Gaylussacia sp.: *Incisalia henrici* 29

Rhododendron sp.: *Tros philoxenus* 68

Vaccinium sp.: *Graphium marcellus* 6, *Incisalia henrici* 29, *I. niphon* 6, *Thorybes pylades* 6

EUPHORBIACEAE

Croton sp.: *Libytheana bachmanii* 71

Croton linearis: *Lerodea eufala* 48

Poinsettia sp.: *Pratapa cleobis* 68

FAGACEAE

Castanopsis sp.: *Satyrium kingi* 11

GERANIACEAE

Erodium cicutarium: *Vanessa cardui* 30

GRAMINEAE

Sorghum sp.: *Libytheana bachmanii larvata* 70

HIPPOCASTANACEAE

Aesculus sp.: *Aporia leucodyce*, *Delias belladonna*, *Tros philoxenus*, *Zetides cloanthus*, *Z. sarpedon* (all 68)

Aesculus californica: *Chlosyne leanira* 69, *Epargyreus clarus* 20, *Euphydryas* *chalcedona* 20, *Incisalia iroides*, *Mitoura spinetorum*, *Ochlodes agricola* (all 69), *Satyrium adenostomatis* 53, *S. auretorum* 20 & 53, *S. saepium* 20 & 53, *Speyeria callippe inornata* 69, *S. egleis atossa* 9

HYDROPHYLLACEAE

Eriodictyon sp.: *Atlides halesus*, *Celastrina argiolus echo*, *Cercyonis silvestris paulus*, *Euphydryas editha baroni*, *E. chalcedona*, *Heliopetes ericetorum*, *Hemiargus isola*, *Ministrymon leda*, *Mitoura johnsoni*, *M. nelsoni* (all 69), *M. spinetorum* 54, *Ochlodes agricola*, *Papilio eurymedon*, *P. indra pergamus*, *Satyrium auretorum*, *S. californica* (all 69), *Speyeria callippe macaria* 51

Eriodictyon angustifolium: *Mitoura spinetorum* 54

Eriodictyon californicum: *Hesperia columbia* 33, *Satyrium californica* 20, *Speyeria callippe macaria* 71

IRIDACEAE

Iris sp.: *Carterocephalus palaemon* 64, *Mitoura spinetorum* 54, *Papilio rutulus arizonensis* 71, *Parnassius clodius* 69

Iris missouriensis: *Coenonympha tullia mono* 69, *Papilio rutulus* 69

LABIATAE

Marrubium vulgare: *Erynnis funeralis* 9, *Speyeria callippe macaria* 51 & 71

Monarda sp.: *Erora quaderna* 45, *Speyeria aphrodite ethne* 3 & 69, *S. coronis*, *S. c. halcyone*, *S. cybele leto*, *S. hydaspe*, *S. zerene garretti* (all 69)

Monarda menthaefolia: *Ochlodes snowi* 3

Monardella sp.: *Cercyonis silvestris* 69, *Chlosyne hoffmanni* 20, *Oeneis nevadensis* 69, *Speyeria atlantis dodgei* 69, *S. callippe inornata* 53, *S. c. juba* 69, *S. hydaspe* 20, *S. zerene malcolmi* 20

Monardella odoratissima: *Chlosyne hoffmanni* 19, *Papilio zelicaon* 17, *Parnassius clodius baldur* 19, *Plebejus shasta*, *Polygonia zephyrus*, *Speyeria egleis* (all 17)

LAURACEAE

Umbellularia californica: *Lycaena arota* 20, *Incisalia iroides* 69, *Mitoura johnsoni* 69

LEGUMINOSAE

Astragalus sp.: *Yvretta rhesus* 3

Bauhinia sp.: *Trogonoptera brookiana albescens* 10

Cercis sp.: *Incisalia henrici* 29

Cercis canadensis: *Incisalia henrici* 6

Cercis occidentalis: *Incisalia iroides* 69

Crotalaria sp.: *Jamides celeno aelianus* 10

Lupinus sp.: *Incisalia eryphon* 3, *I. niphon* 6 & 29, *Mitoura nelsoni* 69, *M. spinetorum* 54

Medicago sativa: *Cercyonis silvestris paulus* 9 & 69, *Chlosyne minuta* 71, *C. nycteis* 71, *Colias eurytheme*, *Heliopetes ericetorum*, *Hemiargus gyas*, *Hesperia harpalus*, *Leptotes marina*, *Pholisora catullus* (all 69), *Phyciodes tharos* 71, *Polites themistocles* 69, *Speyeria edwardsii* 71, *Zerene eurydice* 9

Melilotus sp.: *Cercyonis silvestris paulus* 9

Melilotus albus: *Chlosyne nycteis* 25, *Everes comyntas* 6, *Satyrium falacer* 7, *S. liparops* 62

Melilotus officinalis: *Satyrium falacer* 7

Trifolium pratense: *Colias eurytheme*, *Danaus plexippus*, *Hylephila phylaeus* (all 6), *Satyrium falacer* 7

LILIACEAE

Camassia scilloides: *Hesperia metea* 26

Gloriosa superba: *Papilio demoleus* 27, *P. polytes* 27

LOGANIACEAE

Buddleia sp.: *Badamia exclamationis* 68, *Chlosyne nycteis* 25, *Delias belladonna* 68, *Dilipa morgiana* 68, *Limenitis archippus* 71, *Papilio polyctor*, *Zetides cloanthus*, *Z. sarpedon* (all 68)

MALVACEAE

Hibiscus sp.: *Catopsilia crocale*, *C. florella gnoma*, *C. pomona*, *C. pyranthe minna* (all 56)

Sida hederacea: *Strymon columella* 71

MYRTACEAE

Psidium guajava: *Papilio aristodemus ponceanus* 49

ONAGRACEAE

Epilobium sp.: *Mitoura spinetorum* 71

ORCHIDACEAE

Bonatea darwinii: *Pyrgus elmo* 61

Maxillaria ontoglossom: *Perichares philetes dolores* 16

Orchis pyramidalis: *Syricthus alveolus* 61

Platanthera hookeri: *Nisoniades* sp. 61

Pogonia ?ophioglossides: *Poanes hobomok* 37

PALMAE

Serenoa sp.: *Eumaeus atala* 29

POLYGONACEAE

Eriogonum sp.: *Libytheana bachmanii* 71, *Speyeria egleis tehachapina* 15

Eriogonum deserticola: *Eurema nicippe* 69, *Microtia dymas imperialis* 69

Eriogonum fasciculatum: *Cercyonis silvestris* 69, *Hemiargus isola* 69, *Mitoura spinetorum* 54, *Philotes battoides bernardino*, *Satyrium sylvinus*, *Speyeria callippe comstocki* (all 69)

Eriogonum giganteum: *Strymon avalona* 9

Eriogonum umbellatum: *Mitoura spinetorum* 54, *Satyrium saepium* 3

Eriogonum wrightii: *Apodemia mormo tuolumnensis* 69

Polygonum sp.: *Limenitis archippus* 71, *Mitoura spinetorum* 54

PORTULACACEAE

Calyptridium sp.: *Lycaena cupreus* 69, *Mitoura nelsoni* 20, *M. spinetorum* 54, *Nymphalis milberti* 69, *Philotes enoptes* 69, *Speyeria callippe elaine* 53, *S. c. juba* 69, *S. egleis* 71

Calyptridium umbellatum: *Mitoura johnsoni* 54, *Satyrium californica* 20

PYROLACEAE

Monotropa uniflora: *Epargyreus clarus* 6

RANUNCULACEAE

Clematis sp.: *Tros philoxenus* 68

Delphinium carolinianum: *Hesperia metea* 26

Ranunculus sp.: *Hesperia columbia* 33

Ranunculus californicus: *Incisalia fotis bayensis* 69

RHAMNACEAE

Ceanothus sp.: *Apodemia nais* 3, *Incisalia iroides* 69, *Mitoura nelsoni muiri* 69

Ceanothus americanus: *Satyrium edwardsii* 42, *S. ontario* 29, *S. titus* 42, *S. t. mopsus* 6
Ceanothus cordulatus: *Mitoura johnsoni* 38 & 54, *M. spinetorum* 38 & 54
Ceanothus fendleri: *Erora quaderna* 45, *Mitoura spinetorum* 54
Ceanothus ovatus: *Mitoura spinetorum* 54

ROSACEAE
Chamaebatia foliolosa: *Mitoura nelsoni* 53 & 69
Dryas octopetala: *Boloria alberta* 67, *B. astarte* 67
Fragaria sp.: *Hesperia metea* 29, *Mitoura johnsoni* 54
Fragaria virginiana var. *illinoensis*: *Hesperia metea* 26
Potentilla sp.: *Hesperia metea* 29, *Mitoura nelsoni* 69
Potentilla fruticosa: *Lycaena rubidus sirius* 3, *Mitoura spinetorum* 54
Prunus sp.: *Callophrys dumetorum* 71, *Glaucopsyche lygdamus* ssp. 69, *Incisalia eryphon* 3, *I. niphon*, *Limenitis weidemeyerii*, *Speyeria aphrodite ethne*, *S. coronis* ssp., *S. edwardsii* (all 71)
Prunus americana: *Incisalia niphon* 47, *Mitoura spinetorum* 54
Prunus fasciculata: *Callophrys comstocki* 69, *C. dumetorum* 69, *Mitoura spinetorum* 54
Prunus emarginata: *Incisalia eryphon* 69, *Mitoura nelsoni* 69
Prunus melanocarpa: *Limenitis weidemeyerii* 71, *Mitoura spinetorum* 54, *Speyeria coronis halcyone* 71
Prunus virens: *Erora quaderna* 45
Rubus sp.: *Libytheana bachmanii* 70
Spiraea latifolia: *Celastrina argiolus pseudargiolus* 6

RUBIACEAE
Cephalanthus sp.: *Atrytone conspicua* 29, *Autochton cellus* 29
Cephalanthus occidentalis: *Atalopedes campestris*, *Atrytone pontiac*, *Colias eurytheme*, *Epargyreus clarus*, *Speyeria cybele* (all 6)
Ixora sp.: *Papilio demolion* 10
Morinda roioc: *Papilio aristodemus ponceanus* 49
Mussaenda sp.: *Trogonoptera brookiana albescens* 10

RUTACEAE
Thamnosma montana: *Papilio indra fordi* 69

SALICACEAE
Salix sp.: *Callipsyche behrii*, *Cercyonis oetus*, *Chlosyne acastus*, *C. leanira alma* (all 69), *Mitoura spinetorum* 54, *Satyrium californica* 69

SAXIFRAGACEAE
Hydrangea sp.: *Autochton cellus* 29
Philadelphus lewisii var. *californicus*: *Satyrium auretorum spadix* 20
Ribes sp.: *Mitoura spinetorum* 71

SCROPHULARIACEAE
Castilleja sp.: *Papilio indra pergamus* 69
Mimulus sp.: *Battus philenor hirsuta* 69
Penstemon montanus: *Papilio eurymedon albanus* 3
Penstemon tolmiei ssp. *formosus*: *Speyeria callippe semivirida* 53 & 69, *S. coronis*, *S. egleis* ssp., *S. zerene* ssp. (all 53)
Veronica sp.: *Chlosyne nycteis* 25

SOLANACEAE
Lycium andersonii: *Papilio indra fordi* 69

THYMELEACEAE
Primelea sp.: *Anisynta tillyardi, Exometoeca nycteris, Ogyris idmo* (all 4), *Papilio macleayanus* 2
UMBELLIFERAE
Cymopterus sp., probably: *Mitoura spinetorum* 54
Daucus carota: *Satyrium falacer* 7
Eryngium yuccaefolium: *Phyciodes tharos* 6
Lomatium dasycarpum: *Callophrys viridis, Incisalia fotis bayensis, Phyciodes mylitta* (all 69)
Lomatium utriculatum: *Incisalia fotis bayensis* 69
VERBENACEAE
Duranta sp.: *Atella phalantha* 68
Lantana sp.: *Atella phalantha* 68, *Atrophaenura coon doubledayi* 10, *A. nox erebus* 10, *Cethosia chrysippe cydippe* 2, *Cirrochroa regina sophene* 2, *Cynthia erota* 68, *Euripus consimilis* 68, *Graphium agamemnon* 10, *Idea leuconoe* 60, *Ismene jaina* 68, *Jamides celeno aelianus* 10, *Lebadea martha malayana* 10, *Papilio liomedon* 68, *P. polydorus queenslandicus* 2, *Parathyma nefte subrata, Parthenos sylvia lilacinus, Phalanta alcippe alcesta* (all 10), *Prioneris sita, Tros aidoneus, T. hector, T. jophon, Troides helena* (all 68), *Vanessa carye* 9, *Vindula arsinoe erotella* 10, *Zetides agamemnon* 68, *Z. sarpedon* 68
Lantana camara: *Baoris mathias, Catopsilia pyranthe, Danaus chrysippus, Papilio demoleus, P. polytes, Precis almana* (all 13)
Verbena sp.: *Appias lyncida* 68, *Hesperia metea* 26
VIOLACEAE
Viola sp.: *Erynnis brizo* 29
Viola pedata: *Hesperia metea* 26

Subfamily Relationships of the Butterfly Genera Mentioned

PAPILIONIDAE
Papilioninae: *Atrophaenura, Battus, Graphium, Papilio, Trogonoptera, Troides, Tros, Zetides*
Parnassiinae: *Parnassius*
PIERIDAE
Pierinae: *Anthocaris, Aporia, Appias, Delias, Neophasia, Pieris, Prioneris*
Coliadinae: *Catopsilia, Colias, Eurema, Gonepteryx, Nathalis, Zerene*
LIBYTHEIDAE
Libytheana
NYMPHALIDAE
Satyrinae: *Coenonympha, Maniola, Oeneis*
Danainae: *Danaus, Euploea, Idea, Lycorea*
Ithomiinae: *Hymenitis, Hypothyris, Ithomia, Mechanitis, Melinaea, Tithorea*
Nymphalinae: *Atella, Boloria, Cethosia, Chlosyne, Cirrochroa, Cynthia, Dilipa, Euphydryas, Euptoieta, Euripus, Lebadea, Limenitis, Microtia, Nymphalis, Phalanta, Parathyma, Parthenos, Phyciodes, Polygonia, Precis, Speyeria, Vanessa, Vindula*
LYCAENIDAE
Riodininae: *Apodemia, Emesis, Lephelisca*
Lycaeninae: *Atlides, Callipsyche, Callophrys, Celastrina, Erora, Eumaeus,*

Everes, *Glaucopsyche*, *Hemiargus*, *Incisalia*, *Jamides*, *Leptotes*, *Lycaena*, *Ministrymon*, *Mitoura*, *Ogyris*, *Philotes*, *Plebejus*, *Polyommatus*, *Pratapa*, *Sandia*, *Satyrium*, *Strymon*

HESPERIIDAE

Trapezitinae: *Anisynta*

Hesperiinae: *Ancyloxipha*, *Atalopedes*, *Atrytone*, *Baoris*, *Carterocephalus*, *Hesperia*, *Hylephila*, *Lerodea*, *Nisoniades*, *Ochlodes*, *Perichares*, *Piruna*, *Poanes*, *Polites*, *Pseudocopaeodes*, *Yvretta*

Coeliadinae: *Badamia*, *Ismene*

Pyrginae: *Achalarus*, *Autochton*, *Epargyreus*, *Erynnis*, *Exometoeca*, *Heliopetes*, *Pholisora*, *Pyrgus*, *Syricthus*, *Thorybes*

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70. From my unpublished ms. on the Libytheidae.

71. Records from correspondence (see acknowledgments).

SCIENTIFIC NOTE

Notes on the Feeding Habits of *Haemolaelaps glasgowi* (Acarina: Laelaptidae).—Specimens of the mite *Haemolaelaps glasgowi* (Ewing), utilized in this study, were recovered from the round-tailed ground squirrel, *Spermophilus tereticaudus neglectus* Merriam, near Tucson, Arizona, or from its nests. Feeding studies were conducted at a mean room temperature of 84°F and at a mean relative humidity of 20%. A juvenile mouse, *Mus musculus* Lin., was thoroughly examined, before placing a mite on it, to ascertain that it was ectoparasite free. All mites placed on the mouse went to the rump. Starved mites were deprived of blood or its constitutes for 10 days. Starved adult females remained attached to the dermis from one to two hours after which they appeared engorged. Most of these were on the mouse from 12 to 15 hours. All adult females fed one to three days previously on moist raw beef did not feed on the mouse. Most starved adult females were attracted to the beef. Approximately half of these wandered over it for a minute, probed it with their mouthparts, then fed. They would then go to a different location and repeat this probing and feeding. The time spent on the beef was four to five minutes. One starved adult male fed 20 to 30 seconds on it while one recently fed adult male ignored it. All protonymphs and deutonymphs ignored the raw beef.—James D. Lang, *Department of Entomology, University of Arizona, Tucson, 85721.*

Larval Distribution of *Paraclunio alaskensis* at Point Pinos Sewage Outfall, Monterey County, California

(Diptera: Chironomidae)

DOUGLAS T. CHEESEMAN, JR. AND PAUL PREISSLER

De Anza College, Cupertino, California 95014, and Stanford University, Stanford, California 94305

The midge *Paraclunio alaskensis* Coquillett, an intertidal insect, was observed in large numbers in the area of the Point Pinos sewage outfall of Pacific Grove, California. A five week study during the months of July and August 1971 was undertaken because *P. alaskensis* represented an unusually abundant macroscopic organism close to a point source of pollution. The Pacific Grove Primary Sewage Treatment Plant releases into the outfall an average of 1.6 million gallons per day of effluent containing chlorine to lower coliform counts. Chlorine concentrations of 10 ppm are common near the outfall.

The larvae of *P. alaskensis* were chosen for study because they provided a better index of population distribution than the adults which were too mobile and completed their life functions within the time of one low tide (Saunders, 1928).

The larvae in the area of the Pt. Pinos outfall fed on organic detritus or "slime" found in greatest concentrations on the rocks within the first 14 meters from the outfall. The slime consisted of organic sewage, a diatom slick, occasional stunted specimens of the alga *Gigartina papillata* Agardh, and other unidentified components. Each *P. alaskensis* larva spins a silken tube which attaches it to the rocky outcrops where the slime is abundant. During the two daily high tides the tube provides protection from heavy wave action on the vertical rocky surfaces. Saunders (1928) noted that preference is shown for the vertical sides of large boulders and rocks which is also the case at Pt. Pinos. When the larvae leave the tubes to feed during low tides they are able to cling to their rocky habitat by means of prothoracic and abdominal pseudopods.

METHODS.—Data were collected on the distribution of the larvae in the vicinity of the outfall and correlated with distance from the outfall. Thirty-six samples were taken at random at Point Pinos ranging from 0.0 tidal height to approximately 1.5 m above mean low water. Six samples were taken at two control areas within Monterey County: rocky outcrops near Asilomar Beach and Malpaso

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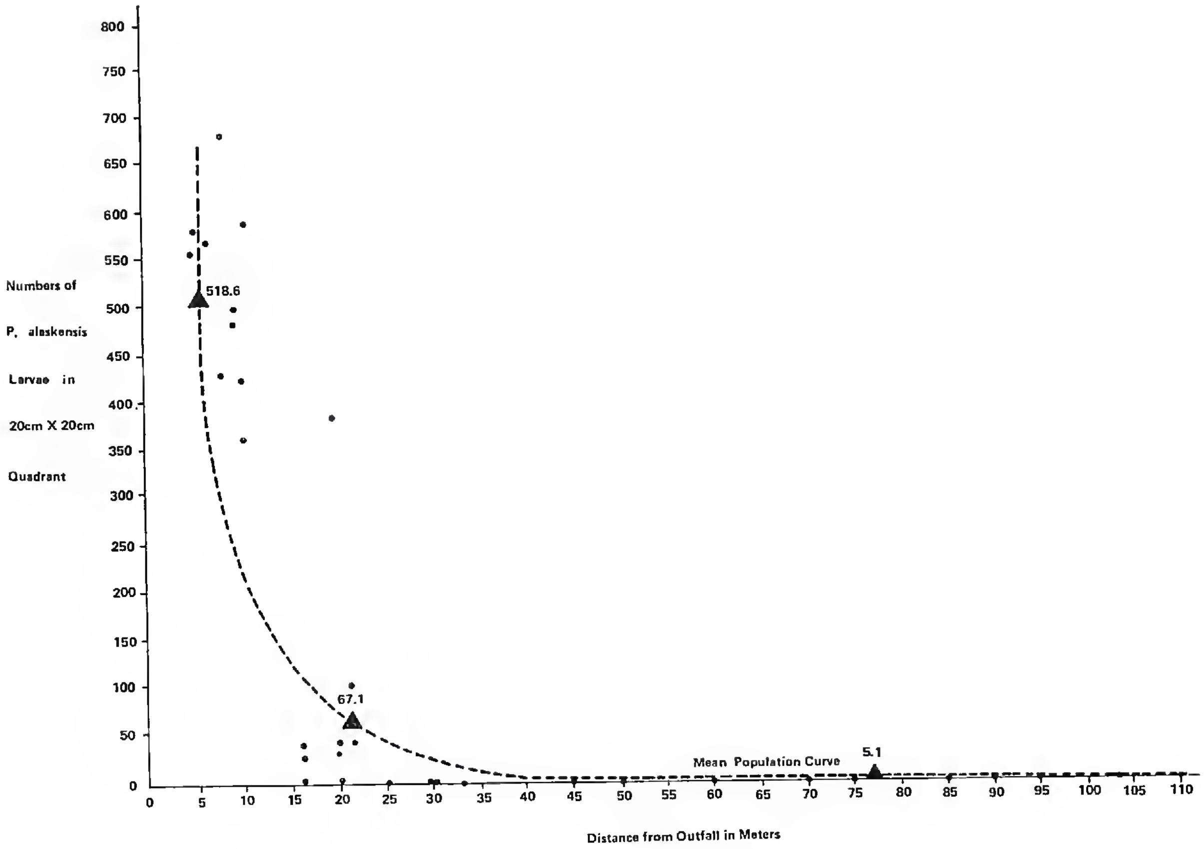

FIG. 1. Distribution of *P. alaskensis* larvae as a function of distance from sewage outfall.

Creek tidepools. Each sample covered a quadrant 20 cm × 20 cm.

The 36 samples taken in the area of the outfall were divided into three groups according to distance from the outfall: 0–14 m, 15–28 m and 29–160 m. Attention was given to the type of substrate and the surrounding vegetation. Ten quadrants were selected from 0–14 m, the area of granitic substrate covered with organic slime. The substrate of the second sample area included eight quadrants with assorted algae, one quadrant from a *Mytilus* bed, and only one quadrant found with organic slime. The quadrants in the third sample area contained slime in one and rocks with a large variety of matted algae and invertebrates in the remaining fifteen. The samples collected in the control areas were from rocks densely covered with macroscopic algae.

Large algae samples were put directly into plastic bags after they were removed. The exposed rock surface was then sprayed with a 50% solution of sodium hypochlorite and all remaining organisms collected.

A collecting tray was constructed to remove larvae from the slime covered vertical rock surfaces surrounding the outfall. This consisted of a sheet metal box measuring 40 cm × 10 cm × 5 cm from which one of the long sides had been removed. Sponges were wrapped in a plastic bag and compressed into the tray. A piece of cheesecloth was then folded and placed over the outer, top edge of the bag covered sponges. This was to provide a surface to which the larvae or any falling particulate matter could cling. The apparatus was firmly held against the lower edge of the 20 × 20 cm quadrants so that the sponges were compressed and took the shape of the rock. The entire quadrant was subsequently scraped and washed with a 50% sodium hypochlorite solution. Both particulate matter and organisms fell onto the cheesecloth. When the quadrant was completely bare the sponges, cheesecloth, and bag were carefully removed from the tray. The plastic bag was turned inside out enveloping the cheesecloth and sample and freeing the sponges. The sample was then taken to the laboratory for counting.

RESULTS.—In the 36 samples taken at Point Pinos (Fig. 1) the mean population for sample group 1 (0–14 m) was 518.6 larvae per quadrant, for sample group 2 (15–28 m) 67.1 larvae, and for sample group 3 (29–160 m) 5.1 larvae. The *t* and Mann Whitney U tests, performed to compare the three groups, passed the 95% confidence limits. There was a significant difference in numbers of larvae as the distance from the outfall increased. No larvae were found beyond 35 m from the outfall. In 22 quadrants containing algae, few larvae were found, except for one sample at 23 m which contained 114 larvae. Very few larvae were in habitats other than organic slime. For example, the sample from the *Mytilus* bed at 25 m from the outfall contained no larvae, whereas at 35 m the sample, the only one of slime in the third area, had 79 larvae. In a quadrant at 9 m, 488 larval tubes were attached to dead *Balanus*; much slime was also present on the rock. No larvae of *P. alaskensis* were found in the samples from the control areas.

At increasing distances from the outfall the number of attached algae and sessile invertebrates increased and *P. alaskensis* larvae decreased. At increasing distances the slime on rocky outcrops, which extended at least 160 m beyond the outfall, also decreased. The larvae seem to thrive when they are not in direct competition with other organisms for substrate, although Saunders (1928) stated that "in spring and early summer on the Pacific Coast of Canada they may be found in almost any matted growth of filamentous algae." Saunders also indicated that sufficient algae were neccessary to harbor larvae. This was not true at Pt. Pinos where larvae subsisted on organic detritus.

The large volume of fresh water effluent may be a significant factor for the abundant *P. alaskensis* larvae and sparse intertidal invertebrates and algae. The effluent is quickly diluted beyond 14 m from the outfall by sea water and this dilution may also lead to declining numbers of *P. alaskensis* larvae. An unpublished study done at Hopkins Marine Station showed that the salinity is approximately 1,000 ppt within the first 14 m beyond the outfall at high tide instead of the normal 3,300–3,500 ppt. Chironomidae are generally found in fresh water and *P. alaskensis* may do best in areas of fresh water flow into the intertidal. Studies will be conducted to sample areas for *P. alaskensis* where fresh water streams containing no sewage empty into the rocky intertidal.

The success of *P. alaskensis* at Pt. Pinos may also be partially attributed to its reproduction by copulation. The female lays her fertile eggs in rocky crevices, whereas most intertidal invertebrates and algae shed their gametes directly into sea water. In an environment polluted with effluence and chlorine, the fertilization of gametes may be adversely affected.

CONCLUSIONS.—*P. alaskensis* larvae are abundant in the area of the sewage outfall at Pt. Pinos where food in the form of organic slime is plentiful on boulders and rocky vertical outcrops. A possible attributing factor for the success of *P. alaskensis* is little or no competition for space from other organisms not physiologically suited to polluted water or to diluted salinity. It is possible that *P. alaskensis* larvae could be used as an index of human sewage pollution in intertidal areas where there is a primary sewage outfall and a rocky substrate.

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Biology of the Zebra Caterpillar, *Ceramica picta*[1]
(Lepidoptera: Noctuidae)

George Tamaki, R. E. Weeks, and B. J. Landis
Entomology Research Division, Agr. Res. Serv., USDA, Yakima, Washington 98902

In the Yakima valley, several noctuid species, the bertha armyworm, *Mamestra configurata* Walker, the beet armyworm, *Spodoptera exigua* (Hübner), the yellowstriped armyworm, *Spodoptera ornithogalli* (Guenée), and the zebra caterpillar, *Ceramica picta* (Harris), sporadically attack sugarbeets. Of these species, the zebra caterpillar is generally the most damaging, and in late autumn in some years, it so severely defoliates sugarbeets that only the leaf petioles are left above ground. Therefore, from 1967 to 1971, the zebra caterpillar was reared and studied at the Potato, Pea, and Sugarbeet Insects Investigations laboratory at Yakima, Wash., and tests of the sex pheromone of the female were made in cooperation with the Pesticide Chemicals Research Branch (Wallis et al. 1972). In addition, Tamaki et al. (1972) reported life tables which can be used to evaluate the rearing procedure of the zebra caterpillar. The present paper reports details of the life stages to supplement the description of Payne (1918).

Materials and Methods

A series of tests was made to determine the reproductive potential, optimum incubation temperature, the number and size of the larval instars, and the duration of instars.

The reproductive potential of the adult female zebra caterpillar was studied by counting the number of oocytes and matured eggs in 25 one-day to six-day-old females. The actual reproduction of the species was estimated by placing 12 pairs in individual oviposition cages and counting the numbers of eggs laid. The cages were 473-ml ice cream cartons lined with paper toweling for ovipositional sites and with wet vermiculite in the bottoms to maintain a high humidity and a cotton wick saturated with 10% sucrose solution for food.

The duration of the incubation of the egg was investigated by taking an egg cluster about 12 hours old from each of four females (laid on paper toweling), separating each into six parts, and placing each part in a ventilated plastic jelly cup. Then four jelly cups (one from

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each cluster) were placed in a glass gallon-size jar and exposed in a temperature control cabinet maintained at 10, 15.6, 21.1, 26.7, 32.2, or 37.8°C. A wire screen stage held the cups above a saturated solution of calcium nitrate salt placed in the bottom of each jar to maintain the relative humidity within a range of 50–70%.

To determine the number of larval instars and the differences in size between instars, we placed several hundred neonate larvae in a tray with sugarbeet leaves and in another tray on Shorey's (1963) bean-based artificial diet (the primary diet used to rear zebra caterpillars in the laboratory). Each treatment was replicated three times. Then 10 randomly selected larvae from each treatment were removed every 12 or 24 hr (rotated between trays), preserved in 70% alcohol, and measured to determine the greatest width of the head capsule and length of body. The head capsules of field-collected zebra caterpillar larvae found on sugarbeets in the autumn were also measured.

The developmental rate of the life stages of the zebra caterpillar was determined by rearing a total of 600 caterpillars (200/treatment) in the laboratory with three procedures. Procedures one and two differed only in that the diet was sugarbeet leaves or Shorey's (1963) artificial diet. Otherwise, 100 neonate larvae per tray were reared with a technique similar to that used for the tobacco hornworm, *Manduca sexta* (L.) (Yamamoto 1969). Thus, the larvae were checked daily for stage of growth, and the trays were cleaned; however, fresh leaves were provided two to three times per week when the larvae were small (changed daily in later instars). Procedure three involved rearing 200 caterpillars singly on about 15 ml of Shorey's diet in 30-ml jelly cups capped with tight lids (no food was added to the cups). All 600 larvae were from one egg cluster from one female and were held in the same room at an average rearing temperature of 25°C (18–28°) with a 16-hr photophase. Then as the last-instar larvae changed to the prepupal stage, the insects were transferred to vermiculite for pupation. Pupae were easily sexed using the characters illustrated by Butt and Cantu (1962) for sexing pupae of other Lepidoptera.

Results

The reproductive system of the female zebra caterpillar contains a pair of ovaries with a total of eight ovarioles. In a newly emerged female, an ovariole is 10–12 cm long and filled with a single strand of oocytes. Egglaying (reproductive) potential determined by dissecting nonparous virgin females showed that the zero- to one-day-old

TABLE 1. Mean hatching time of eggs of *Ceramica picta* held at various constant temperatures (from adults reared on artificial diet), December 1970.

Temperature °C	No. of eggs incubated	No. of eggs hatched	Mean hatching time (days)
38.0	512	0	—
32.2	356	0	—
26.7	294	294	5.0
21.1	279	275	6.2
15.6	388	290	12.3
10.0	365	0	—

females contained no mature eggs (eggs with ribbed rows of chorion were indexed as mature); the two-day-old females had 40% mature eggs; and the three- to six-day-old females had 50–58% mature eggs. In these older females, egg laying had been delayed because fertilized females normally lay their eggs two to three days after emergence. The total number of oocytes plus mature eggs per female in 25 females averaged 1,236 (range 884–1,884). The average number of eggs actually deposited by the 12 mated females in the oviposition cages was 986 (range 59–1,998). Therefore, many females were apparently able to lay their full complement of eggs, but a few laid only a small proportion.

The effects of temperature on the rate of development of eggs of the zebra caterpillar are shown in Table 1. Eggs did not hatch at high temperatures (32.2°C and 38°C), but at 26.7°C, 100% egg hatch occurred within five days, the shortest hatching time; this temperature was therefore designated as optimum. At 21.1°C, 99% hatch occurred, but the incubation time was about 20% longer than at the optimum temperature. At 15.6°C, hatch was still relatively high (75%), but the incubation time was increased by 140% over the optimum. No egg hatch occurred at 10°C.

Payne (1918) reported that the zebra caterpillar had five larval instars in Nova Scotia. However, he presented only a range of measurement for use in separating the instars and gave no average measurements for the width of the head capsules and the length of the bodies. In our studies in eastern Washington, both the laboratory-reared and the field-collected caterpillars had six larval instars (Table 2). However, the range of width of the head capsules of the second instar given by Payne (1918) fell between our measurements for the second and third instars.

TABLE 2. Measurements of *Ceramica picta* reared in the laboratory on sugarbeets and on artificial diet and of field-collected larvae taken from sugarbeets.

In-star	No. and width of head capsule (mm ± SD)						No. and length of larvae (mm ± SD) reared in the laboratory on					
	Reared in laboratory on				Field-collected from sugarbeet							
	Sugarbeets		Artificial diet				Sugarbeets			Artificial diet		
	No.	Width	No.	Width	No.	Width	No.	Length	Range	No.	Length	Range
1	60	0.29 ± .04	83	0.34 ± .05	1	0.33	60	3.68 ± 0.65	2.0–4.5	83	3.64 ± .97	2.2–5.0
2	68	.54 ± .04	53	.58 ± .05	47	.58 ± .08	68	6.01 ± 1.27	4.0–9.0	53	6.75 ± 1.38	4.5–9.5
3	65	.87 ± .06	49	.95 ± .08	110	.89 ± .07	65	10.61 ± 1.82	7.0–14.0	49	11.29 ± 2.30	6.0–15.0
4	57	1.44 ± .07	47	1.50 ± .09	99	1.37 ± .09	57	17.03 ± 2.32	11.0–22.0	47	18.01 ± 3.14	12.0–27.0
5	76	2.12 ± .07	107	2.13 ± .07	61	2.11 ± .12	76	26.82 ± 4.84	17.0–36.0	107	25.91 ± 3.50	17.0–32.0
6	75	3.01 ± .12	85	3.02 ± .09	39	3.07 ± .14	75	37.40 ± 6.33	20.0–50.0	85	39.82 ± 5.01	28.5–50.0

TABLE 3. Pupal weight of male and female *Ceramica picta* reared by three procedures.

	Weight of pupa (mg ± SE)[a]	
Rearing methods	♂	♀
Artificial diet—in cups	496.5 ± 9.08	600.8 ± 15.53
Artificial diet—in tray	481.9 ± 14.63	556.4 ± 25.93
Sugarbeet leaves—in tray	388.3 ± 3.13	434.0 ± 4.15

[a] Standard error (SE).

We found no significant differences in the size of the capsules of the same instar among laboratory-reared larvae fed artificial diet, laboratory-reared larvae fed sugarbeet leaves, or field-collected larvae. However, the measurements for instars did differ significantly for all larvae (Table 2). Also, diet did not cause any significant differences in the length of a given instar, and the differences in length between succeeding larval instars were not statistically significant.

The developmental periods for each life stage of the zebra caterpillar reared in the laboratory on sugarbeets and on artificial diet are illustrated in Fig. 1. At a relatively high rearing temperature (average 25°C), the length of the first to fifth larval stadia reared on sugarbeets ranged from two to five per stage; the sixth stadium averaged about five days though some individual insects took as much as 10 days. The length of the larval stadia for larvae reared on artificial diet in cups was similar to that of larvae reared on sugarbeets, but when the larvae were reared in trays, a few in the later instars had an extended developmental period. Most larval development was completed after 27 days on all diets. Also, except for the decreasing number of insects surviving on artificial diet, no striking differences were evident in the developmental periods of the larval instars when the larvae were reared by the three procedures. In contrast, Tamaki and Weeks (1972) reported that the *Geocoris* ssp. fed an incomplete diet had a prolonged rate of development in the later nymphal instars which was associated with high mortality.

The duration of the prepupal stage was difficult to assess because the cocoons had to be disturbed to check the developmental stage; therefore, checks were infrequent. The average prepupal period was estimated at five days, but a few insects reared on artificial diet in trays had an extended prepupal period (Fig. 1).

The average pupal periods for zebra caterpillars reared on sugarbeet leaves in trays and on artificial diet in trays and in cups were

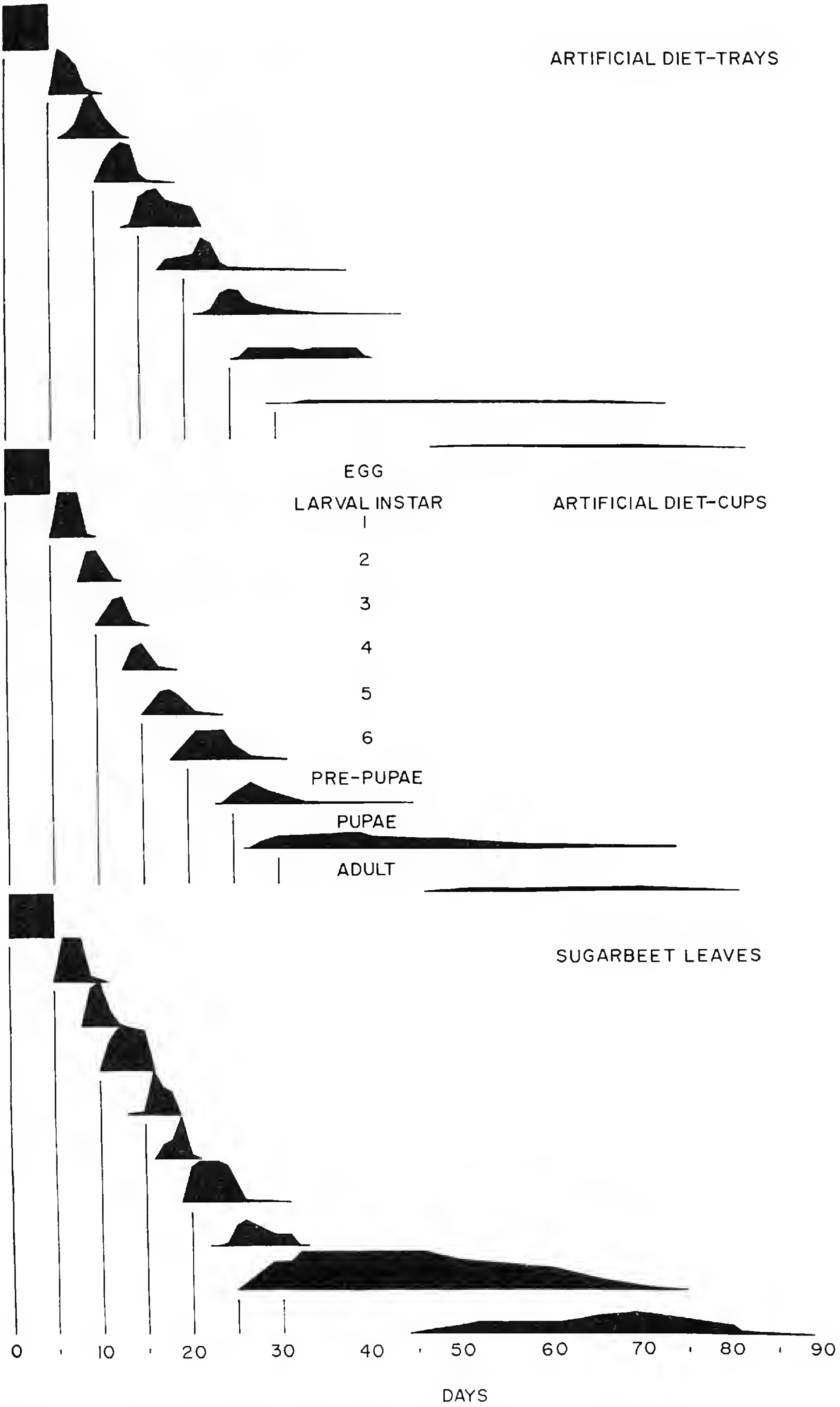

FIG. 1. The developmental periods of all life stages of zebra caterpillars reared on artificial diet and on sugarbeets by three methods.

34 days (range 16–52), 30 days (range 15–40), and 27 days (range 14–41), respectively. Female pupae were heavier than male pupae (Table 3). Pupae from larvae reared on sugarbeet leaves weighed less than pupae from larvae reared on artificial diet, and the heaviest pupae were obtained from larvae grown on artificial diet in cups (these pupae also had the shortest duration of the pupal stage). However, as shown in Fig. 1, the number of moths was much greater when the larvae were reared on sugarbeet leaves than on artificial diet.

The first emergence of adults occurred at 45 days, but the mean time for females to reach maturity by all three rearing procedures ranged from 62 to 67 days. The preoviposition period averaged two days; the oviposition period averaged seven days (though some females had an extended period that lasted as much as 15 days); and the postoviposition period averaged 0–1 day. When the larvae were reared on sugarbeet leaves, the average lifespan of the female was 10.5 days (range 2–19), and that of the male was 12 days (range 2–21).

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Two New California Species of *Silis*[1]

(Coleoptera: Cantharidae)

KENNETH M. FENDER
Linfield Research Institute, McMinnville, Oregon 97128

The two species herein described as new to science, help confirm Green's hypothesis (1966) that numerous unrecognized species of *Silis* await discovery, especially from western North America.

In the genus *Silis*, the posterior angles of the pronotum are excised, retracting these angles and forming an anterior subangulate prominence called the anterior process. The excised portion is occupied by a projected portion of the hypomeron, called the posterior process. Both of these processes vary considerably in outline and are excellent for the recognition of species groups. In some instances they appear to be adequate for the recognition of species.

The characters for the determination of the species within the species groups are usually found in the aedeagus of the male. As Green (1966) has noted, a certain amount of variability in the aedeagae resulted in his recognition of some species complexes that he was unable to resolve. The attemped resolution of these is not yet possible.

Silis (Silis) spinigerula Fender, new species

(Figs. 1, 3–5)

Black. Mandibles testaceous, becoming infuscate towards tips. Prothorax pale rufous. Pubescence piceous.

MALE.—Length 5 mm, length-width ratio 3.25 : 1. Antennae four-fifths length of body, moderately stout, subfiliform, becoming compressed apically, intermediate segments about three and one-half times as long as wide. Pronotum as in Fig. 1, anterior process of basal excisure bilobed, lobes rounded, posterior process produced as forward curving spiniform process, excision only partially closed by dorsal surface of extended hypomeron. Pubescence erect, fine, short and inconspicuous. Aedeagus. Dorsal plate broadly shallowly emarginate apically, without raised median lobe. Basophyses fused into broad subparallel-sided plate about half as wide as tegmen and with apex shallowly emarginate. Median lobe with two pair of apical spines; in dorsal or ventral views, lower pair abutting with tips blunt, upper pair remote with tips acute; in lateral view, both pairs acute.

FEMALE.—Unknown.

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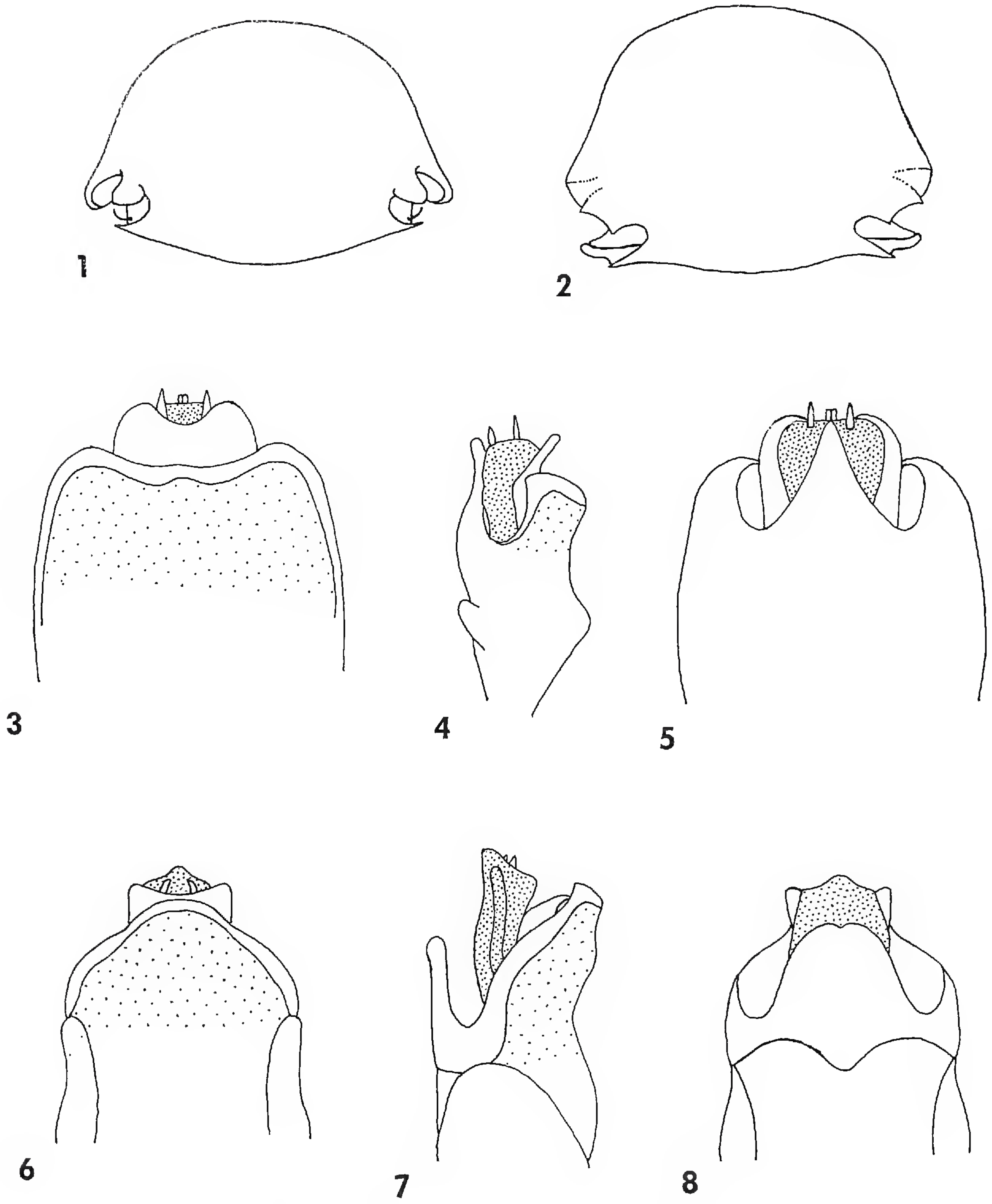
[1] This study was supported by National Science Foundation Grant: GB-6283X.



FIGS. 1, 3–5. *Silis* (*Silis*) *spinigerula*. FIG. 1. pronotum. FIG. 3. aedeagus of male, dorsal view. FIG. 4. same, lateral view. FIG. 5. Same, ventral view. FIGS. 2, 6–8. *Silis* (*Silis*) *alexanderi*. FIG. 2. pronotum. FIG. 6. aedeagus of male, dorsal view. FIG. 7. same, lateral view. FIG. 8. same, ventral view.

Holotype male, CAMPO LAKE ON MEXICAN BORDER, SAN DIEGO COUNTY, CALIFORNIA, 2 April 1963, 2,565 feet, collected by C. P. Alexander, in the collection of the California Academy of Sciences, San Francisco.

This species is most closely related to *S. filicornis* Van Dyke. That species differs in not having the anterior process of the basal excisure of the pronotum bilobed, having the pubescence decumbent and the dorsal plate of the aedeagus with an apical raised and produced median lobe.

Silis (Silis) alexanderi Fender, new species

(Figs. 2, 6–8)

Black. Prothorax and head in front of antennae pale rufous; palpi black; basal two or three antennal segments testaceous beneath; head beneath pale rufous at gular sutures. Protibiae pale piceous to dark piceous. Apical angles of first four visible abdominal sternites narrowly testaceous. Pubescence cinereous.

MALE.—Length 4.75 to 5.25 (average 5) mm. Length-width ratio 2.75 : 1. Antennae filiform, about three-fourths length of body, intermediate segments three times as long as wide. Pronotum as in Fig. 2, excision of posterior angles of pronotum deep, rather narrow; posterior margin of anterior process with two spicules, outer spicule as produced posterior margin of posterolateral furrow, inner spicule simple; posterior process broad, subfoliate in outline. Aedeagus. Dorsal plate apically entire, rounded, becoming sinuate towards each side. Median lobe with an apical pair of short acute spines. Basophyses (lateral view) stout, evenly curved up and narrowing apically, not attaining margin of dorsal plate. Basal plate (ventral view) short and stout, apex shallowly notched.

FEMALE.—Normal, not recognizable unless taken in association with males.

Holotype male, allotype female and 13 male and 4 female paratypes: SEVEN OAKS, SAN BERNARDINO MOUNTAINS, SAN BERNARDINO COUNTY, CALIFORNIA, 21 May 1963, 5,000 feet, collected by C. P. Alexander, types in the collection of the California Academy of Sciences, San Francisco.

This species somewhat resembles the members of the *cava* group of *Silis*. In these, the anterior process of the basal excisure of the pronotum is simple, the posterior margin without spicules.

Named for the collector, C. P. Alexander, in appreciation of the many novelties that he has donated to my collection and the great interest that Mrs. Alexander and he have continually shown in my work.

LITERATURE CITED

GREEN, J. W. 1966. Revision of the Nearctic species of *Silis* (Cantharidae: Coleoptera). Proc. Calif. Acad. Sci., 32(16): 447–513, 65 figs.

SCIENTIFIC NOTES

Notes on *Diaulota harteri* with new synonymy (Coleoptera: Staphylinidae).—Since the description of *Diaulota harteri* Moore and *D. megacephala* Moore (Trans. San Diego Soc. Natur. Hist., 12: 103–152, 1956) many more specimens have been collected. In all cases specimens of the former have been females and specimens of the latter males. I am convinced that the feeble lobe on the posterior margin of the sixth sternite of the holotype of *D. harteri* is a small variation of a female specimen. Consequently, I propose the following synonymy:

Diaulota harteri Moore, 1956: 123
Synonym *D. megacephala* Moore, 1956: 124 NEW SYNONYMY

I have seen a good series of this species collected from intertidal rock crevices at Gaviota Beach, Santa Barbara County, California, 23 March 1971, by Derham Giuliani. This is a northern extension of range for the species.—IAN MOORE, *Division of Biological Control, University of California, Riverside, 92502.*

***Xystridiogaster* Scheerpeltz, a synonym of *Paracraspedomerus* Moore (Coleoptera: Staphylinidae).**—The genus *Paracraspedomerus* was proposed by Ian Moore (1960, Pan-Pac. Entomol., 36: 99–101) for *Cafius speculifrons* Fauvel. Otto Scheerpeltz described the genus *Xystridiogaster* (1966, Naturhist. Mus. Wien Ann., 69: 393–418) based on the same type species. Since *Xystridiogaster* is isogenotypic with *Paracraspedomerus*, I propose the following synonymy:

Paracraspedomerus Moore, 1960
Xystridiogaster Scheerpeltz, 1965 NEW SYNONYMY

—IAN MOORE, *Division of Biological Control, Department of Entomology, University of California, Riverside, 92502.*

Notes on dry-season survival in two species of Elmidae (Coleoptera).—During June 1969, I visited a small stream which empties into the Navarro River near Philo, Mendocino County, California. The only water which remained in the stream was in the form of small, widely scattered pools. I selected a spot approximately midway between two such pools about 200 feet apart and attempted to determine, by digging into the stream bed, whether any subsurface flow of water connected the pools. After digging down about 16 inches, I encountered water, then dug a few more inches to form a small basin. I watched the debris settle and was able to detect a slight flow evidently connecting the pools. Much to my surprise, I noticed several apparently dead Elmid beetles drifting about at the bottom of the excavation. These beetles feign death when disturbed so I observed them carefully for a few minutes for signs of activity. After several minutes with no response, I transferred the beetles to a collecting pan containing about one inch of water. About ten minutes later the beetles began to evidence signs of life and started crawling about the bottom of the pan. Careful further excavation resulted in a number of additional specimens and demonstrated clearly that these insects were actually surviving in the sandy gravel bed and had not merely fallen into the hole during my digging.

The beetles were subsequently identified as *Zaitzevia parvula* (Horn) and *Narpus angustus* Casey. No other adult or larval aquatic insects were found in the gravel beds, but the few remaining pools supported abundant insect life. This same creek was revisited in November, after the annual winter rains had begun, and these two species were found clinging to rocks in flowing water, the more usual niche for these insects.

Perhaps the small size of these elmids permitted them to work their way into the gravel bed, either from above as the stream dried up, or outward from the pools along the flow paths. Of the two, I suspect the former to be the most likely. This experience would suggest that some species of Elmidae routinely aestivate, or at least survive seasonal drying, within the beds of intermittent streams. Such behavioral adaptation has obvious survival benefit in any area subject to such seasonal fluctuation in water levels.—L. NEIL BELL, *141 Mt. Shasta Court, Clayton, California 94517.*

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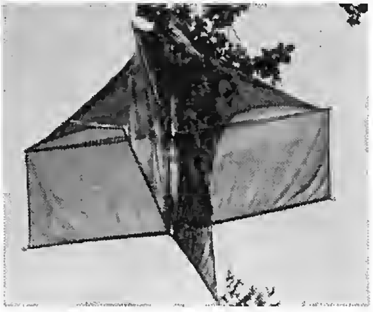

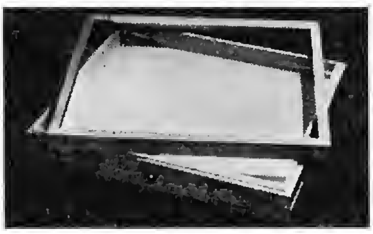

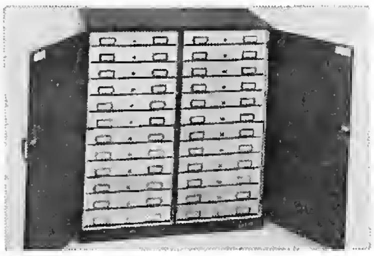

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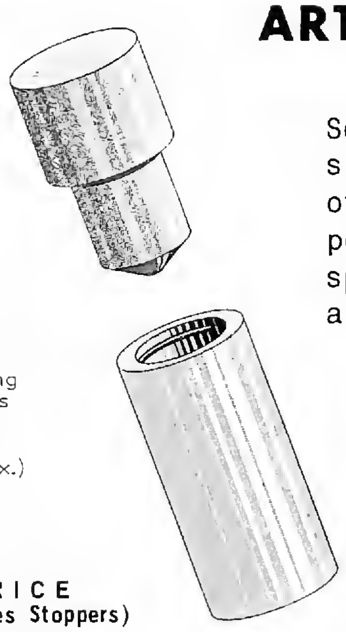

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An Eye Deformity in a Tarantula Spider, *Aphonopelma reversum* (Araneae: Theraphosidae)

PATRICK J. MARER

United States International University, Elliott Campus, San Diego, California 92124

A recent study of the fauna inhabiting Palomar Mountain in northern San Diego County, California, produced many specimens of Mygalomorph spiders, including several hundred tarantulas of the species *Aphonopelma reversum* Chamberlin. This is the most common large tarantula in the southwestern corner of the United States, its distribution being fairly uniform throughout the county.

During the course of examining these specimens, one specimen, Number 51, was discovered to have a severe eye structural anomaly. This deformity is believed to be of a genetic or developmental origin. Figures 1 and 3 are drawings of this unique structure, while Figures 2 and 4 are drawings of a normal eye structure in a male *Aphonopelma reversum*, collected on the same day.

This specimen was obtained in a pitfall trap, as described by Banta (1957). The trap was located at station number 55 on the Nate Harrison Grade road, leading up the southwestern slope of Palomar Mountain from Pauma Valley. Station number 55 is at an elevation of 1,650 feet. The spider was a freshly molted, mature male and was collected on 22 August 1970.

The extent of this eye deformity includes an irregularly shaped eye tubercle, malformation or dislocation of all but one eye, and coloration and hair differences in the eye area compared to a normal specimen (Fig. 1).

The only eye that is not malformed or dislocated is the left posterior-lateral eye. The left anterior-lateral eye appears somewhat in its proper place and its base is of the correct size and shape. The eye itself extends laterally to the left about twice its normal length. The whole segment is covered with lens tissue. There is an apparent attempt for this eye to divide into two or possibly three segments.

The posteromedian eye on the left side is in its normal position, al-

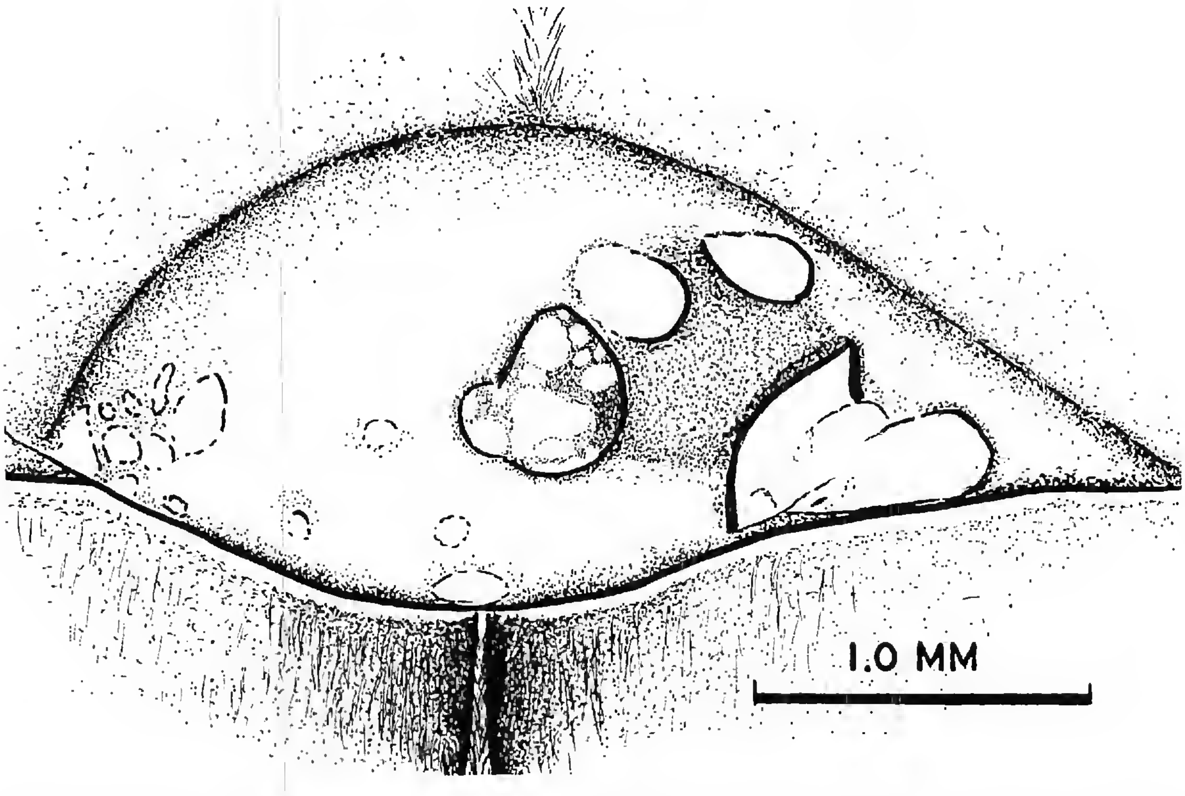

FIG. 1. Dorsal view of abnormal eye tubercle of *Aphonopelma reversum*, specimen number 51. Note many oval shapes and darker matrix in central eye, as well as irregular shape of tubercle.

though its separation from the adjacent posterolateral eye is greater than the record for this species. This distance is about the width of the posterolateral eye, while in a normal specimen there is little or no separation between these eyes. The eye is larger than normal and is partially obscured by the anomalous eye anterior to it (Fig. 1).

The right lateral side of the eye bulb has no definite eyes, although in the location where the right anterolateral eye would normally be there is found a mass of eye tissue, including lenses, which has divided into 10 different circular shapes, resembling small eyes of various sizes. There are four additional shapes on the anterior aspect of the bulb, nearer the midline. These four "eyes" are greatly separated from each other as compared to the close proximity of the eye structures located on the right lateral aspect.

In the midplane of the eye tubercle there is one other large eye structure which is extremely complex, appearing to divide into many segments (Fig. 1). This is a teardrop shaped structure, more than twice the size of a normal eye. It is positioned to the left side of the eye tubercle, rather than in the center. The large end of the teardrop is anterior. There is an extra bulb on the right anterolateral aspect composed of additional lens tissue, and appearing to form two oval shaped eyes. The main body of this structure resembles a large eye with a smooth lens,

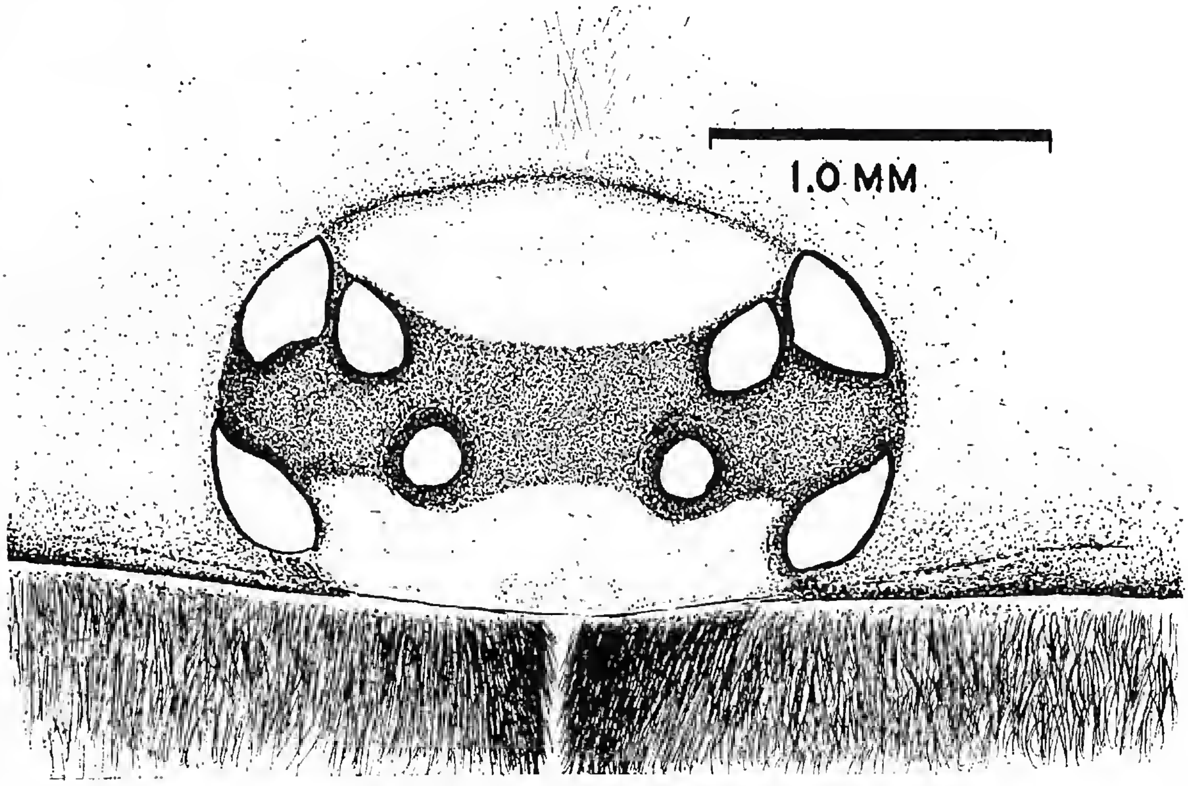

FIG. 2. Dorsal view of normal eye tubercle of *Aphonopelma reversum*, specimen number 42.

except the lens contains a complex dark brown marking, separating it into 12 oval and round shapes of various sizes. Each shape studied individually resembles an eye. This entire eye structure has the characteristic tissue bordering it that is found around normal eyes.

The eye tubercle is considerably asymmetrical (Fig. 1 and 3). The left side is more oblong from its midline to its lateral terminus than the right. The right half, divided along a mid-transverse line, is broader from front to back than the left. Viewed anteriorly, the tubercle is higher on the left side, corresponding to the large anomalous eye structure near the midline. The tubercle is nearly twice as thick in this location as the normal eye tubercle (Fig. 4).

The eye tubercle is lighter in color on the right side. The area bounded by the left anterior and posterolateral eyes, median eye and anomalous central eye is black in color. The rest of the tubercle is reddish brown, lighter on the right side near its anterior margin. All the lens areas appear pearl colored, those of the right side with a yellowish cast. The normal eye tubercle in this species has a black marking running between the anterior and posterior rows of eyes in a lateral direction along the entire width of the eye tubercle (Fig. 2).

The cephalothorax in the area of the eye tubercle is lighter colored on the right side, and hair in this area is more sparse than on the left. This

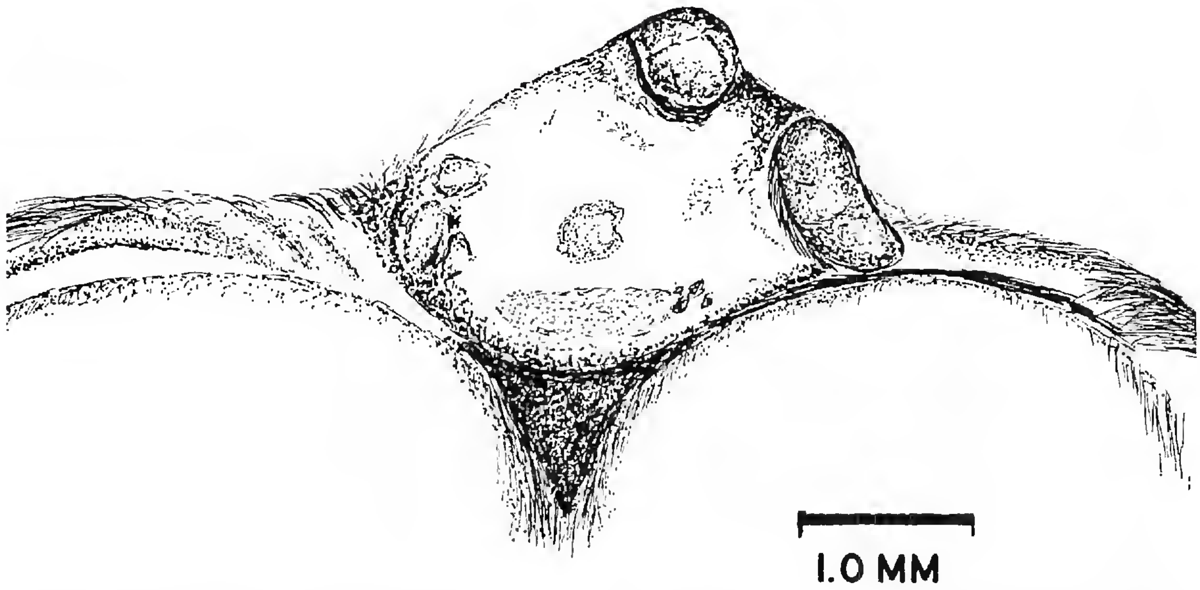

FIG. 3. Anterior view of eye tubercle of *Aphonopelma reversum*, specimen number 51, showing asymmetry of this structure.

hair is growing in irregular patches in many different directions, as opposed to a normal, more symmetrical growth pattern of hair.

The rest of the body and appendages of this spider are normal in color, structure and appearance and compare favorably with other specimens of mature male *Aphonopelma reversum*.

Due to the complexity of this abnormality, coupled with its vital location—the eye tubercle— it seems unlikely that the deformity could have resulted from an injury. It is apparent that the ectodermal layer which produced the eye structure has either been damaged or infolded during formation or in some other way is not complete. An injury to this area of the tarantula's body, sufficient to damage the underlying germ layer, would most likely result in the death of the spider due to loss of blood. A molt associated injury would seem to produce the same results or cause irreparable damage to underlying structures. This is a vital area of the tarantula's body (Firstman, 1954).

This specimen was captured during the peak activity period for male tarantulas of this species. According to observations of the activities of this species, this peak activity period is preceded by the final molt of the male (Petrunkevitch, 1934). This particular specimen's condition and color indicates that it had molted about one week or so before being caught in the trap. Any injury during this final molt would not have healed within this period of time even if the spider could have survived the loss of blood or damage to tissues.

The only possible remaining causes of this deformity would be of either a congenital or a developmental nature. This could explain the many

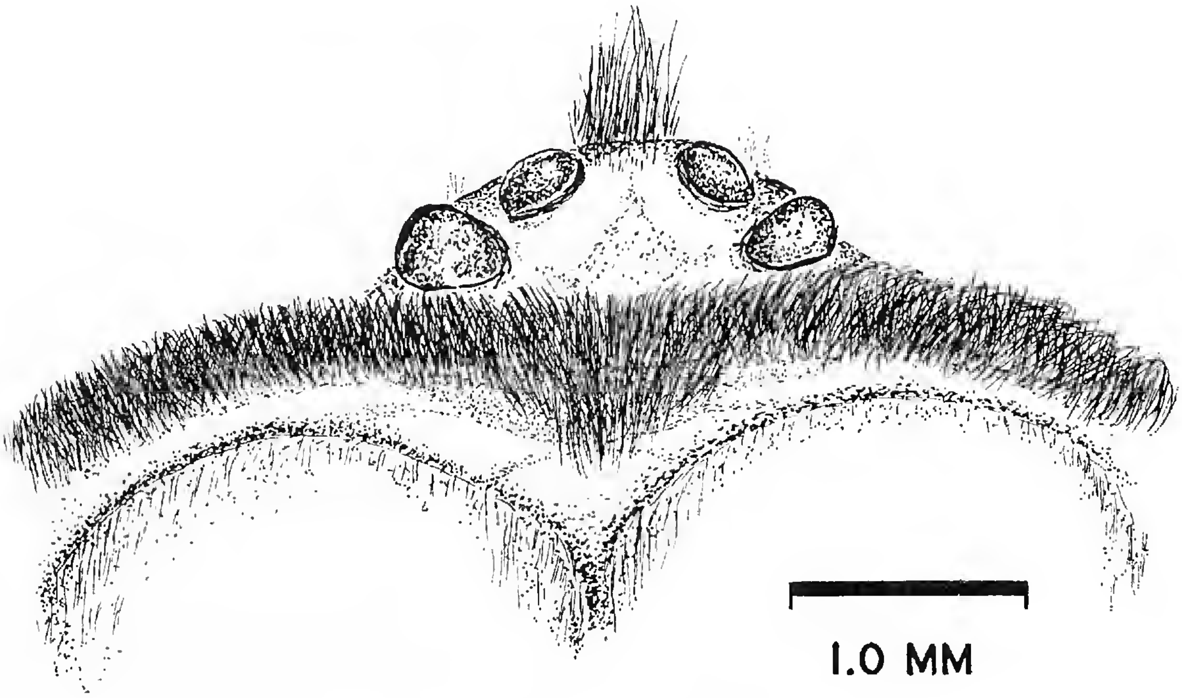

Fig. 4. Anterior view of eye tubercle of *Aphonopelma reversum*, specimen number 42, showing appearance of a normal structure.

eye shapes and attempts to form eyes. The divisions within the central eye and the smaller lateral eye segments suggest that the structure attempted to divide, but the number of irregular divisions and the misplacement of eyes indicates that control of the process was lost or the process itself was interrupted by some factor.

Vision in this genus of Mygalomorph spiders is very poor, the eyes possibly being used only as photoperiod receptors. It is doubtful, therefore, that this deformity had any serious effect on the life of this particular specimen, especially considering that it had reached sexual maturity, which takes as long as 12 years for this species.

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New Species of the Genus *Baetodes*

(Ephemeroptera: Baetidae)

VELMA KNOX MAYO

2702 E. Seneca St., Tucson, Arizona 85716

The genus *Baetodes* is known at the present time from Arizona and Texas in the United States, and from Mexico, Central and South America. In Central America it has been taken from Guatemala, Honduras, Costa Rica, El Salvador, Panama and the Canal Zone. In South America it has been collected in Brazil, Venezuela, Ecuador, Peru, and Bolivia.

The genus was established in 1924 by Needham and Murphy. A review of the characteristics of the genus by Needham and Murphy (1924), by Traver (1943, 1944) and by Edmunds (1950) was included in a paper by the writer (Mayo, 1968). Traver (1943) described the only known adult, *Baetodes spiniferum.* She requested that the writer emend the spelling on her *B. spiniferum* to *Baetodes spinifer.* Cohen and Allen (1972) have described nine new species of *Baetodes* from Mexico and Central America.

GENERIC DIAGNOSIS

NYMPHS.—*Head* (Fig. 16, Mayo, 1968). Ocelli prominent, two large ones laterad of epicranial fork, and small one, below these within fork. Mouthparts as follows: *Labrum* with sclerotized band along lateral margins and thick fringe of setae around margin, apical margin with cleft at midline, row of stout, prominent spines of varying length and number and arranged in two groups (one near midline, and one closer to lateral margin). Behind apical margin with numerous scattered, shorter setae behind these (Figs. 5, 8). *Mandibles* with thumblike process at base of molar surface of left mandible that varies in size and shape in different species, rim of molar surface near the thumb with one tooth larger than others (Fig. 24), lacinia well developed on left mandible, situated close to incisors (Fig. 17), lacinia on right mandible represented by small, slender, pointed process situated half way between molar surface and incisors. Highly sclerotized "anterior articulatory process" (Traver and Edmunds, 1968) extends parallel and posterior to molar surfaces on both mandibles; right mandible with short bristle extending from rim of molar surface (Fig. 4). *Maxillae* with palpi two segmented (Fig. 22), and crowns of maxillae with fringe of long, stout setae (Fig. 16). *Labium* with palpi three segmented (Figs. 12, 15), apical segment of labium with spines (Figs. 12, 15), paraglossae with thick brush of curved pectinate spines of varying lengths and curving mesally with all pinnae directed mesally (Fig. 2), glossae with setae at tips (Fig. 12). *Thorax* with anterior border of pronotum concave and anterolateral corners acute (Fig. 9), hind wings absent, narrow, elongated cervical sclerite articulates with posterior border of propleuron, and extends to head on

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either side, high dorsal crest on each coxa, legs unusually long and slender, tibiae slightly longer than femora and tarsi slightly less than ⅓ as long as tibiae, femora with variable number of stiff spines along dorsal crests, tibiae distinctly marked with narrow strip which extends over ⅔ of dorsal surface and terminates at ventral margin, shaft of tibia beyond this point abruptly more narrow and narrow point of segment marked with diagonal streak (Fig. 14), fringe of setae along dorsal crests of femora and tibiae, femoral and tibial articulations heavily sclerotized, claws each with long, stout, colorless bristle originating near base of first marginal denticle and curving out as far as the tip of claw (Figs. 3, 6), variable number of denticles, decreasing in size rearward. *Abdomen* with simple gills on abdominal terga 1–5 only, gills attach near low pleural fold. *Caudal filaments* without setae, terminal filament short stub and correspondingly narrower than lateral cerci.

Discussion

The spines behind the apical margin of the labrum are prominent, varying in length, and are often alternated, one long, one short (Fig. 5). According to Traver and Edmunds (1968), Macan (1961) "shows how the pattern of spines on the dorsal surface of the labrum serves to differentiate four different species of *Baetis*." The spines behind the apical margins of the labra of *Baetodes* described in this paper are distinctive for each species except for *B. obesus* (Fig. 32) and for *B. sancticatarinae* (Fig. 45). Those of *B. sancticatarinae* are much farther from the apical margin than those of *B. obesus.*

In some species a hump or tubercle occurs on the posterior border of the pronotum.

The spines along the dorsal crests of femora of most species are prominent but are difficult to detect on *B. obesus.* On one species examined they were invisible under the binocular microscope, but three yellow spines were visible under high power of the compound microscope.

Discussion of the long bristle behind the claw was omitted from the descriptions of *B. spinae* and *B. levis* and from Fig. 19 (Mayo, 1968).

There are no tubercles on the abdomen of the species herein described. Abdominal tubercles occur on the majority of species and where there are tubercles on the abdomen there is usually one on the metanotum. These tubercles are always unpaired, arising from the posterior border at the midline. Some are very small, directed rearward and some are erect and prominent.

On many species elongated fingerlike gills occur at the bases of all three pair of coxae. Some of these are single, and some are paired. There are three different sizes, long, intermediate, and small. The largest, and by far the most common, are four times the length of the smallest size.

Many species have scattered setae on the dorsal surface of the body segments.

Baetodes chilloni Mayo, new species

(Figs. 1–5)

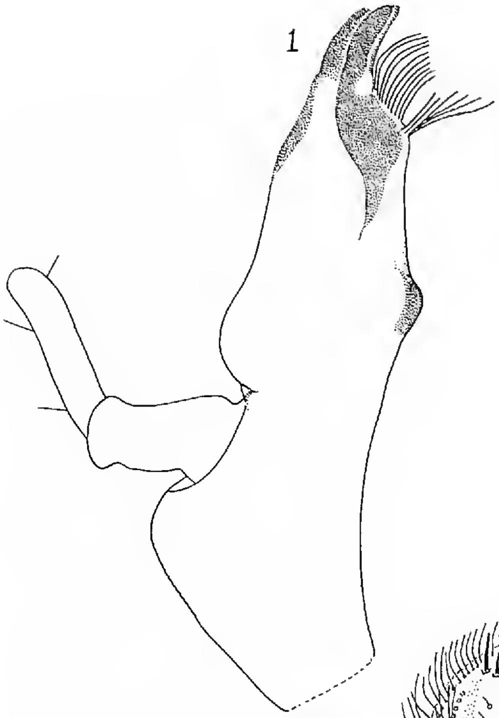
Female nymph.—Length of body about 4 mm, cerci slightly shorter. General color brown dorsally. *Head* brown; darker brown spots on either side midline between eyes; eyes bordered with yellow; antennae pale yellow. Mouthparts as in Figs. 1, 2, 4, 5. All intersegmental membranes pale yellow. *Thorax* with pronotum brown; anterior border narrowly rimmed with dark brown; mesonotum and wing pads brown; numerous fine white setae dorsally on thorax; pleural sclerites brown; unsclerotized areas pale yellow. Coxae and trochanters brown; femora an even brown except for a large pale yellow spot near joining with trochanters; rimmed with dark brown at joinings with tibiae; six or seven reddish brown spines on dorsal crests of femora. Tibiae pale brown with usual white streak entire length. Tarsi light brown; reddish brown at joining with claw. Claw as in Fig. 3. Sternum pale yellow except for brown, curved sclerites at apodemes. *Abdomen* with all terga an even brown, anterior borders narrowly rimmed with dark brown; without tubercles. Abdominal gills light yellow, darker on basal half, each coxa with two fingerlike gills of long type. Sternum 1 pale brown, lighter mesally; 2–9 brown, 6–9 with pale yellow horizontal streak laterally near anterior borders; 8–10 with triangular yellow area with base along entire posterior borders and apex at midline on anterior borders; pleural fold yellow. Cerci and terminal filament yellow tinged with brown distally.

Holotype female nymph, Station V, Rio Chillon, Peru, 500 m, 3 May 1958, J. Illies. In Entomological collection University of Utah, Salt Lake City. Paratype: 1 nymph, same data, same deposition as holotype.

Discussion.—General color of thoracic sternum pale yellow; that of abdominal sternum brown as on dorsal surface. *Baetodes chilloni* can be distinguished from *B. solus* by the presence of coxal gills. The thoracic sternum of this species is pale, whereas that of *B. solus* is dark brown. The labrum differs in details of the spines behind apical margin from those of *B. solus* (Fig. 5, 18). Details of the mouthparts of this species distinguish it from *B.* sp. No. 1 (Figs. 7, 8, 10, 20, 24, Mayo, 1968).

→

Fig. 1. Maxilla of *B. chilloni.* Fig. 2. Labium of *B. chilloni.* Fig. 3. Claw of *B. chilloni.* Fig. 4. Right mandible of *B. chilloni.* Fig. 5. Labrum of *B. chilloni.* Fig. 6. Claw of *B. traverae.* Fig. 7. Cerci and terminal filament of *B. traverae.* Fig. 8. Labrum of *B. traverae.* Fig. 9. Dorsal view of head and thorax of *B. traverae.* Fig. 10. Gill IV of *B. traverae.* Fig. 11. Left mandible of *B. traverae.* Fig. 12. Labium of *B. traverae.* Fig. 13. Maxilla of *B. traverae.* Fig. 14. Leg II of *B. traverae.*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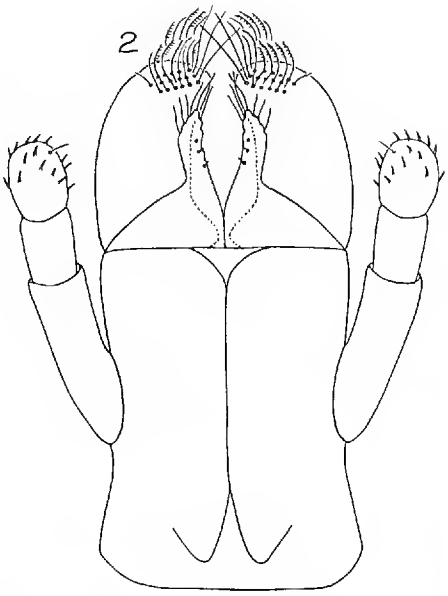
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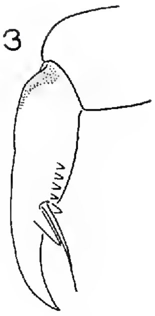
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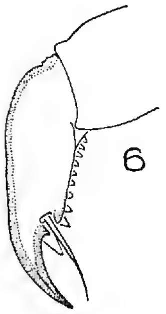
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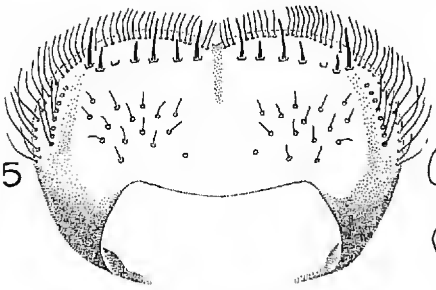
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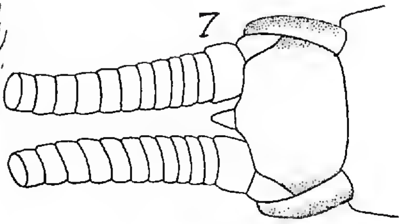
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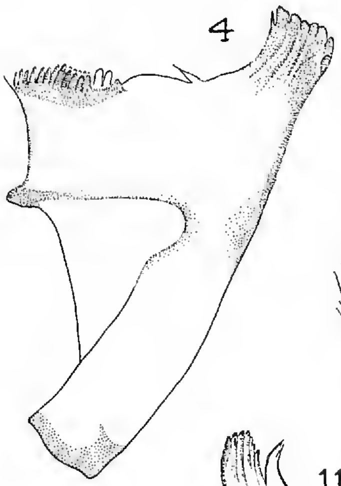
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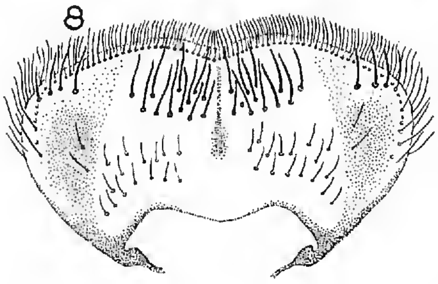
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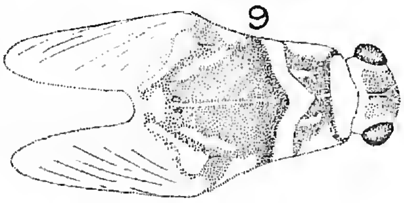
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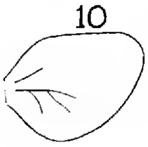
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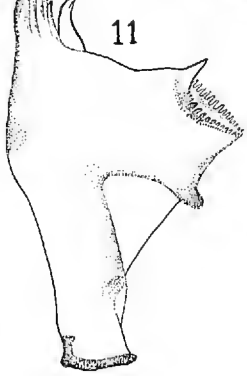
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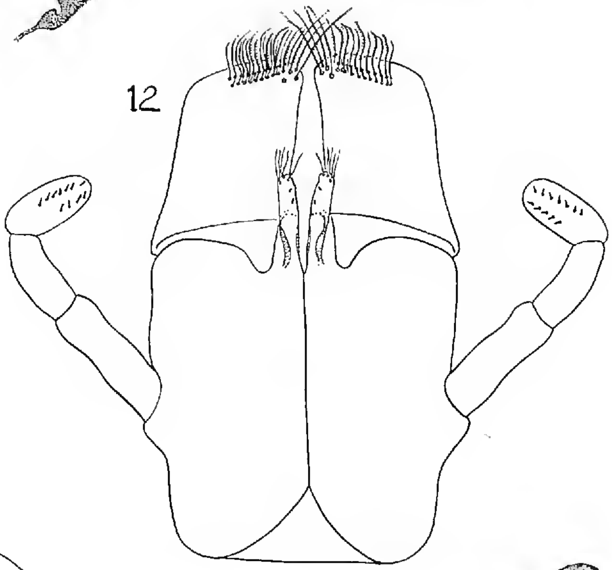
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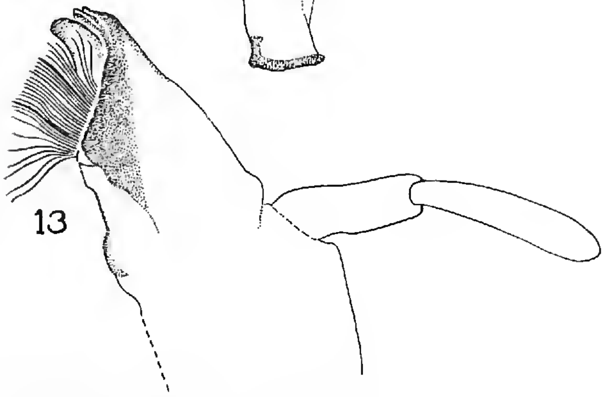
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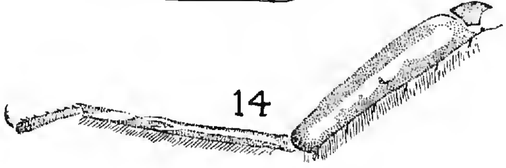
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Baetodes traverae Mayo, new species

(Figs. 6–14)

FEMALE NYMPH.—Length of body about 6 mm, cerci about 7 mm. General color dark brown; unsclerotized areas yellow. Head more narrow than that of other species; area between eyes dark brown; yellow anterior to eyes and around bases of antennae; first two segments of antennae yellow, remaining segments pale brown; mouthparts as in Figs. 8, 11–13. Spines behind apical margin of labrum grouped together (Fig. 8); glossae short (Fig. 12) thumb on left mandible pointed (Fig. 11). Two long bladelike spines among setae on crowns of maxillae. Large ocelli with black crescent on inner margins; small one rimmed with black on anterior margin. *Thorax* with pronotum dark brown along anterior border; irregular yellow areas as in Fig. 9; anterior margin concave; posterior margin convex so that medial portion of pronotum less than half as deep as lateral borders. Mesonotum brown along anterior border; and on either side of midline to scutellum. Two diagonal, wide yellow areas on scutum at border of wing pads; two dark brown dots close to midline anterior to scutum (Fig. 9) and laterally, half way between anterior border and wing pads. Metanotum dark brown. Posterior border yellow lateral to midline. Thoracic sclerites of pleuron dark brown; unsclerotized areas pale yellow; femora with wide pale yellow stripe on dorsal surface; dark brown at joinings with tibiae; tibiae brown (Fig. 14); tarsi brown with seven spines along lower edge; blackish brown at joining with claw; claw with ten denticles (Fig. 6). Sternum pale yellow except for small brown sclerites around apodemes at postero-lateral corners of meso- and metasternum. *Abdomen* with terga darker brown than thorax; midline with very faint yellow streak on all terga; more prominent on 10; shaded with yellow at pleural fold; posterior borders of terga 3–6 yellow to midline. Without abdominal tubercles; abdominal gills oval, tracheae white (Fig. 10). Sterna very pale brown; narrow brown markings horizontally on 2–9 on either side of midline close to anterior border; vertical brown streaks ⅔ distance between anterior and posterior borders near pleural fold on segments 2–9. Cerci light brown; terminal filament unusually short stub; not as long as depth of first segment of cerci; at base about ⅓ width of base of cerci; appears to be unsegmented; better seen from ventral aspect (Fig. 7).

MALE NYMPH.—Length of body about 5 mm, cerci 5 mm.

Holotype female nymph, STATION II RIO CHILLON, PERU, 2500 m, 3 May 1958, J. Illies. In Entomological collection University of Utah, Salt Lake City. Paratypes five nymphs same data, same deposition as holotype. Twelve nymphs, station III Rio Chillon, Peru, 1900 m, 3 May 1958, J. Illies. Same deposition as holotype.

DISCUSSION.—*Baetodes traverae* can be distinguished from all other species by the terminal filament which is so small as to be hard to see from the dorsal view (Fig. 7, ventral view). The glossae are much shorter than those of any other species examined (Fig. 12); the thumb on left mandible is more pointed (Fig. 11); the spines behind apical margin of labrum are grouped together as on no other species (Fig. 8). Thoracic sterna of mature specimens are developed as in subimago.

This species is named in honor of Dr. Jay R. Traver, emeritus professor of Zoology, University of Massachusetts, Amherst, Massachusetts.

Baetodes solus Mayo, new species

(Figs. 15–19)

FEMALE NYMPH.—Length of body about 3 mm, cerci somewhat longer. General color yellowish brown. *Head* pale brown patches either side midline between eyes; light brown in epicranial fork; first two segments antennae pale, rest pale smoky brown. Mouthparts as in Figs. 15–18. One wide bladelike spine distally near inner margin of each paraglossa (Fig. 15). Two long bladelike spines among setae on crowns of maxillae. *Thorax* with nota of all segments light brown mottled with yellow. Pleural sclerites brown. Femora light brown except for yellow area near distal end; narrowly rimmed with reddish brown at joinings with tibiae; tibiae pale brown. Tarsi pale brown, darker at joinings with claw. Sternum dark brown mottled with fine yellow dots. *Abdomen* with terga pale brown, darker along anterior borders; without tubercles. Abdominal gills as in Fig. 19. Without coxal gills. Sternum 1 dark brown and mottled as on thorax; 2–9 brown, somewhat lighter than thoracic sternum; 10 light brown. Cerci and terminal filament pale, smoky tinged.

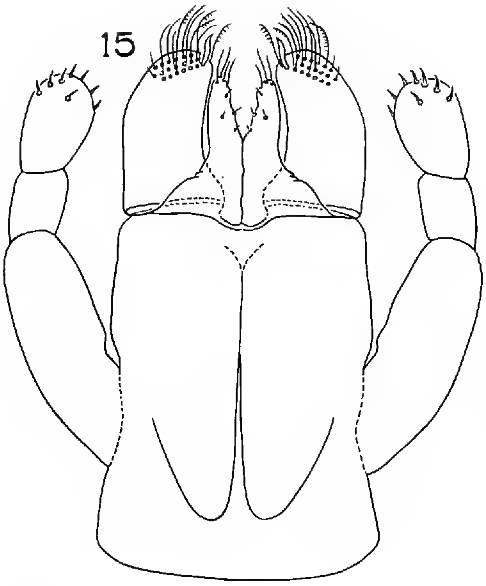
Holotype female nymph, RIO BELLA AT JCT. OF RIO MONZON, MONZON VALLEY, HUANUCO PROVINCE, PERU, 25 July 1963, W. L. Peters. In Entomological collection University of Utah, Salt Lake City.

DISCUSSION.—*Baetodes solus* has no abdominal tubercles or coxal gills. See discussions of *B. obesus*, *B. bellus*, and *B. traverae* for distinguishing characters between these species and *B. solus*. *B. solus* can be separated from *B.* sp. No. 1 by the details of the mouthparts, particularly those of the labrum (Figs. 7, 8, 10, 20, 24, Mayo, 1968).

Baetodes andamagensis Mayo, new species

(Figs. 20–26)

MALE NYMPH.—Length of body 4.5 mm; cerci longer. *Head* with brown on either side midline between turbinate eyes; brown in fork; pale spot over small ocellus. Antennae very pale brown. Mouthparts as in Figs. 21–26. Each paraglossa with long seta, not pinnate, directed mesally with base below bases of pinnate spines. Tip of each glossa with two short blunt spines at base of one long bladelike spine (Fig. 23). Mandibles with two small lobes of incisors at inner margin; other incisors compacted into single lobe as in Figs. 24, 25; delicate setae scattered on surfaces as in Figs. 24, 25. Labrum (Fig. 21) with long sclerotized strip behind cleft. Maxillae with two wide bladelike spines with blunt tips among setae on crown (Fig. 22). *Thorax* with pronotum dark brown with pale yellow area at midline along posterior border. Posterior rims of pleural sclerites visible on either side of pronotum from dorsal view. Intersegmental membrane between pro- and mesonota pale yellow. Mesonotum dark brown; dark reddish brown streaks parallel to midline half way between midline and borders of wing pads; mottled with reddish brown at bases of wing pads; scutellum pale; wing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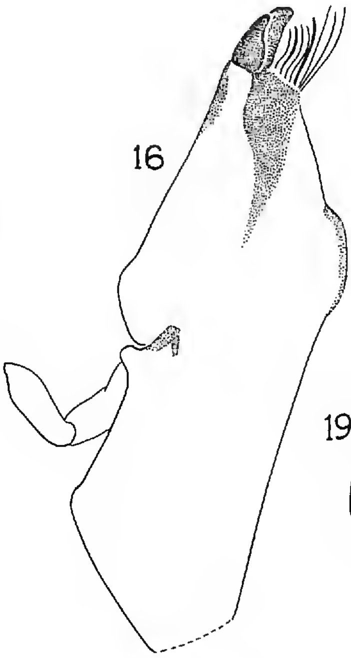
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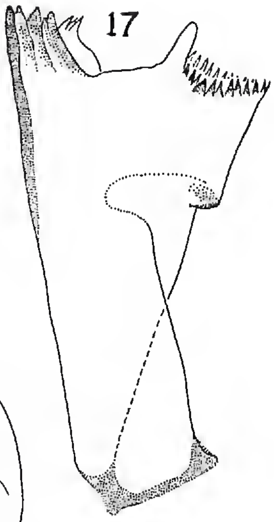
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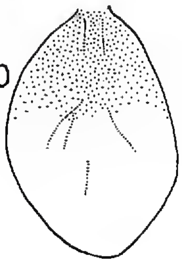
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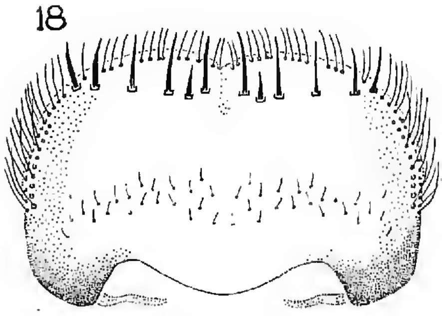
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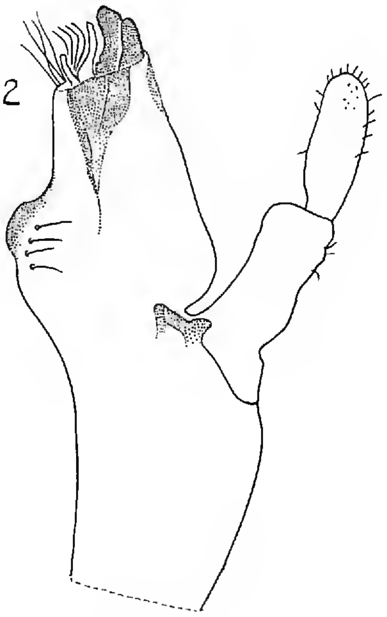
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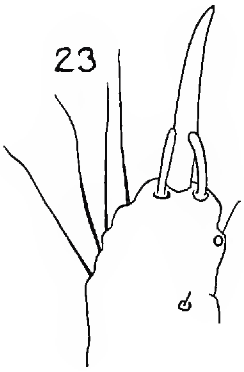
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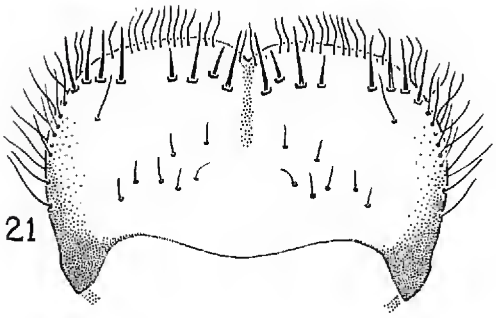
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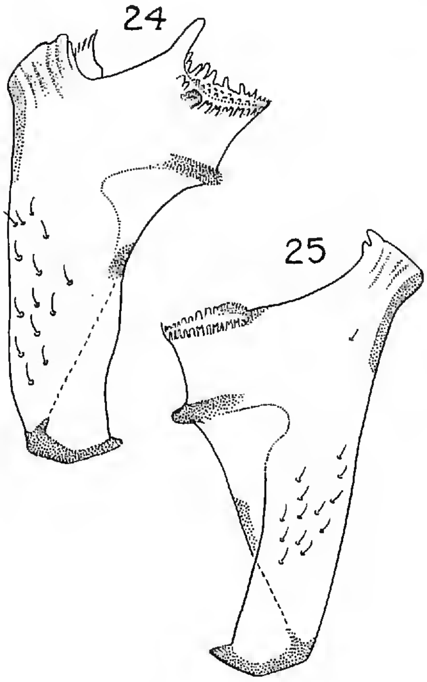
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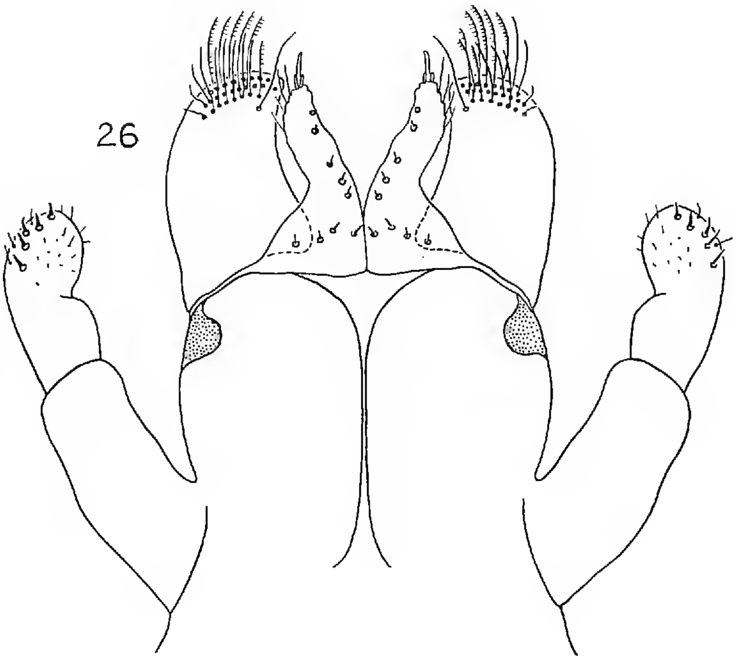
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pads brown; pleural sclerites, coxae and trochanters brown; femora brown, same color as thoracic notum; pale yellow spot near joining with trochanter, rimmed with reddish brown at joining with tibiae; fringe of white setae on tarsi; tibiae and tarsi very pale brown; tibiae narrowly rimmed with reddish brown at joining with femora. Sterna pale yellow, except for brown curved strip on prosternum between apodemes, and dark brown apodemes at leg bases on meso- and metasternum. *Abdomen* with terga dark brown. Intersegmental membranes yellow. Tergum light brown anteriorly, dark brown posteriorly along posterior border. Dark streak on either side midline on terga 2–8, indistinct on 2–5; terga 5–7 darker, 9 an even brown, 10 pale brown. All terga narrowly rimmed with reddish brown along anterior borders. Without tubercles. Abdominal gills oval, smoky in basal half (Fig. 20). Two fingerlike gills from each coxa of the intermediate type. Numerous white setae clustered along midline. Sternum 1 pale yellow; 2–6 brown from anterior to posterior borders on medial third of segments, laterally yellow, each lateral area medially with narrow brown streak extending from anterior border half way to posterior border; 7–9 darker brown, lateral yellow areas mere streaks, streaked with dark brown along pleural fold; 9 yellow along posterior border; 10 yellow. Cerci and terminal filament very pale brown.

FEMALE.—Head more pale; tibiae and tarsi very pale; cerci and terminal filament pale yellow.

Holotype male nymph, ANDAMAGO RIVER NEAR ONGORO, PERU, 16 May 1958, J. Illies. In Entomological collection of University of Utah, Salt Lake City. Six paratypes, same data, same deposition as holotype. Two paratypes, irrigation canal near hacienda, Ongoro, Peru, 16 May 1958. J. Illies. Same deposition as holotype.

DISCUSSION.—On the mandibles there are two small lobes on the incisors at the inner margin. The rest are compacted into a single lobe as in Figs. 24, 25. This is unique. The labrum can be distinguished from all others by the spines behind the apical margin (Fig. 21). Maxillae have two wide bladelike spines with blunt tips among setae on crown (Fig. 22).

Baetodes obesus Mayo, new species

(Figs. 27–32)

FEMALE NYMPH.—Length of body 3 mm, cerci about 4 mm. Stout species. *Head* widely yellow around eyes; laterally tips of large ocelli very close to eyes; light brown either side midline between ocelli, in fork and on genae; pale yellow anterior

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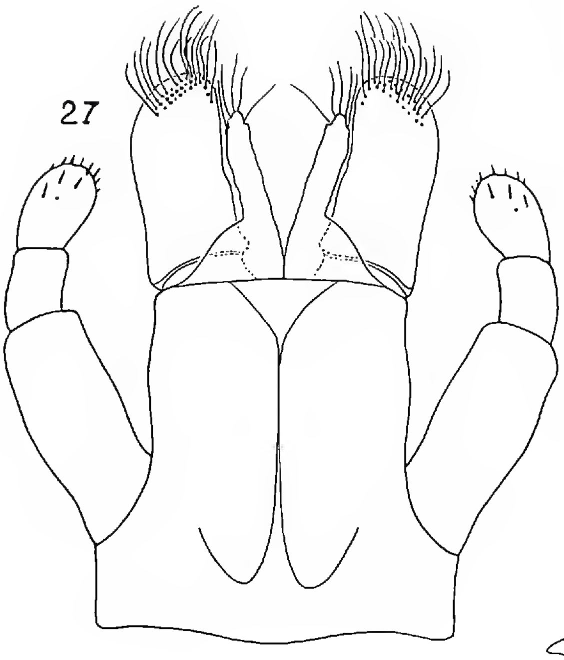
FIG. 15. Labium of *B. solus.* FIG. 16. Maxilla of *B. solus.* FIG. 17. Left mandible of *B. solus.* FIG. 18. Labrum of *B. solus.* FIG. 19. Gill of *B. solus.* FIG. 20. Gill III of *B. andamagensis.* FIG. 21. Labrum of *B. andamagensis.* FIG. 22. Maxilla of *B. andamagensis.* FIG. 23. Tip of glossa of *B. andamagensis.* FIG. 24. Left mandible of *B. andamagensis.* FIG. 25. Right mandible of *B. andamagensis.* FIG. 26. Labium of *B. andamagensis.*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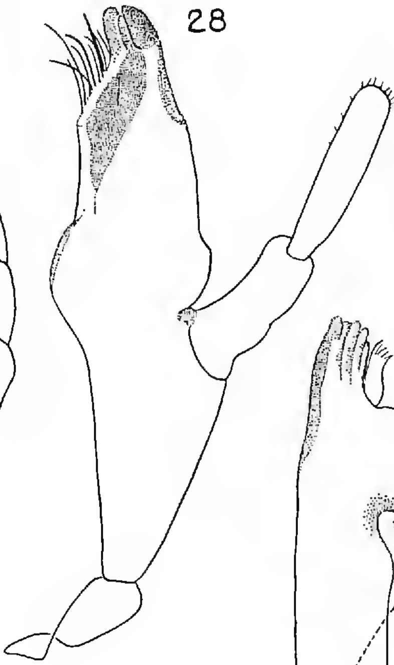
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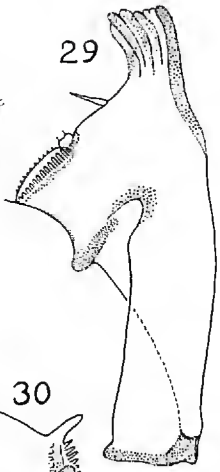
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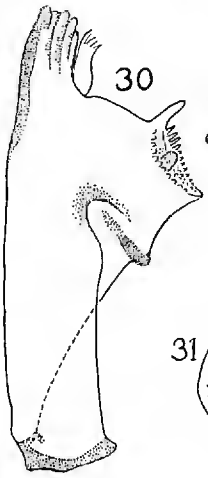
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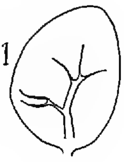
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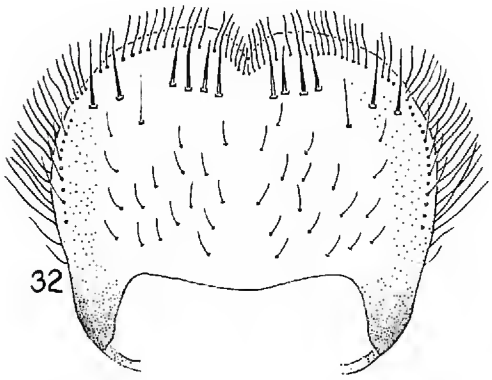
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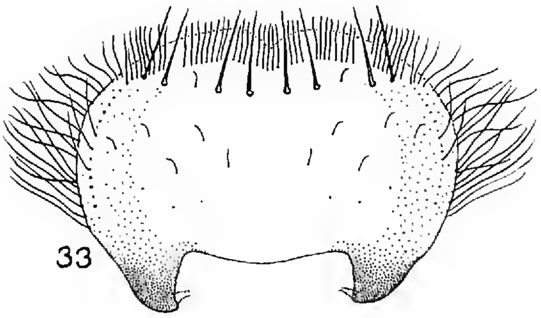
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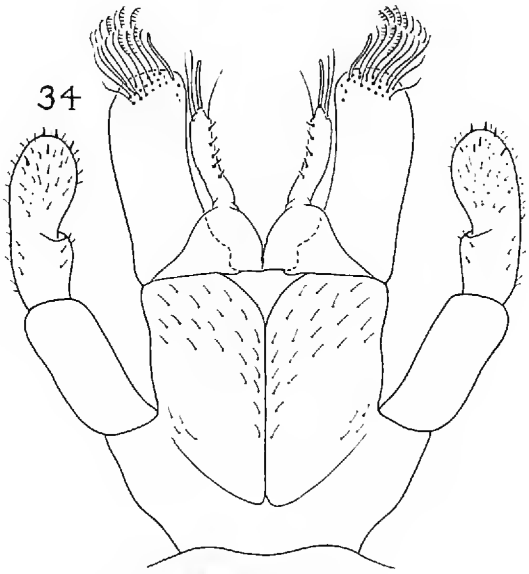
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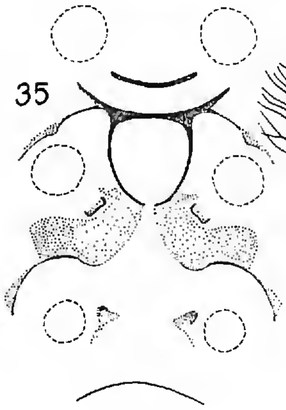
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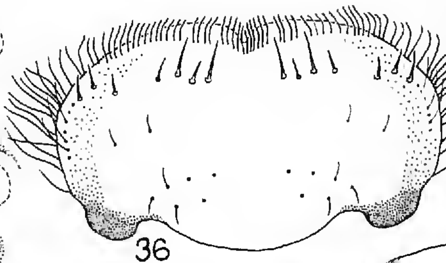
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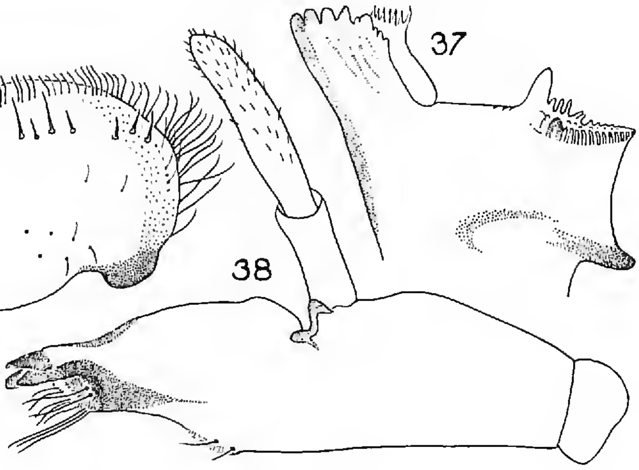
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to small ocellus; anterior margin very narrowly rimmed with dark brown between antennae and around bases of antennae; antennae yellow, tinged with pale brown near tips. Clypeus pale, labrum light brown. Mouthparts as in Figs. 27–30, 32. Labrum not sclerotized below medial cleft. Two long bladelike spines among setae on crown of maxillae; very faintly pinnate. Intersegmental membrane between head and pronotum white, penciled with gray medially; gray area extends from anterior to posterior borders half way from midline to lateral border. *Thorax* with anterior border of pronotum evenly bordered with brown except at midline which is pale; pronotum yellow with pale area along midline and posterior border near midline; two yellowish brown stripes from anterior brown border to pale area along posterior border, about half way between midline and lateral borders; two brown oval spots on either side near posterior border; narrow reddish brown rims of pleural sclerites show on either side of pronotum. Mesonotum yellow except for brown anterior border, light brown side stripe on either side pale midline tapering to half width anterior to scutellum; mottled with light brown laterally with two darker brown oval spots, one either side midline anterior to scutellum, and several near borders of wing pads yellow, with three brown oval spots, one mesally and two anteriorly; scutellum and borders of wing pads pale; reddish brown streak on scutum anteriorly along border of wing pads; brown area either side of scutellum. Metanotum dark brown. Legs pale yellow; pleural sclerites light brown. Cervical sclerites reddish brown. Coxae and trochanters light brown. Femora yellow, darker in medial third; spines on dorsal crests inconspicuous. Tibiae rimmed with reddish brown at joinings with femora, otherwise pale; several spines on ventral surface. Tarsi yellow, washed with reddish brown in distal third at joining with claw; narrowly rimmed with reddish brown at joining with tibiae; six to eight fairly long spines along ventral surface of tarsi. Claw with five denticles. Sternum pale yellow. *Abdomen* with tergum 1 dark brown; 2 dark brown except for yellow area mesally on posterior margin and on either side midline ⅔ way to anterior border; tergum 3 the same except brown area more pale and yellow area larger; terga 4–6 yellow, 7–8 light brown, 9–10 yellow; intersegmental areas pale yellow. Without tubercles. Abdominal gills oval, white (Fig. 31). Two elongated fingerlike gills from each coxa of the long type. Sterna 1–6 pale yellow tinged with brown along anterior margin, 7–8 amber tinged with brown anterolaterally, 9 yellow with brown anterolaterally, 10 yellow. Cerci yellow, stout at bases; terminal filament yellow, much thinner.

Holotype female nymph, Tenndido River, 3 km N. El Fortin, Vera Cruz, Mexico, 1 July 1955, R. B. and J. M. Selander. In Entomo-

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Fig. 27. Labium of *B. obesus*. Fig. 28. Maxilla of *B. obesus*. Fig. 29. Right mandible of *B. obesus*. Fig. 30. Left mandible of *B. obesus*. Fig. 31. Gill of *B. obesus*. Fig. 31. Gill of *B. obesus*. Fig. 32. Labrum of *B. obesus*. Fig. 33. Labrum of *B. bellus*. Fig. 34. Labium of *B. fortinensis*. Fig. 35. Thoracic sternum of *B. fortinensis*. Leg bases indicated by dotted circles. Fig. 36. Labrum of *B. fortinensis*. Fig. 37. Left mandible of *B. fortinensis*. Fig. 38. Maxilla of *B. fortinensis*.

logical collection University of Utah, Salt Lake City. Paratype, 1 female nymph, same data, same deposition as holotype.

DISCUSSION.—*Baetodes obesus* can be distinguished from *B. solus*, *B. traverae*, and *B. bellus* by the coxal gills. The spines on dorsal crests of femora are fine, inconspicuous, in contrast to the prominent spines of the other species in this group. The labrum can be distinguished from that of all other species in this group by the spines behind the apical margin (Figs. 5, 8, 18, 32, 33, 36, 39). The two bladelike spines among setae on crowns of maxillae are faintly pinnate. This is not the case among the other species in this group.

Baetodes bellus Mayo, new species

(Fig. 33)

MALE NYMPH.—Length of body 4 mm, cerci about 5 mm. *Head* light reddish brown on vertex, between turbinate eyes, along midline and epicranial suture; widely rimmed with yellow around turbinate eyes; pale between large ocelli and eyes; brown in fork and between antennae; pale around small ocellus; very narrowly rimmed with reddish brown between and around bases of antennae; antennae pale yellowish brown, darker distally; intersegmental membranes pale; clypeus and labrum pale. Labrum slightly sclerotized below medial cleft (Fig. 33). Each glossa with pointed bladelike spine at tip. Two long, bladelike spines among setae on crowns of maxillae. Intersegmental membrane between head and pronotum white, penciled with gray across medial third. *Thorax* with pronotum yellow, narrowly bordered with light brown along anterior margin; three pale brown areas on either side midline; dark reddish brown margin of pleural sclerites shows on either side pronotum. Intersegmental membrane between pro- and mesonota white bordered with dark gray posteriorly. Anterior border mesonotum penciled with dark brown along fairly wide strip; mesonotum yellow faintly mottled with light brown; midline pale with brown stripes along either side terminating in two brown spots anterior to scutellum; another stripe lateral to each stripe; mottled with brown at wing bases. Metanotum yellow mottled with brown, darker brown along pale midline. Pleural sclerites light brown. Coxae and trochanters light brown; femora light brown with pale yellow spot near joining with trochanters; pale elongated spot below this in medial third, pale spot distally; brown at joinings with tibiae; tibiae rimmed with reddish brown at joinings with femora; remainder of segment light brown; few minute spines along ventral surface. Tarsi yellow in apical half and reddish brown at joinings with claws; darker dorsally; about six minute spines along ventral surface of tarsi. Claws with five denticles. Pro- and mesosterna pale yellow; metasternum slightly darker. *Abdomen* dark brown and yellow; tergum 1 dark brown on anterior two thirds, yellow along posterior border; terga 2–3 yellow laterally and along posterior borders at midline; remainder dark brown; 4–6 dark brown along anterior borders, and narrowly touched with brown along posterior borders at midline; remainder yellow, more pale laterally; 7 with yellow point at midline on anterior border, yellow mesally and laterally; dark brown along anterior border half way to lateral border; touched with brown along posterior border

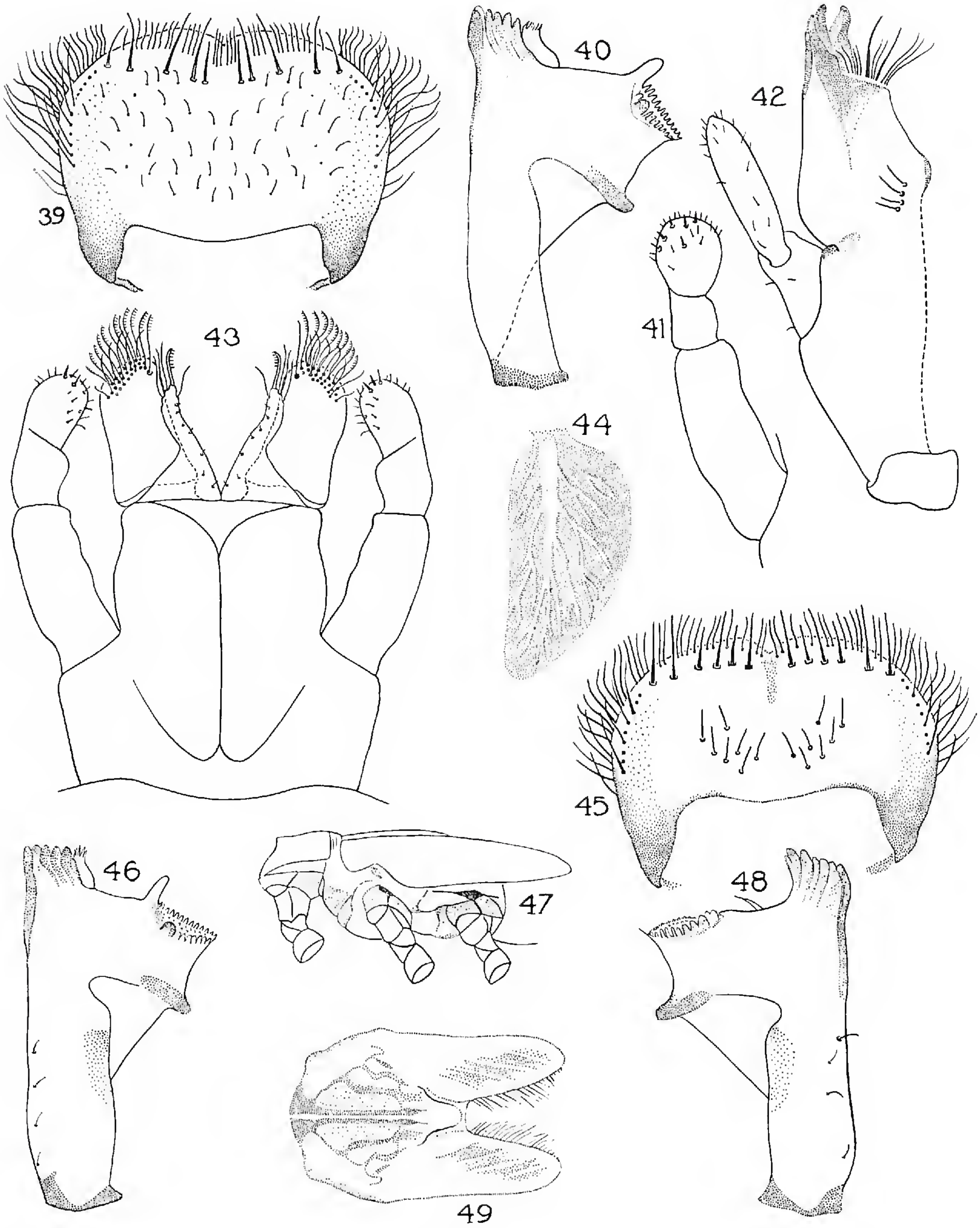

FIG. 39. Labrum of *B. veracrusensis*. FIG. 40. Left mandible of *B. veracrusensis*. FIG. 41. Labial palpus of *B. veracrusensis*. FIG. 42. Maxilla of *B. sancticatarinae*. FIG. 43. Labium of *B. sancticatarinae*. FIG. 44. Gill I of *B. sancticatarinae*. FIG. 45. Labrum of *B. sancticatarinae*. FIG. 46. Left mandible of *B. sancticatarinae*. FIG. 47. Thoracic pleuron of *B. sancticatarinae*. FIG. 48. Right mandible of *B. sancticatarinae*. FIG. 49. Mesonotum of *B. sancticatarinae*.

mesally; 8–9 with yellow triangle along midline, with apex at anterior border; dark brown on either side from anterior to posterior border, brown area extending along anterior border half way to lateral border; yellow laterally and along posterior border; 10 yellow. Intersegmental membranes pale yellow streaked with dark gray along posterior borders. Abdominal gills oval, white. Without coxal gills. Without tubercles. Sternum slightly darker than that of thorax. Cerci yellow, terminal filament more pale.

Holotype male nymph, TENNDIDO RIVER, 3 KM N. EL FORTIN, VERA CRUZ, MEXICO, 1 July 1955, R. B. and J. M. Selander. In Entomological collection University of Utah, Salt Lake City.

DISCUSSION.—*Baetodes bellus* can be distinguished from *B. obesus*, *B. chilloni*, and *B.* sp. No. 1 (Mayo, 1968) by the absence of coxal gills. It can be distinguished from *B. solus* by the pale yellow sternum; that of *B. solus* is dark brown.

Baetodes fortinensis Mayo, new species

(Figs. 34–38)

MALE NYMPH.—Length of body 3 mm; cerci longer. *Head* with turbinate eyes rust color, black around bases, very close to midline; pale rim around area of future top in subimago. Lower eyes black. Large ocelli touching eyes; light brown around ocelli and on genae; darker in epicranial fork; pale yellow anterior to small ocellus, narrowly bordered with dark brown between antennae and around bases; deeply notched at bases of antennae; antennae pale brown, darker at tips; intersegmental areas pale. Clypeus pale with black articulations on either side; labrum light brown. Mouthparts as in Figs. 34, 36–38. Labial and maxillary palpi with numerous setae. Each glossa with bladelike spine at tip; bladelike spine without pinnae on each paraglossa at medial side of tip; first segment of labial palpus shorter than other two combined. No sclerotization below medial cleft on labrum. *Thorax* with pronotum yellowish brown; anterior border rimmed with dark brown except at midline; reddish brown area on either side midline; yellowish brown laterally; posterior border slightly elevated at midline. Mesonotum yellowish brown with reddish brown pattern; midline pale; anterior border dark brown; reddish brown stripe either side midline terminating about midway to scutellum; dark dot either side midline half way between this stripe and scutellum; wider stripe lateral to this terminating near dot; laterally mottled with reddish brown; wing pads yellowish brown; scutellum pale yellow narrowly bordered with dark brown. Metanotum dark brown, somewhat mottled. Pleural sclerites brown; coxae and trochanters yellowish brown; femora yellow, narrowly bordered with reddish brown at joinings with tibiae; ten to twelve spines along dorsal crests small. Tibiae yellow; tarsi light brown dorsally, darker at joining with claw; small spines on ventral surface of tibiae and tarsi. Claw with six denticles. Sternum pale yellow with dark brown sclerites on furcisternum as in subimago (Fig. 35); sclerites around apodemes at leg bases dark brown. *Abdomen* with terga 1 and 7–8 dark brown, mottled; terga 2–6 and 9 yellowish brown; 10 lighter, more yellow. Without tubercles. Abdominal gills oval, white. Two white, elongated fingerlike gills from each coxa of the long type. Sterna 2–6 and 9–10 yellow, 7–8 brown. Cerci yellow at bases, yellowish brown distally; terminal filament pale yellow.

Holotype mature male nymph, TENNDIDO RIVER, 3 KM N. EL FORTIN, VERA CRUZ, MEXICO, 1 July 1955, R. B. and J. M. Selander. In Entomological collection University of Utah, Salt Lake City.

DISCUSSION.—The mouthparts of *Baetodes fortinensis* differ from those of the others in group without abdominal tubercles. The maxillary and labial palpi of this species have numerous setae (Figs. 34, 38). The first segment of labial palpus is shorter than the other two combined. The spines behind the apical margin of labrum differ. There is no sclerotization below the medial cleft of labrum (Fig. 36).

Baetodes veracrusensis Mayo, new species

(Figs. 39–41)

MALE NYMPH.—Length of body 4 mm; cerci about 5 mm. Head narrowly mottled with light brown between eyes on either side midline; turbinate eyes rimmed medially with brown; brown on either side of epicranial suture, anterior to large ocelli and on genae anterior to compound eyes; yellow around small ocellus; narrowly rimmed with reddish brown between and around antennae; antennae and clypeus pale yellow; labrum light brown bordered with darker brown. Bladelike spine on each glossa pointed. Two long bladelike spines among setae on crowns of maxillae. Labrum very slightly sclerotized below medial cleft. Mouthparts as in Figs. 39–41. Intersegmental membrane between head and pronotum penciled with gray near anterior border of pronotum. *Thorax* with anterior border of pronotum light brown; pronotum yellow mottled with pale brown on either side of midline. Mesonotum reddish brown along anterior border; rest of mesonotum yellow mottled with darker brown than that on pronotum; two pair of brown stripes on either side yellow midline converge anterior to pale scutellum; mottled with brown spots laterally; wing pads yellow. Metanotum yellow; pale brown anteriorly. Pleural sclerites pale yellowish brown. Coxae pale brown, trochanters yellow with brown articulations with femora; femora light brown except pale yellow at joining with trochanters; large elongated yellow spot medially and yellow near tibiae; fringe of white setae on tarsi. Tibiae yellow rimmed with reddish brown at joinings with femora and tarsi. Tarsi yellow, brown dorsally at joinings with claws; six small spines along ventral margin. Claw with seven denticles. Sternum pale yellow. *Abdomen* with tergum 1 dark brown anteriorly and yellow posteriorly; irregular margin of dark brown and yellow between anterior and posterior borders; 1–10 yellow posterolaterally and along pleural fold near attachment of gills; 2–3 brown with yellow medially along posterior borders; 4–6 bordered with brown anteriorly with narrow strip of brown along posterior border on either side midline; 7 like 6 with wider brown area anteriorly; 8–9 with brown triangles based along anterior border and touching at midline; rest of segments yellow; 10 yellow. Dark gray trachea visible laterally near pleural fold on 6–9. Abdominal gills oval, white. One small white fingerlike gill from each coxa, of intermediate type. Sterna 2–9 light yellowish brown, progressively more pale rearward; 10 yellow. Cerci and terminal filament pale yellow.

Holotype male nymph, TENNDIDO RIVER, 3 KM N. EL FORTIN, VERA CRUZ, MEXICO, 1 July 1955, R. B. and J. M. Selander. In Entomological collection University of Utah, Salt Lake City.

DISCUSSION.—*Baetodes veracrusensis* can be separated from all other species without abdominal tubercles by the presence of small coxal gills of the intermediate type. The spines behind apical margin of labrum differ from those of the other species.

Baetodes sancticatarinae Mayo, new species

(Figs. 42–49)

MATURE FEMALE NYMPH.—Length of body 4 mm. Cerci about the same. *Head* with prominent ocelli; large ocelli touching eyes. Reddish brown on either side pale midline and in fork. Pale yellow around small ocellus and elsewhere on head; narrowly rimmed with reddish brown between antennae; antennae pale brown. Mouthparts as in Figs. 42, 43, 45, 46, 48. Two pointed bladelike spines among setae on crowns of maxillae. Pinnate spine resembling a brush on each glossa. A long simple spine not pinnate on each paraglossa arising below pinnate spines, mesally. *Thorax* with pronotum light brown with large yellow spots; rims of pleural sclerites visible on either side of pronotum. Mesonotum dark reddish brown with amber; pattern as of subimago; reddish brown stripe on either side of pale area along midline terminates in dark elongated dot (Fig. 49). Scutellum very pale yellow; metanotum brown; scattered setae on dorsal surface of thorax. Pleural sclerites amber with dark reddish brown vertical line between anterior margins and coxal articulations. The elongated dark reddish brown streak anterior to pleural sclerite III is typical of all mature specimens (Fig. 47). Coxae and trochanters amber; unsclerotized areas pale yellow; femora yellow except brown at joinings with trochanters and rimmed with reddish brown at joinings with tibiae; washed faintly with light brown in medial third; fringe of white setae on coxae; tibiae yellow; tarsi yellow with reddish brown dorsally at joinings with claws; claw with eight denticles; minute spines along ventral surfaces of tibiae and tarsi. Sternum typical of mature nymph with sclerites as of subimago, sclerites of furcisternum amber in contrast to the narrow dark brown sclerites of basisternum on segment II. Prosternum pale yellow anterior to apodemes; pale brown posterior to these. Meso- and metasternum pale brown mottled with very fine yellow dots giving slightly roughened appearance. Unsclerotized areas around leg bases pale yellow. *Abdomen* without tubercles. Setae on abdomen clustered near midline; many setae encrusted with silt. Terga 1–2 brown, dark brown along anterior borders; 3–8 dark reddish brown along anterior borders, remainder of segments amber; 9 more pale, 10 yellow touched with brown along anterior and posterior borders. Abdominal gills as in Fig. 44; tracheae visible over entire surface; gill I large, others decrease in size rearward; white. One fingerlike gill from each coxa of the long type. Sternum 1 pale brown mottled with very fine yellow dots; 2–6 light brown; 7–9 with brown areas decreasing in size rearward with yellow anteriorly and posteriorly. Cerci amber; with minute reddish brown spines on segments in basal third; terminal filament yellow.

MATURE MALE NYMPH.—Length of body 3 mm. Cuticula of head and thorax split along midline showing subimago with fairly wide pale yellow strip along midline, pale scutellum narrowly rimmed with reddish brown. On either side of midline is a reddish brown strip terminating in two prominent reddish brown elongated dots anterior to scutellum with narrow white line separating brown strip laterally from rest of brown scutum. Terga brown, except 4–6 amber medially; 7–8 dark brown, 9 more pale, 10 yellow touched with brown along anterior and posterior margins as in female. Cerci amber with brown spines as on mature female; terminal filament yellow.

Holotype female nymph, RIVER PIRABEIRABA, 26′ 15°B. 48′ 54°L. 10 M, SANTA CATARINA STATE, BRAZIL, November 1965, F. Plaumann. In Entomological collection University of Utah, Salt Lake City. Five paratypes same data, same deposition as holotype.

DISCUSSION.—The pattern of spines behind apical margin of labrum differs from all others in the group without abdominal tubercles. More trachea show on gills than on gills of all other species. Spines on basal third of cerci on mature specimens are unique.

Immature specimens: don't have spines on cerci (these occur only on mature specimens); none of their terminal filaments have spines; their thoracic sterna and abdominal sternum 1 are pale yellow; 2–5 pale brown, remainder increasingly more yellow rearward; they have a brown streak laterally on 6–10; their cerci are pale yellow basally, light brown distally; with the terminal filament yellow.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the kindness of Dr. George F. Edmunds Jr., chairman of the Department of Environmental Biology, University of Utah for the loan of his collection of *Baetodes*. She is also indebted to Dr. Jay R. Traver, emeritus professor of Zoology, University of Massachusetts, for her help in going over the manuscript.

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A New Species of *Rhagonycha* from Alaska[1]

(Coleoptera: Cantharidae)

Kenneth M. Fender

Linfield Research Institute, McMinnville, Oregon 97128

The following species had been tentatively placed with *Rhagonycha mandibularis* (Kirby), its nearest relative. Additional material and the redescription of Kirby's species by Green (1940) proved this to be misplaced. An undescribed species was at hand.

Fall (1926) resurrected *Cantharis mandibularis* Kirby when he compared specimens with one of Kirby's cotypes. Prior to this it had been placed as a synonym of *Cantharis fraxini* Say.

In 1971, I assigned to the genus *Rhagonycha* Eschscholtz, that section of *Cantharis* of North America in which the species had the third tarsal segment simple and the insertion of the fourth segment apical. *Rhagonycha* has been recognized as a valid genus by European students for years. Both Green and McKey-Fender (1950) had suggested such a separation but neither followed through on it.

Rhagonycha alaskensis Fender, new species

(Figs. 1–4)

Dark brown, sides of pronotum obscurely paler; head black, antennae and maxillary palpi piceous, palpi a little paler; mandibles and trochanters of prolegs ferruginotestaceous. Pubescence cinereous, suberect, fine, sparse and inconspicuous.

Male.—Eyes moderately large and prominent, separated by about one and one-third combined widths as viewed from above. Head as wide as pronotum, finely sparsely punctured, shining in front of antennae, finely alutaceous behind; clypeal apex oblique each side of median notch; antennae slender, filiform extending to about middle of elytra, third segment nearly twice as long as second, intermediate segments nearly four times as long as wide. Pronotum subquadrate, slightly wider than long; anterior margin evenly rounded and shallowly reflexed, anterior angles evenly rounded into nearly straight and almost parallel lateral margins; basal angles sharply rounded; basal margin feebly arcuate, strongly reflexed medially; sides shallowly reflexed at hind angles, becoming feebly explanate towards anterior angles; sub-basal convexities not prominent; surface finely sparsely punctured, feebly shining. Combined elytra wider than pronotum, about three and one-third times as long as width at humeri, coarsely sparsely punctured basally, rugose punctate beyond basal fifth, two costae feebly elevated and feebly indicated in each. Metasternum shining, finely sparsely punctured. Abdominal sternites dull, finely sparsely punctured, finely transversely strigulose towards sides. Tarsal claws narrowly cleft at apices. Aedeagus with apical margin of dorsal plate narrowly deeply

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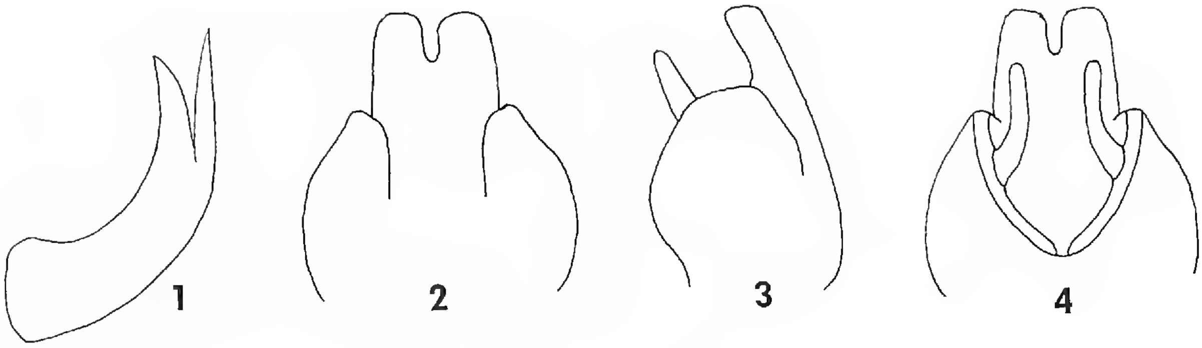
[1] This study was supported by National Science Foundation Grant: GB-6283X.



FIGS. 1–4. *Rhagonycha alaskensis*. FIG. 1. Protarsal claw of male. FIG. 2. Male aedeagus, dorsal view. FIG. 3. Same, lateral view. FIG. 4. Same, ventral view.

incised. All tarsi with third segment simple, insertion of fourth segment apical. Length 5.5 mm.

FEMALE.—Unknown.

Holotype male, MATANUSKA, ALASKA, 26 June 1914, rotary trap, J. C. Chamberlain. In the collection of the California Academy of Sciences.

This species is nearest to *Rhagonycha mandibularis* (Kirby). But the pronotum of *R. mandibularis* is more transverse, being three-tenths wider than long and narrowed in front to the obsolete anterior angles. The tarsal claws of *R. mandibularis* are unusually small, and the dorsal plate of the aedeagus narrows from base to apex with the apical margin more broadly and less deeply incised.

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On page 226, line 16 should be inserted between lines 12 and 13.—C. D. JOHNSON, *Northern Arizona University, Flagstaff, 96001.*

A New Genus of Biting Midge from California Related to *Neurohelea* Kieffer

(Diptera, Ceratopogonidae)

WILLIS W. WIRTH AND NIPHAN CHANTHAWANICH RATANAWORABHAN[1]

Systematic Entomology Laboratory, U. S. D. A., c/o U. S. National Museum, Washington, D. C. 20560, and Applied Scientific Research Corporation, Bangkok, Thailand

Wirth (1952) described *Bezzia granulosa* from Monterey County, California, pointing out that in several characters it did not fit the genus *Bezzia* Kieffer, stating: "The anterior radial cell is very long, the radius produced, and the fifth tarsal segment swollen as in *Neurohelea*; the hind tarsal claws are long and unequal, and the abdomen is marked much as in *Probezzia*." While presently undertaking a revisionary study of the genera of Ceratopogonidae, we have studied additional material of *B. granulosa* which indicates that this species must be placed in a new genus of Heteromyiini (Wirth, 1962) near *Neurohelea* Kieffer. The wing of *Neurohelea* has two radial cells, the female tarsal claws are equal on all legs, and the female abdomen is uniformly dark.

Neurobezzia Wirth and Ratanaworabhan, new genus

Type-species, *Bezzia granulosa* Wirth.

Diagnosis.—Female: Small black midges with whitish wing and bicolored legs (Fig. 1g) and abdomen. Very similar to *Neurohelea*; differing as follows: Wing (Fig. 1b) with one radial cell. Legs (Fig. 1h) with tarsal claws long and curved; equal on fore and mid legs, unequal on hind legs, shorter claw approximately three fourths as long as longer one; claws (Fig. 1e) each with small, slender, internal barb. Abdomen milky white, third and fourth segments with variable internal pigmentation; eighth segment (Fig. 1i) sclerotized, forming dark brown ring.

NEUROBEZZIA GRANULOSA (Wirth), NEW COMBINATION

(Fig. 1)

Bezzia granulosa Wirth, 1952: 240 (female; California).

Type.—Holotype, female, Arroyo Seco Ranger Station, Monterey County, California, 1 July 1948, W. W. Wirth (Type no. 59964, USNM).

Distribution.—California.

New Records.—CALIFORNIA: Mono Co., Convict Creek, 7,200 ft, 17 July 1963, H. D. Kennedy, light trap, 1 female; Sardine Creek, 8,500 ft, 6 July 1951, A. T. McClay, 1 female. Tehama Co., Red Bluff, 11 May 1949, H. P. Chandler, light trap, 1 female. Trinity Co., Trinity River Camp, 17 July 1953, A. T. McClay, 2 females.

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[1] Acknowledgment is gratefully made to the Southeast Asia Treaty Organization in Bangkok for financial assistance for study at the U. S. National Museum.

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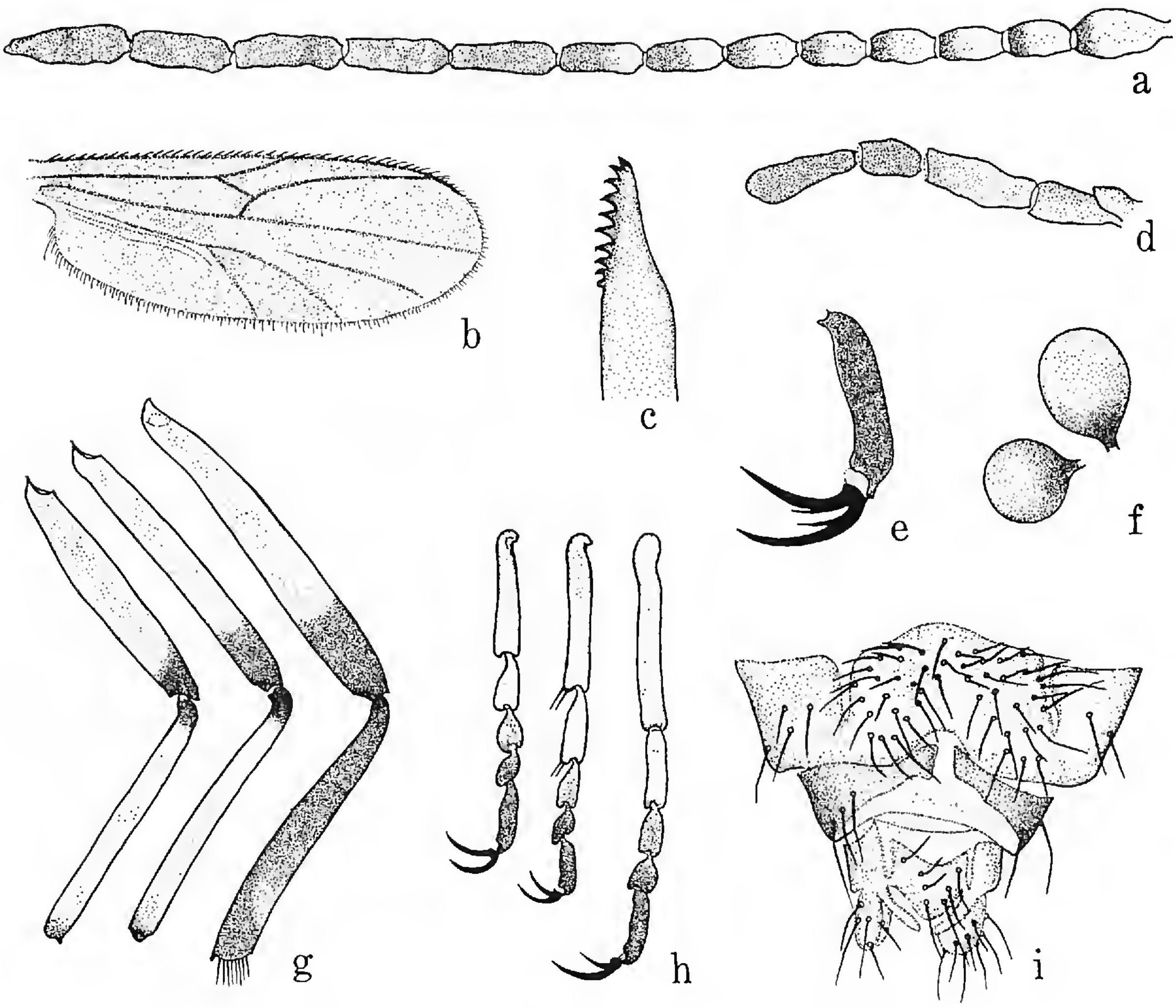

FIG. 1. *Neurobezzia granulosa*, female: a. antenna; b. wing; c. mandible; d. palpus; e, fifth tarsomere and claws of fore leg; f. spermathecae; g. femora and tibiae of fore, mid and hind legs, left to right; h. same, tarsi; i. genital sclerotization of terminal abdominal segments.

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Notes and Synonymy in *Largus* Hahn with a Key to United States Species

(Hemiptera: Largidae)

THOMAS F. HALSTEAD
Arizona Commission of Agriculture and Horticulture
Phoenix, 85005

In 1970 I described a new species of *Largus* Hahn, and provided a key to southwestern species of the genus. This material was based on data available to me prior to 1968 and ignored several taxa described by Bliven (1956 and 1959) and a subspecies named by Van Duzee in 1923. Since that time I have acquired additional information relating to the genus and have described a new species from Florida (Halstead, 1972). This paper will present comments on distribution and synonymy for species encountered in the United States, as well as a key for their differentiation.

LARGUS HAHN OF THE UNITED STATES

1\. Rectangular hemelytral patch, pronotal posterior and abdominal venter white .... *sellatus* (Guerin)

Rectangular white hemelytral patch absent, pronotal posterior and abdominal venter not white 2

2\. Membrane white or very light tan, veins concolorous or light tan 3

Membrane tan to black, veins brown to black 5

3\. Two very distinct transverse black maculations at juncture of claval suture and membrane .... *maculatus* Schmidt

Without two distinct black maculations at juncture of claval suture and membrane 4

4\. Ground color distinctly yellow; abdominal venter at least basally and usually entirely yellow .... *pallidus* Halstead

Ground color red; venter black, very rarely with slight red suffusion of basal abdominal segments .... *davisi* Barber

5\. Thoracic sterna around base of coxae red to orange 6

Thoracic sterna around base of coxae black 7

6\. Coxae often red; trochanters and femora black .... *convivus* Stal

Coxae, trochanters and proximal ends of femora all red to yellow-orange .... *cinctus* Herrich-Schaffer

7\. Trochanters and proximal ends of femora orange to orange-red .... *succinctus* Linnaeus

Trochanters and femora all black .... *semipunctatus* Halstead

A number of species of *Largus* show great variation in expression of a given color trait. The same portion of the anatomy of individuals of the

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same species may vary from pale yellow or tan to deep red. It is therefore of questionable value to base taxa on color shade. It is a completely different matter to base taxa on patterns of coloration. The above key is based entirely on color expression, and is simply a guide to identification of specimens. The various species represented differ with respect to a number of morphological characters as well.

Largus cinctus.—W. North America from British Columbia to southern Mex., e. to central Tex. *Largus cinctus californicus* (Van Duzee), 1923 is a synonym based on characters of pubescence and coloration which break down when compared with a large series of specimens. Unpublished thesis data (Halstead, 1967) involving comparative analysis of specimens from seven populations of *Largus cinctus* ranging from Washington to southern Mexico show that while a tendency for specimens from the south to be paler and less pubescent does exist, some specimens from any population will match Van Duzee's description. *L. cinctus californicus* was designated as a geographic variation from northern areas in California, as different from specimens originating in Arizona and Mexico. Bliven (1959) proposed *Largus semipletus* from northern California citing difference in relative antennal segment length as the major separatory character. Comparison of Bliven's antennal segment measurements with measurements of specimens from four California counties (Halstead, 1967) shows that data cited by Bliven fall well within variation shown by *L. cinctus* populations in California. The other major character cited by Bliven was pubescence. The description of this characteristic is not sufficient to separate the new taxon from *L. cinctus.* Careful analysis of the long description given by Bliven has failed to show me any other criteria than the two mentioned above which could possibly justify proposal of a new species. It is my opinion that *L. semipletus* is a synonym of *L. cinctus. Largus sculptilis* Bliven, 1959 was separated from other *Largus* species by reason of differing coloration, pubescence, punctation and antennal segment length. The range of variation with respect to all of these characters shown by *L. cinctus* populations is sufficient to encompass Bliven's new species. Comparative analysis shows that antennal segment length values given by Bliven fall within the range for *L. cinctus* populations (Halstead, 1967). *Largus sculptilis* Bliven is synonymous with *L. cinctus.* I have examined several thousand specimens of *Largus* from California localities; to date all have been *L. cinctus.* This includes material determined by Van Duzee and others as *L. convivus.* I have examined Torre-Bueno's "paraplesiotypes" (specimens bearing that label) through the courtesy of Dr. G. W. Byers of the Snow Entomological Museum of the University of Kansas and find specimens of both *L. cinctus* and *L. convivus* bearing *L. cinctus* labels.

Largus convivus.—Mountainous regions of Ariz. w. to Tex., s. to central Mex. *Wupatkius semo* Bliven, 1956 was proposed as a new Largid genus and species from northern Arizona. Bliven's description of *Wupatkius* shows absolutely no variation from Hahn's original description of *Largus* in 1831. *Wupatkius* must therefore fall to *Largus.* Furthermore, Bliven's description of *W. semo* is very clearly a description of *L. convivus. Wupatkius semo* Bliven must therefore fall in synonymy to *L. convivus.*

Largus succinctus.—Fla. n. to N.Y., w. to Tex. The common Eastern species corresponding to *L. cinctus* in the West.

Largus semipunctatus.—S. Ariz., s.e. N.M., with one doubtful California record. A rare mountain species.

Largus maculatus.—Brownsville, Tex. and perhaps s. Ariz. s. to Colombia. This is the *Largus bipustulatus* of my 1970 key. Examination of Stal's type through the courtesy of Dr. Per Inge Persson of the Stockholm Museum proved to me that this apparently rare Mexican species differed from the specimens from the Brownsville area.

Largus sellatus.—Extreme s. Fla. Differs from all other *Largus* of the United States by the distinct white markings, as noted in the key. A Caribbean species.

Largus davisi.—Fla. only, not uncommon.

Largus pallidus.—Key Largo, Fla. and adjacent areas. Generally larger and more robust than *L. davisi.*

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Two New Species of *Orus* from California

(Coleoptera: Staphylinidae)

IAN MOORE AND E. F. LEGNER[1]
Division of Biological Control, University of California, Riverside, 92502

The genus *Orus* was completely revised by Herman (1964, 1965). In his revision he gave detailed drawings of the male secondary sexual characters and of the aedeagus of each species making identifications of male specimens positive. Two new species not represented in the material which Herman examined have come to hand from areas in California. These are described and illustrated below. Both belong to the subgenus *Orus* (*sensu stricto*).

KEY TO THE MALES OF ORUS (*s. str.*)

1. Last visible abdominal sternite shallowly incised 2
Last visible abdominal sternite deeply incised 3
2. Fifth visible abdominal sternite emarginate; neck one-fifth the width of head .... *montanus* Fall
Fifth visible abdominal sternite sinuotruncate; neck one-fourth the width of head .... *shastanus* Casey
3. Fifth visible abdominal sternite sinuate along the posterior margin .... *sinuatus* Herman
Fifth visible abdominal sternite with the posterior margin lobed or emarginate 4
4. Fifth visible abdominal sternite emarginate 5
Fifth visible abdominal sternite lobed 7
5. Fifth visible abdominal sternite deeply emarginate (Fig. 1) .... *giulianii* Moore and Legner, n. sp.
Fifth visible abdominal sternite shallowly emarginate 6
6. Fifth visible abdominal sternite deeply impressed (Fig. 2) .... *frommeri* Moore and Legner, n. sp.
Fifth visible abdominal sternite very shallowly impressed .... *fraternus* Fall
7. Fifth visible abdominal sternite with a tubercle 9
Fifth visible abdominal sternite without a tubercle 8
8. Paramere short, not extending beyond apex of median lobe, broad, with lateral margins straight in dorsal aspect .... *hemilobatus* Herman
Paramere long, extending beyond apex of median lobe, slender, with lateral margins sinuate in dorsal aspect .... *punctatus* Casey
9. Abdominal tubercle well developed, margined laterally by carina; metafemora carinate .... *femoratus* Fall
Abdominal tubercle feeble, not margined by carina; metafemora not carinate .... *distinctus* Casey

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[1] Staff Research Associate and Associate Professor of Biological Control, University of California, Riverside, respectively.

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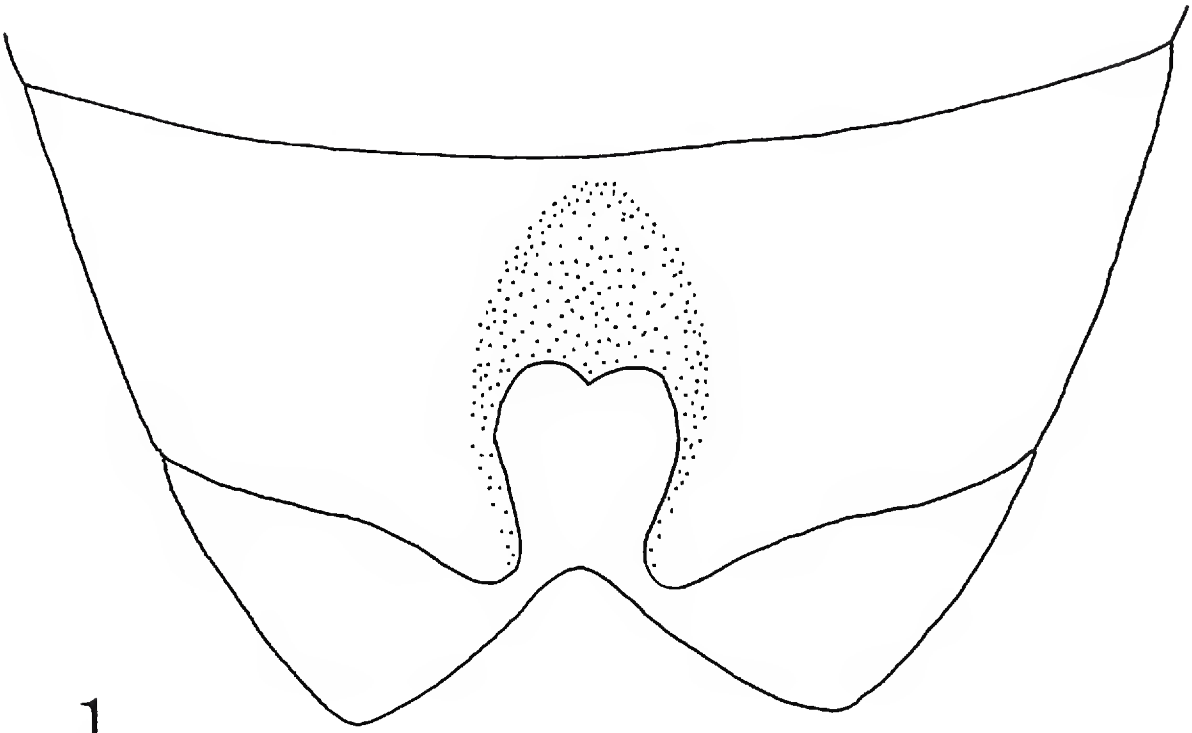

FIG. 1. Fifth and sixth visible sternites of male of *Orus giulianii*, new species.

Orus giulianii Moore and Legner, new species

HOLOTYPE MALE.—Piceous with tarsi and mouth parts just perceptibly paler. *Head* one-fourth longer than wide; above finely, densely punctured and finely, densely microreticulate, beneath sculptured much as above except smooth and not impressed gula. *Pronotum* one-tenth longer than head, one-fifth longer than wide, surface sculptured much as head except for vague smooth central longitudinal area. *Elytra* one-fourth longer than pronotum, conjointly nine-tenths as wide as long, surface sculpture much like that of pronotum. *Abdomen* more finely punctured than elytra, finely microreticulate; first four visible sternites unmodified; fifth visible sternite with the posterior margin deeply emarginate, bottom of emargination produced as small cusp, sides of emargination slightly convergent posteriorly; sixth sternite with posterior margin moderately deeply incised.

Holotype male, OAK CREEK, INYO COUNTY, CALIFORNIA, 4,100 feet elevation ultraviolet black light, June 1971, Derham Giuliani collector [California Academy of Sciences]. Paratypes, same data as holotype (1 male); Big Pine, Inyo County, California, ultraviolet black light, July 1970 (4 males); March 1971 (1 male), Derham Giuliani collector [California Academy of Science and University of California, Riverside]. We have also seen twenty-two females with the above data which are not designated paratypes.

The modifications of the fifth and sixth sternites of this species are similar to those of *O. ferrugineus* and *O. guatemalenus*, both of which belong to the subgenus *Leucorus* having either a bidentate or edentate

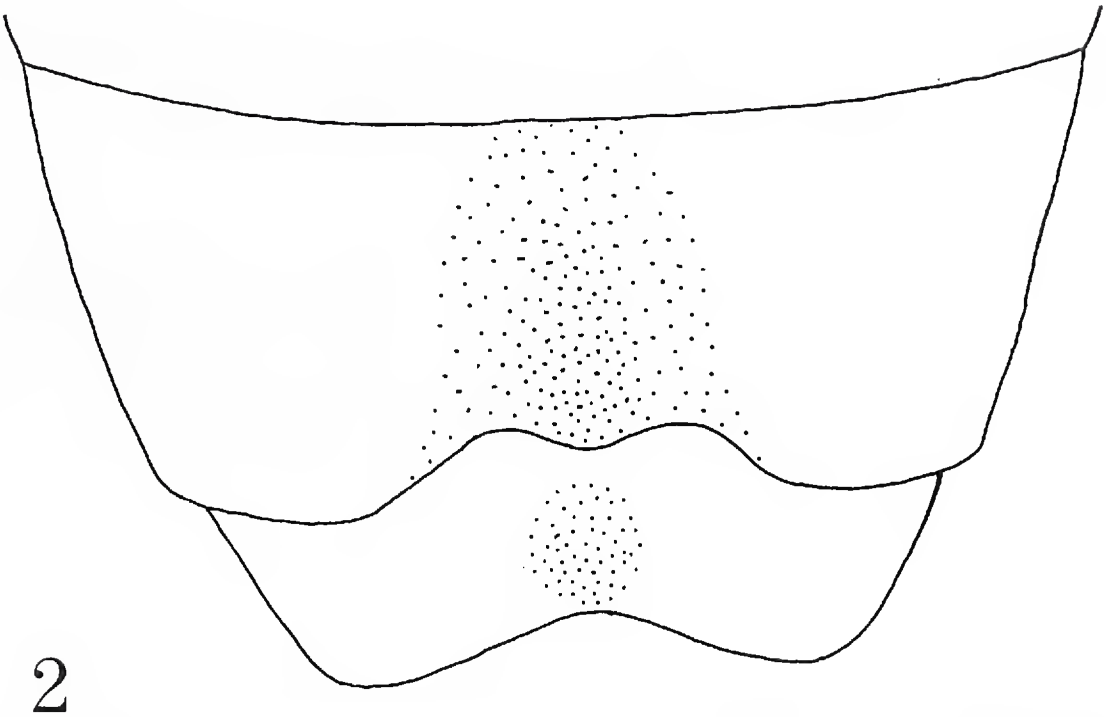

FIG. 2. Fifth and sixth visible sternites of male of *Orus frommeri*, new species.

labrum. The labrum of *O. giulianii* is distinctly and strongly quadridentate and the sixth sternite is more shallowly and broadly incised than those of the two species mentioned above.

Orus frommeri Moore and Legner, new species

HOLOTYPE MALE.—Castaneous with head and bases of elytra darker, legs testaceous, beneath testaceous. *Head* one-fifth longer than wide; finely somewhat densely punctured above with very feeble microreticulation; beneath sculptured much as above except highly polished and not impressed gula. *Pronotum* one-tenth longer than head, seven-tenths as wide as long; sculpture very similar to that of head. *Elytra* one-fifth longer than pronotum, conjointly four-fifths as wide as long; surface densely but somewhat more coarsely punctured than head and pronotum, with more pronounced ground sculpture. *Abdomen* very finely punctured with fine but dense microreticulation; with first four visible sternites unmodified; fifth visible sternite with posterior edge emarginate, bottom of emargination shallowly sinuate, surface of sternite deeply, broadly impressed for its entire length before emargination; sixth visible sternite moderately incised, shallowly impressed in middle.

Holotype male, VICINITY OF SANTA YNEZ RIVER, SANTA BARBARA COUNTY, CALIFORNIA, 1,000 feet elevation ultraviolet and white light, 13 June 1971, Saul Frommer collector [California Academy of Sciences]. Paratype male, same data as holotype (1 male) [University of California, Riverside].

This species is most similar to *O. sinuatus* in the secondary male sexual characters. It differs from that species by the more deeply emarginate posterior margin of the fifth visible sternite and the more shallowly incised posterior margin of the sixth sternite and particularly in the wide, deep impression on the surface of the fifth sternite.

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BOOK REVIEW

THE LIVES OF WASPS AND BEES. By Sir Christopher Andrews. American Elsevier Publishing Company, Inc., New York. 204 pages, illus. 1970. $5.75.

As a popular account of the life histories of aculeate Hymenoptera attempting to "show that among wasps and bees in particular there are many with fascinating and often bizarre habits" the book is generally successful. The book consists of 27 short, easy to read chapters, 16 plates of excellent photos, and 15 additional well drawn figures. For the systematically oriented, scientific names of species mentioned along with phonetic guides to their pronunciation appear at the end of each chapter, and the higher classification (superfamilies to genera) of the taxa treated follows the last chapter. The numbers of chapters devoted to wasps versus bees or to those with solitary versus social habits balance nicely. The author limits coverage principally to species of Europe and North America and to some of the more general literature principally in English from 1905–1967.

Errors consist of several types: Typographical errors (e.g. the first initial for K. V. Krombein on page 44; *Bembix* captures flies resting, not "nesting on vegetation" on page 55; etc.) ; Misleading statements (e.g. from the discussion on page 28 one expects to see a grasshopper, not a caterpillar in plate 2A; the title "Some Wood-borers" for Chapter 6 which deals with species of *Trypoxylon* which use pre-existing cavities or construct pipe-organ mud nests) ; and Errors of omission (e.g. works of many European and American authors including Friese, von Frisch, Grandi, Malyshev, Linsley & MacSwain, Plath; discussion of massarid wasps). The errors of omission disturb only specialists and other errors are easily overlooked by the general reader.

This popularized treatment does expose some of the marvels of the insect world to public view. As such it provides entertaining and informative reading for those whose knowledge of bees and wasps does not extend much beyond the habits of honey bees and yellow jackets.—R. W. THORP, *University of California, Davis, 95616.*

Notes on the Caviceps Group of the Genus *Epicauta* with Descriptions of First Instar Larvae[1]

(Coleoptera: Meloidae)

JOHN D. PINTO
Department of Entomology, University of California, Riverside, 92502

Fifteen species of North American *Epicauta* have been placed in the Caviceps Group (Werner, 1955; Werner, Enns and Parker, 1966). Those included are *E. aspera* Werner, *E. wheeleri* Horn, *E. rehni* Maydell, *E. occipitalis* Werner, *E. singularis* Champion, *E. diversipubescens* Maydell, *E. cicatrix* Werner, *E. excavatifrons* Maydell, *E. straba* Horn, *E. afoveata* Werner, *E. impressifrons* Van Dyke, *E. caviceps* Horn, *E. rileyi* Horn, *E. insueta* Werner, and *E. stuarti* LeConte. Adults of this group are primarily active in autumn. Records for several species suggest that adults feed solely on the inflorescences of fall-blooming Compositae. Geographically, the group is almost totally confined to southwestern North America. Exceptions are *E. excavatifrons* from southeastern United States, and *E. insueta* from southern Mexico.

The purpose of this paper is to briefly review the adult and larval anatomy of the Caviceps Group and to alter its limits slightly by including two additional species. Also, the first instar larvae of three species are described and compared with those previously studied by MacSwain (1956). New food-plant records for adults are included.

ADULTS

The Caviceps Group has been defined primarily by adult anatomy (Werner, 1955). It has contained all North American species having males with the ventral and posterior surfaces of the meso- and metafemora, and the hind two pair of trochanters denuded, the two denuded femoral areas being separated by a fringe of long hairs. Long, tapering antennae is the only other important characteristic present in all members of the group. Several other traits which are absent in some of the species, however, do help delimit this taxon. These include various head and eye modifications, black spots on the abdomen and elytral base, a whorled setal pattern on the pronotum, and an elevation of the elytral suture near its basal third.

Based on both adult and larval anatomy *E. californica* Werner and *E. alphonsii* Horn, two cognate species from southern California, should, in

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[1] This study was supported in part by Grant GB 30907 from the National Science Foundation.

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my opinion, be included in the Caviceps Group. Although mentioned as being similar to species of this group, reasons for their exclusion were not given by Werner (1955). These two species lack any indication of the head modifications which characterize several species of the Caviceps Group. However, their leg modifications are pronounced. The ventral surface of the meso- and metafemora in males of both species is not only denuded but also distinctly widened and flattened, and this surface is noticeably concave from base to apex. In addition, the ventral surface of the mesofemur is fringed with long hairs anteriorly as well as posteriorly. These differences merely represent specialized states of morphoclines already found in the Caviceps Group *sensu* Werner. Thus, in some species of the group (e.g. *E. caviceps* and *E. rileyi*) the ventral surface of the hind two pair of femora is simply denuded but in others it is also widened (e.g. *E. wheeleri*), and in *E. afoveata* slightly concave as well. The anterior fringe of long hairs on the mesofemur, although absent in most members of the group, does occur in *E. aspera.*

Associated with these leg modifications the metasternum of *E. californica* and *E. alphonsii* is denuded and distinctly concave rather than hirsute and convex as in most meloids. This trait also occurs to a lesser degree in *E. wheeleri*, *E. impressifrons*, and *E. afoveata.*

The leg and metasternal modifications of males of *E. alphonsii* and *E. californica* are correlated with a distinctive courtship behavior. This involves the male's stimulation of the female by the vigorous rubbing of his venter and hind two pair of legs over her elytra. Similar but less elaborate behavior has been observed in *E. wheeleri*, *E. impressifrons*, and *E. straba* (Pinto, in preparation).

Adults of *E. californica* and *E. alphonsii* are structurally similar to those of other species of the Caviceps Group although, excepting the characteristic leg and antennal structure, and a poorly developed elevation of the elytral suture, they lack all of the other specialized traits listed by Werner (1955). However, as in *E. straba*, two of these attributes (black spots and type of pronotal pubescence) do not apply to these two species since both are almost completely black and have only sparse pubescence on the pronotum. In any case, all traits other than leg and antennal structure vary greatly interspecifically within the group and most of these attributes are also absent in *E. aspera* and *E. rehni* (Werner, 1955).

The inclusion of *E. californica* and *E. alphonsii* in no way complicates the diagnosis of the Caviceps Group. The group now contains all species of North American *Epicauta* in which the meso- and metafemora and trochanters of the male are denuded ventrally, the denuded metafemoral

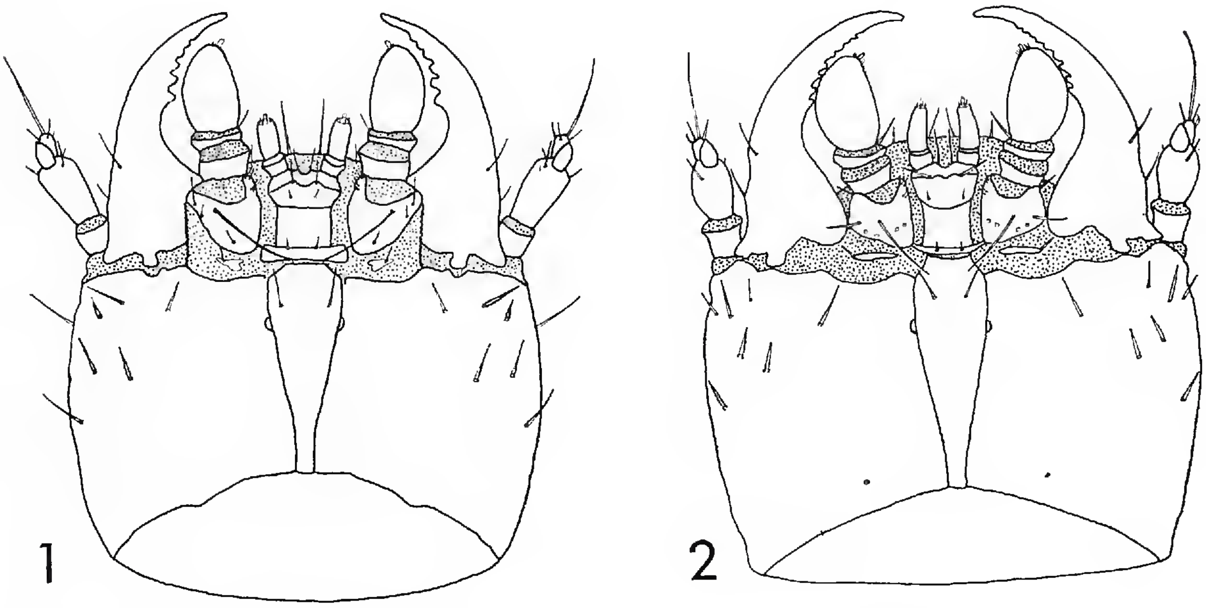

Fig. 1. Ventral view of head of first instar larvae of *Epicauta afoveata*. Fig. 2. Same, *E. alphonsii*. A similar illustration of the head of *E. californica* is given by MacSwain (1956).

area being fringed with long hairs posteriorly, and the mesofemoral area either fringed posteriorly only, or anteriorly as well.

First Instar Larvae

The first instar larvae of *E. californica*, *E. caviceps*, and *E. impressifrons* were described by MacSwain (1956). Those of *E. alphonsii*, *E. afoveata*, and *E. wheeleri* are described and compared with the former three species in Table 1. The terminology used in this section closely follows that of MacSwain (1956).

MacSwain followed Werner in placing *E. californica* in a group of its own, separate from *E. caviceps* and *E. impressifrons*. Yet he considered the three as separable from all other *Epicauta* by their uniformly dark coloration and by the strongly convex lateral margin of segment III of the maxillary palpi.

The original separation of *E. californica* from the two other members of the Caviceps Group was justified by several differences. The maxillary and labial palpi of *E. californica* are longer, the head capsule is abruptly constricted rather than evenly convergent behind, the sensory area of segment III of the maxillary palpi is more confined in area and more mesal in position, and the gular setae are much shorter. With the discovery of the three additional species, however, a continued division based on these attributes is no longer tenable. Thus, *E. alphonsii* agrees with *E. caviceps* and allies for some of these traits rather than with its

TABLE 1. Comparative anatomy of the first instar larvae of six species of the Caviceps Group[a]

Characters	Species					
	caviceps	*impressifrons*	*wheeleri*	*afoveata*	*alphonsii*	*californica*
Color	dark brown	dark brown	light yellow	dark brown except head, pro- & meso-thorax golden brown	dark brown	dark brown except pronotum light brown
Head Capsule						
a. Nature of posterior convergence of sides	even	even	abrupt	even	even	abrupt
b. Ratio of length to width	.88	.90	1.00	.95	.92	.86
c. Length of gular setae relative to length of seg. II of labial palpi	subequal	subequal	subequal	subequal	⅘ as long	½ as long
Mandible						
a. Number of teeth[b]	8	10	8–9	7	10–12	10
b. Length of apical seta relative to that of basal seta	slightly longer	subequal	slightly longer	slightly longer (Fig. 1)	subequal (Fig. 2)	slightly longer
Maxillary palpi						
a. Combined length of segs. I & II relative to that of III	⅓ as long	⅓ as long	⅓ as long	½ as long	½ as long	½ as long
b. Position of sensory area on seg. III	dorsal	dorsal	dorsal	dorsomesal	dorsomesal (Fig. 3)	dorsomesal

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[a] Measurements represent means based on 10 specimens, except for *E. afoveata* where only three were available.

[b] Apical-most two or three may not be visible in outline when viewed from above or below.

TABLE 1. (Cont.)

Characters	Species					
	caviceps	*impressifrons*	*wheeleri*	*afoveata*	*alphonsii*	*californica*
c. Percent of length of seg. III covered by sensory area	65	60	65	60	70	45
d. Length of two-segmented sensory appendix relative to that of surrounding papillae	subequal	subequal (Fig. 5)	slightly longer	almost twice as long	slightly longer (Fig. 4)	slightly longer
Labial palpi						
a. Length of seg. I relative to that of II	½ as long	½ as long	½ as long	½ as long	⅓ as long	⅓ as long
Legs						
a. Number of lanceolate setae on femora	6	6	6	7	6	6
Abdomen						
a. Tergites bearing sclerous evaginations at base of marginal setae	I–V	I–V	I–VII	I–IV	I–VII	I–VII
b. Sternum of segment VII with two small sclerites (1), two small sclerites which may join medially (2), or a single median sclerite (3)	2	3	1	1	2	1
Body length (mm)	2.13	2.35	2.21	2.31	2.76	2.51
Length of caudal setae (mm)	.22	.28	.31	.32	.36	.23

closest relative, *E. californica*; and *E. wheeleri* and *E. afoveata* agree with *E. californica* and/or *E. alphonsii* for others (see Table 1).

As with adult anatomy then, larval characteristics indicate that the retention of *E. alphonsii* and *E. californica* apart from the Caviceps Group is an unnatural division. Although intragroup relationships remain obscure, I am tentatively considering *E. alphonsii* and *E. californica* closest to *E. afoveata* and *E. straba.*

Based on the six species treated here the larvae of the Caviceps Group can now be characterized as follows:

Head capsule (Figs. 1, 2) with lateral margins abruptly constricted or evenly convergent behind. *Antennae* with conical sensory organ attaining apex of segment III. *Mandibles* moderately slender with 7 to 12 teeth. *Maxillary palpi* with lateral margin of segment III markedly convex; sensory organ large, dorsomesal (Fig. 3) or almost completely dorsal in position. *Thorax* with line of dehiscence present full length of pro- and mesonotum, line entirely absent on metanotum. *Legs* with 6 or 7 lanceolate setae on femora. *Abdomen* uniformly colored; line of dehiscence absent; 10 setae present on marginal row of tergites I to VIII; sclerous evaginations absent at base of median transverse row of tergal setae, present at base of at least some marginal setae on segments I to V or VII; first abdominal spiracle slightly smaller than that of mesothorax, slightly larger than that of segment II; sternum of segments I to VI unsclerotized (occasionally 2 or 4 minute sclerites present on segments V and VI), that of VIII and IX fully sclerotized, that of VII partially sclerotized.

The uniformly colored abdomen, the posteriorly convergent sides of the head, the partially sclerotized sternum of segment VII, and the strongly convex lateral margin of segment III of the maxillary palpi serve to distinguish species of this group from all other known North American *Epicauta.* Based on these traits all six species will key to couplet 10 in MacSwain's (1956) "key to the species of *Epicauta.*" The only needed modification is the deletion of the first part of couplet 9, "abdomen yellow or yellow-brown." Five of the six species of the group have a dark brown abdomen but in *E. wheeleri* the body is uniformly yellow.

In comparing material with MacSwain's descriptions I disagree in

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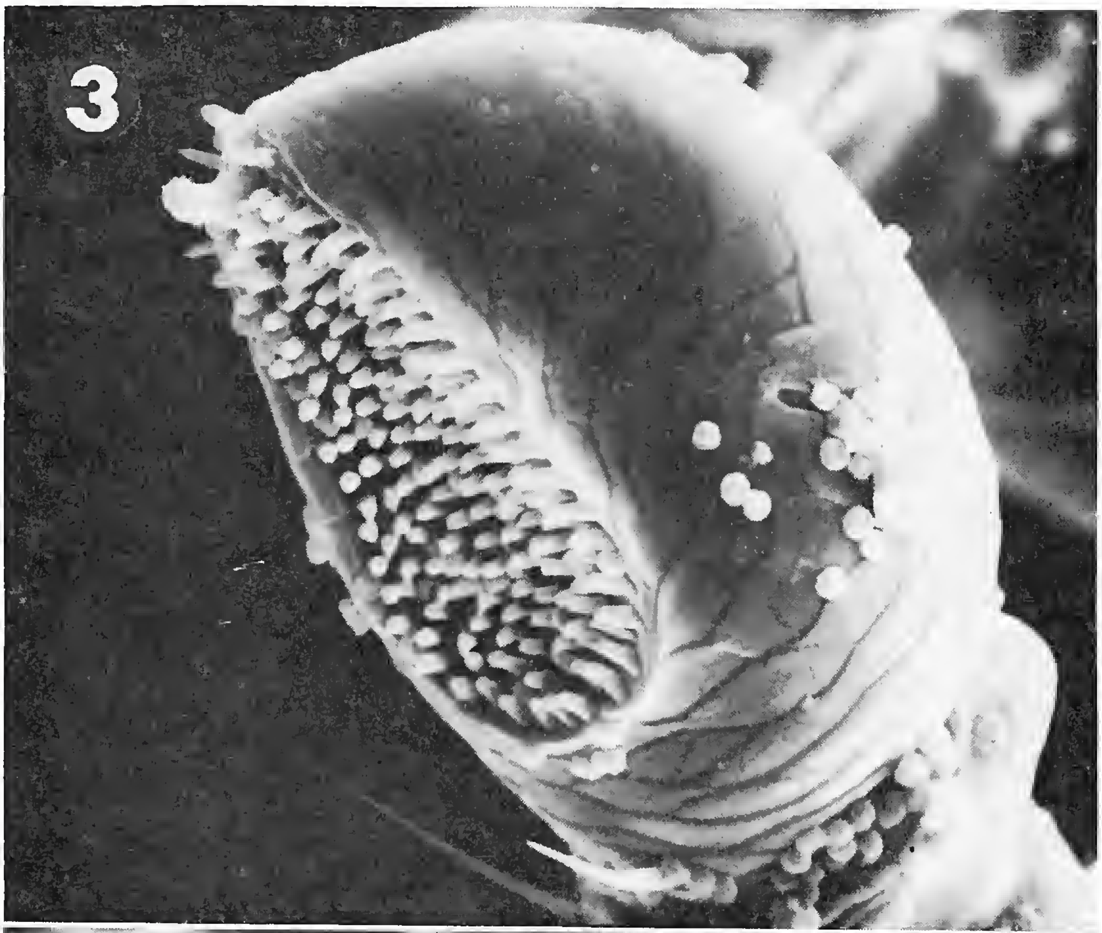
FIGS. 3–5. Scanning electron micrographs of the sensory area on segment III of the maxillary palpi of species of the Caviceps Group. FIG. 3. Dorsal view of right palpus of *Epicauta alphonsii* (800 ×). FIG. 4. Side view of right palpus of *E. alphonsii* showing relative length of two-segmented appendix and surrounding papillae (1000 ×). FIG. 5. Same, of left palpus of *E. impressifrons* (1000 ×). Micrographs made on a Jelco unit (JSMU-3).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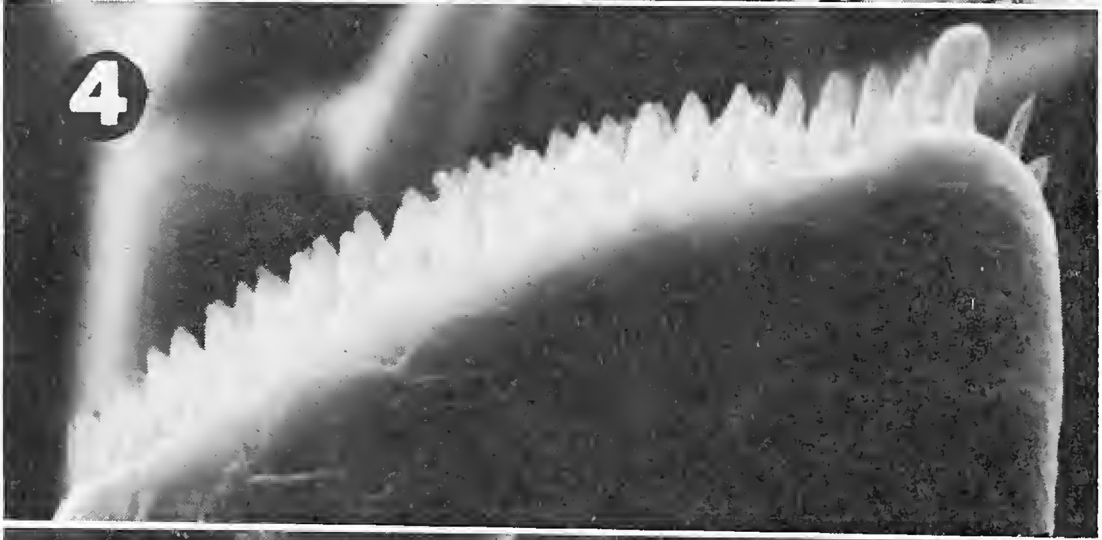
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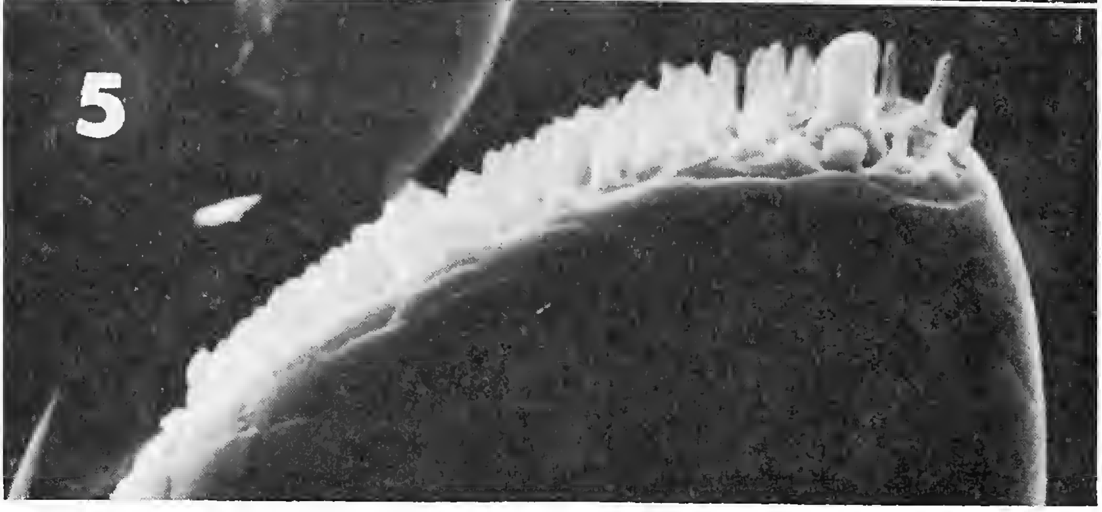
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only two instances. The terminal seta of the antenna in *E. impressifrons* is only slightly longer than segment II, not twice as long; and the two-segmented appendix on segment III of the maxillary palpi in *E. caviceps* and *E. impressifrons* is subequal to the surrounding papillae (Fig. 5) rather than twice as long.

MATERIAL EXAMINED.—MacSwain's (1956) material of *E. impressifrons*, *E. caviceps* and *E. californica* was available for this study. Additional material examined is as follows:

Epicauta impressifrons.—One specimen from a mass of eight eggs; adults, Whitewater Canyon, Riverside County, California, 16 October 1970, feeding on inflorescences of *Haplopappus acradineus* (Greene) Blake, and *Lepidospartum squamatum* (Gray) Gray.

Epicauta wheeleri.—Larvae from a mass of 35 eggs; adults, Whitewater Canyon, Riverside County, California, 16 October 1970, feeding on inflorescences of *Haplopappus acradineus* and *Lepidospartum squamatum.*

Epicauta afoveata.—Three larvae from a mass of 10 eggs; adults, 12 mi. SSW Borrego Springs, San Diego County, California, 15 November 1970, feeding on inflorescences of *Chrysothamnus paniculatus* (Gray) Hall.

Epicauta alphonsii.—Larvae from masses of 20 and 43 eggs, respectively; adults, 4 mi. NNW Lancaster, California, 20 October 1971, feeding on inflorescences of *Chrysothamnus nauseosus* (Pallas) Britton.

Epicauta californica.—Larvae from a mass of 45 eggs; adults, Menifee Valley, Riverside County, California, 5 November 1970, feeding on inflorescences of an unidentified Compositae.

ACKNOWLEDGMENTS

I would like to thank Mr. Steve Ward for his generous assistance in this study. I am also obliged to Dr. J. A. Chemsak (University of California, Berkeley) for making Dr. J. W. MacSwain's collection of first instar larvae available to me. Plant identifications were kindly provided by Mr. O. F. Clarke. Figures 1 and 2 were prepared by Mr. W. D. Sumlin III.

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Nesting Behavior of *Cheyletus eruditus*

(Acarina: Cheyletidae)

F. M. SUMMERS AND R. L. WITT
University of California, Davis, 95616

The nesting behavior of some species of *Cheyletus* is possibly one of the key factors that severely restricts the period within which mating may occur. Mating is most apt to occur very soon after *Cheyletus* females complete their final moult. The acceptance of males by older, unmated, gravid females appears to be unusual. Evidence from laboratory cultures of one species, *C. malaccensis* Oudemans, suggests that there may be limited times or special conditions when older virginal females will mate. In a preliminary study of mating and oviposition in *C. malaccensis*, we postulated that the mating of older virginal females may be prevented by their belligerence after a nest is made (Summers *et al.*, 1972).

Local strains of *C. malaccensis* have both sexes and the females are facultatively parthenogenetic and arrhenotokous. Brooding females of this and other *Cheyletus* species reared in our laboratory exhibit marked ferocity when their nests are disturbed. The place in which eggs are laid is called a "nest" and it is here that the female exhibits an aggressive kind of behavior, which may be interpreted as defense of territory or protection of eggs. This kind of overt behavior has not been detected before the nest is established.

Cheyletus eruditus (Schrank) was selected for this initial study because the race being reared has no males and parthenogenesis is thelytokous. It is thus possible to observe nesting and oviposition apart from mating and other complications which the presence of males may introduce. This species is also quite prolific. Our estimates of productivity by *C. eruditus* fed on *Acarus siro* Linnaeus greatly exceed the values recorded by Beer and Dailey (1956) for *C. eruditus* fed on *Tyrophagus* sp.

There were three reasons for setting up this study. The nesting activities of these predaceous mites are intrinsically interesting. We hope to pursue further research on the interrelations of mating and nesting within several of the species which normally have males and the information developed in this study may be basic. A third reason is that our long practice in the handling of isolation cultures of *Cheyletus* assures that case histories of individual mites can be followed to completion with expectations of a low incidence of mortality by accident.

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METHODS

Active or moulting deutonymphs of the predator were sealed into isolation cells containing a moderate number of prey mites and five to seven flakes of wheat bran. The flakes were selected so as to provide nesting sites acceptable to the mite and convenient for an observer to manipulate. These were usually polygonal in outline, rigid, somewhat dark in color, without complicated curls or folds, and cupped on the rough (endosperm) side.

The isolation cells ultimately developed (Fig. 1) proved to be very serviceable. Each cell comprised a 10 mm length of thick-walled glass tube sealed at one end (bottom) with brown cigarette paper and closed at the other end (top) with thin sheet plastic (Saranwrap®). The cells were sawed from a glass tube approximately 32 mm O.D. and 24 mm I.D. The cigarette paper was permanently affixed with warm, dilute gelatin and the surplus paper margins later burned away. The circular Saranwrap closures were cut with scissors from a paper sandwich, plastic placed between sheets of rough paper. The top closures were fastened was a very thin film of vaseline. They could be peeled off and resealed several times before replacements were required. The tissue paper bottom was freely permeable to water vapor. Each cell was provided with a square plastic base or holder, 50 × 50 × 6 mm, drilled with a 24 mm center hole and a 36 mm countersunk shoulder. The holders made the handling of the cells much easier. The cells containing mites were stored at room temperature in a moist chamber having a wire grid shelf suspended over saturated aqueous KCl (80–85% R.H.). This fairly high humidity was possibly more vital for *Acarus siro* (Solomon, 1962; Knülle, 1965) than for the predators.

Stocks of the prey mite, *A. siro*, were stored under similar conditions. The acarids were cultured in glass tubes 60 mm long, 18 mm O.D., which were sealed on one end with cigarette paper and with a snap-cap on the other. These mites grew very well when they were fed on wheat bran plus quick-cooking oats, about 20:1 by volume. The transfer of prey mites to isolation cells was accomplished easily with the aid of the snap-caps. A cap removed from a thriving acarid culture was inverted over an open culture cell and lightly tapped with a pencil. The striking force was adjusted to sprinkle food mites in small quantities, about 25 to 100 mites. In this manner there was no carry-over of additional bran or crude debris.

The unsupported paper bottoms of these isolation cells are resilient, like the membrane of a drum so that slips of manipulating tools sometimes catapulted both bran flakes and mites out of the cells. Two non-

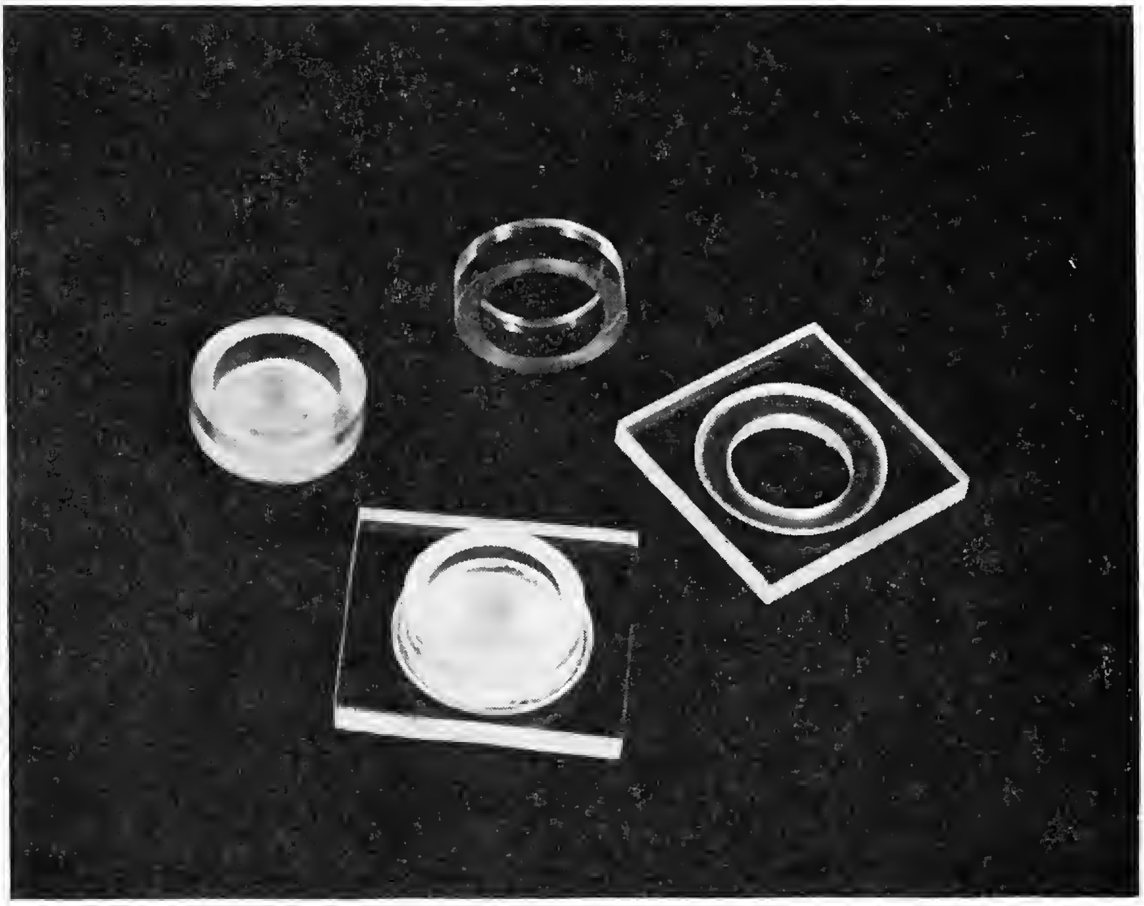

FIG. 1. Components of the culture cells. The one in the lower center is assembled but has no plastic film cover.

flexible tools were generally used: a fine-pointed jeweler's forceps and a rigid-shafted needle having a lancet tip. When a nest was operated upon to remove eggs, shells or dead prey, the cell was lifted from its plastic supporting base and placed directly on the glass stage of a microscope. Closed forceps were used to press the bran flake (nest) against the glass-supported paper bottom while the needle was used as a scoop or pick. Active progeny of the cheyletids were routinely destroyed.

These cells were especially useful for the rearing of *Cheyletus* because the species cultured are cryptic and rarely climb far up the walls of the cells.

OBSERVATIONS

Individuals of *C. eruditus* are negatively phototaxic and positively thigmotaxic within limits not precisely determined since the physical conditions provided were fairly constant. Mites of this species developed vigorous colonies in glass culture tubes partly filled with bran and acarids, and they established nests (Fig. 2) under bran flakes dispersed on the paper bottoms of the isolation cells.

The nesting sites provided were concave flakes of bran having slight

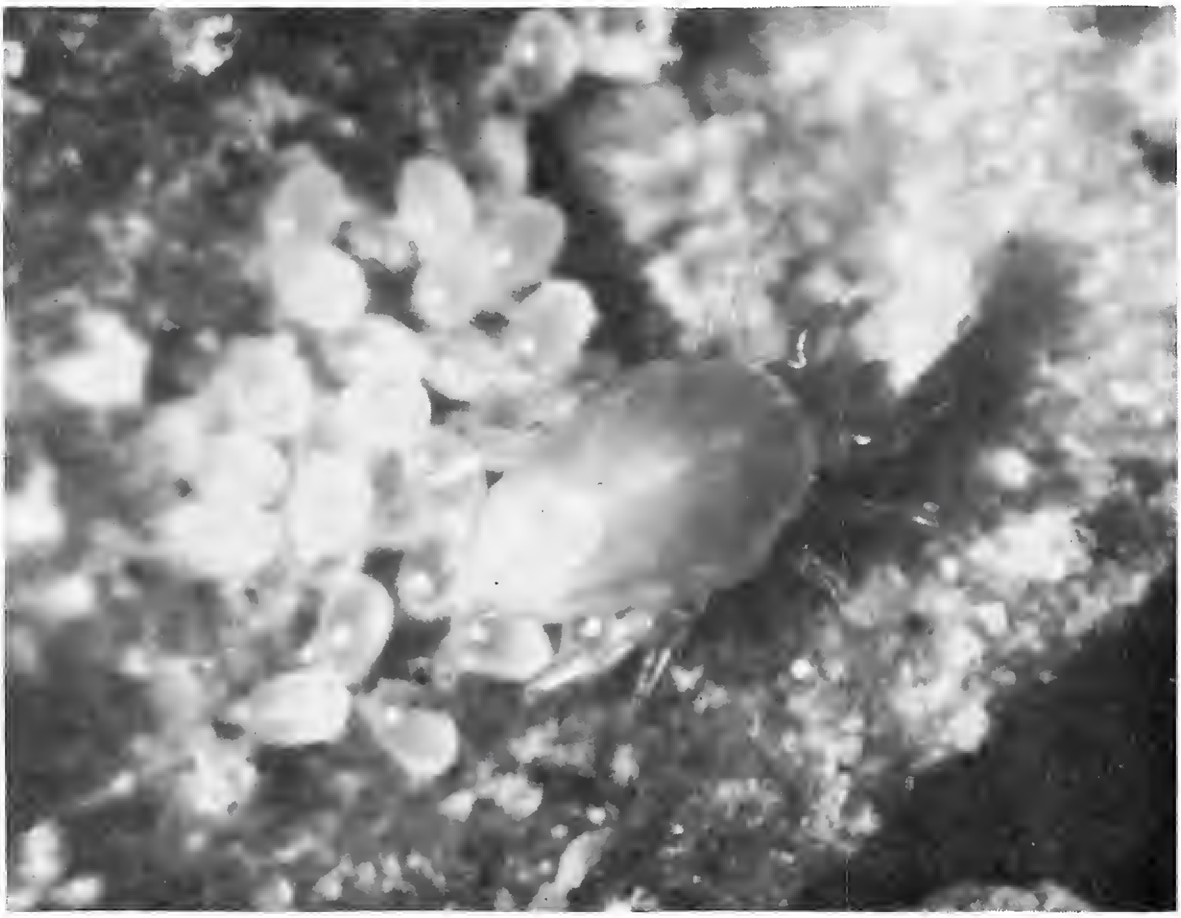

FIG. 2. A prime nest of *Cheyletus eruditus* on the rough surface of a bran flake. Females most frequently stand upon or over the egg mass. The highly reflective spot within the opisthosoma of this female is an accumulation of crystals within the so-called excretory organ (proctodeum).

twists or projections to prop them slightly above the bottoms of the cells. Appreciably elevated pieces were rarely selected by the mites for nesting sites if other options were available. The homesites most often occupied were those in which the vertical dimensions of the free space were not much greater than the thickness of the mites' bodies. Individuals entering nests were not deterred by limited clearance at the access point: they merely lifted the margins by pushing under. Nesting mites most frequently reposed upside down, clinging to the ceiling of the domicile. They either crawled under in the upright position and then inverted themselves, or they crawled in an upright position to the edge of a chip and inverted as they turned under, as though moving from roof to ceiling. Body orientation appeared not to be a critical factor in site selection. The cheyletids were observed to perch in all positions with respect to the gravity axis, usually with their bodies lightly wedged into a restricted space. Movements of the mites on nests beneath bran flakes were often revealed when the flakes themselves appeared to creep.

Two actions were clearly displayed by nesting females. One was combativeness. A nesting or brooding mother quickly attacked an intruding probe. This overt act involved forward body thrust and strong clamping motion of the pincer-like pedipalps. Another aspect of the nesting behavior was the marked tendency of the mother to remain within the nest, on or very close to her clutch of eggs. The counting of eggs by an observer often required that the female be pushed off the pile of eggs. Whenever mothers were completely dispossessed and the homesites removed, they tended to hover and probe as though trying to return.

The actions of the predators appeared to vary when prey mites entered their nests. If food mites were continuously abundant, the predators either tolerated their presence or confronted and turned them away. Less often the predaceous species retreated and avoided the intruders. Of course, at other times, the prey mites were speedily grasped and fed upon. Nests were frequently cluttered with dry or empty bodies of acarids. Partly devoured bodies adhered to the nest or to the eggs therein. The food remnants were sticky and often adhered for a time to various parts of any of the living mites. It is believed that food mites whose body fluids were partly consumed at one feeding were used again. It has been noted that a nesting mother may carry or push food remnants out of the nest. These housecleaning acts were possibly a consequence of efforts of the occupant to feed upon too-dry food remnants.

The deposition of eggs has never been witnessed during the course of many hours of attention to cultures. The eggs were deposited in clusters or piles and on the smooth (integument) or rough (endosperm) surfaces of bran flakes, on paper or on glass. Older, prime nests contained a single mass or pile of embryonated eggs and empty shells. Commonplace also were a few collapsed eggs fed upon by the mother or her neonatal daughters.

The eggs are not fastened to the substrate with copious amounts of adhesive secretion. Their surfaces are tacky, however, and the eggs remain fairly secure when hanging from above or as placed on vertical walls. When they are scooped out of nests with a pick, they readily come away from the surface and it then becomes apparent that they are loosely bound together with strands of silk. The silk or silk-like strands are otherwise rarely noticed.

In a preliminary study of reproductive capability and nest occupancy, 18 moulting deutonymphs were placed in separate cells and reared according to the four regimes listed in Table 1. In this trial, the cells were opened and inspected once daily except Saturdays and Sundays. The eggs were counted individually when possible, otherwise the number was

TABLE 1. Summary of 18 case histories, four regimes of treatment.

Regimes	No. of observations	Vital activities (averages)		
		Life span (days)	Total eggs per female (est.)	Number of nests made
R1. Normal-minimum disturbance	4	56.8	129.0	5.3
R2. Dispossessed	4	47.8	107.8	8.0
R3. Starved continuously	7	52.6	32.9	2.0
R4. Starved first 46 days	3	77.3	110.7	5.7

estimated. Whenever the mites maintained under the dispossessed regime (R2) formed nests, they were dislodged at the time of the inspection and the nests moved to new locations within the cells. The eggs within these nests were not otherwise molested. The data secured in this experiment indicate that the periodically dispossessed females (R2) lived shorter lives, laid fewer eggs and made more new nests than less disturbed females (R1). However, the frequency with which displaced females returned to their original nests was greater than anticipated. There is possibly no individual specificity among nests because we were able to interchange nests and mothers with 100 per cent success (n = 6) and without obvious disruption of the laying functions.

Ten individuals isolated as moulting deutonymphs were maintained thereafter without food for most or all of their adult lives. Each starved female deposited a few eggs during the first 15 days of adulthood and then entered upon a nomadic period during which no nests were established and incidents of cannibalism were commonplace. The continuously starved individuals (R3) did not perish prematurely but their nesting capabilities were severely curtailed.

Three of the starved individuals (R4) were presented with food on and after the 47th day. The starved mites had become pale, flat and somewhat angular in outline. After three days with ample food they plumped up and resumed laying. In respect to nesting behavior and egg productivity, the later fed females were not clearly distinguishable from continuously fed females but their lives appeared to have been prolonged by the initial fasting period. The presentation of prey to the starved predators evoked reactions not very obvious among amply fed individuals. When about 50 acarids were sprinkled into the cells for the first time, the hitherto listless predators quickly became excited or alert to the proximity of food. Their groping gyrations and other overt motor functions were intensified considerably before the first physical contacts occurred. Starved individuals displayed no arousal from lethargy when human breath was gently pipetted into their cells. But a burst of searching activity was triggered very soon after the paper bottoms of isolation cells were placed over the open ends of vials containing cultures of acarid mites.

The foregoing experiment showed that nesting females must feed and are able to leave their nests to forage and then return, and that prolonged starvation induces a state of restlessness or wandering. The estimates of egg production and the data on duration of nest occupancy are fairly crude, however, and the natural causes of nest abandonment were not apparent.

A more refined experiment was then set up to pinpoint, if possible, the duration and rhythms of oviposition and nest occupancy. In this trial, 50 individuals were maintained under three regimes of manipulation and with examinations once every day. All were amply fed on *Acarus siro* but only the 40 included in R2 and R3 were isolated as deutonymphs. Individuals in regime R1 were inspected regularly but disturbed only to the extent necessary to ascertain that the female was "at home." Individuals of regime R2 were manipulated as little as needed to provide accurate counts of eggs laid. Some eggs and all empties were removed so that, as a rule, about five to ten of the newest eggs were left after each inspection. Individuals in regime R3 were dispossessed and their nests taken out whenever found during inspections. These individuals often scattered their eggs instead of depositing them in clusters.

The second experiment (Table 2) provides somewhat better assurance that less disturbed individuals (R2) lived longer lives and laid more eggs than those whose nests were removed daily (R3). Differences in degree of manipulation did not appear to affect the duration of the laying period.

The numbers of eggs obtained under regime R2 showed that egg production per female, as determined by actual counts, exceeded the average production per female according to estimated numbers of eggs (R1, Table 1). The maximum number of eggs laid on one day was 27 and the highest productivity occurred during the first one-third of the laying period. All active instars of cheyletids show marked cannibalism. Accordingly, these estimates exceed all previously reported values because the active progeny were routinely destroyed and the counts include the collapsed eggs fed upon by the mother or by recently hatched larvae.

The period during which reproducing females exhibited nesting be-

TABLE 2. Summary of 50 case histories, three regimes of treatment.

Regimes	No. of observations		Vital activities: Life span (days)	Laying period (days)	Total eggs per female	Number of nests made
R1. Mild disturbance: determinations of nest occupancy	10	Mean	—	—	—	2.5
		Range	—	—	—	1–4
R2. Moderate disturbance: nests inverted, some eggs removed	19	Mean	61.6*	44.2	169.4*	5.0
		Range	33–83	22–59	70–317	1–12
R3. Severe disturbance: nests removed daily	21	Mean	49.8*	41.1	141.6*	—
		Range	20–76	14–60	77–204	—

* Differences significant at $P = 0.05$ by t test.

havior slightly exceeded the duration of laying. Ten females tested under regime R1 (Table 2) were maintained in isolation cells only for data on nest tenure. They were vigorous, young adults when isolated. These individuals averaged one-half as many nests as the individuals manipulated as described in regime R2. Three of 10 individuals in the R1 lot and two of 19 individuals in the R2 lot never left their original nests, except for brief excursions, until oviposition ended. Among R2 individuals, for which actual egg counts were made, approximately 48 per cent of the eggs were deposited in the first nest and an additional 28 per cent in the second nest. Thereafter the frequency of new nest formation increased while oviposition waned. Females in regime R2 averaged 3.9 days pre-oviposition, 44.2 days of oviposition and 13.0 days in the post-ovipositional, wandering phase.

Three extrinsic factors have been observed to terminate or prevent nesting in laboratory cultures of this species: (1) starvation, (2) overcrowding with prey mites, and (3) the turning-over of the nests—physical disruption of the microcavern, too much light or heat. In these trials, the changing of nests by females in the prime period of oviposition may have been induced artificially by movements unavoidable in the handling of cultures. The intervals between the first few nests were short and not noteworthy. The waning of egg laying correlated with the onset of discontinuity in nesting, and most of the new nests were established during the attenuated portion of the oviposition period. In this male-less race of *C. eruditus*, belligerent nesting behavior seems to persist throughout most of the laying cycle.

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BOOK REVIEW

THE INSECT REALM. A GUIDE TO THE HALL OF INSECTS. By Charles L. Hogue and Fred S. Truxal. Los Angeles County Museum of Natural History. 99 pages, 106 figs. 1970. $2.00 [paperback].

Designed to complement the displays in the Hall of Insects of the Los Angeles County Museum of Natural History, the book admirably fulfills its goal. Although expressly not intended as a textbook in entomology, it could stand on its own merits as an introduction to many fascinating aspects of entomology.

The book is not organized in the same sequence as the displays, but an Appendix with map servcs as a cross-reference. The book begins with considerations of the systematic relationships of insects to other animals and the geologic history of insects; then to discussions of structure and function, growth and development; followed by extensive considerations of insects in relation to their environment and insects in relation to man as medical, agricultural and house and garden pests as well as beneficial insects; to final sections on the orders of insects and how to collect and preserve insects.

The discussions and displays are aimed at the general public, but contain sufficient diversity and information to be of interest to undergraduate entomology majors. The major deficiencies in the book are the discrepancies between the ordinal names and phylogenetic relationships used in the genealogical chart (page 4) and the major groups chart (page 70), and the lack of many of the display illustrations. The latter is undoubtedly intentional, so that one must visit the displays and use the book to provide a record of a memorable tour of "The Insect Realm."—R. W. THORP, *University of California, Davis, 95616.*

A New Species of *Leptopteromyia*
(Diptera: Leptogastridae)

CHARLES H. MARTIN
Oregon State University, Corvallis, 97331

The name *Leptopteromyia argentinae* Martin (1971) appeared in a key without an accompaning description, hence the species is described below. *Leptopteromyia argentinae* Martin belongs to the group in the genus with longitudinal stripes. As Martin's (1971) key indicates, it most closely resembles *L. americana* Hardy.

Leptopteromyia argentinae Martin, new species

MALE. Length 8 mm. Head black, face grayish white tomentose, front and occiput gray tomentose; mystax with four short whitish hairs, occipital bristles white.

Thorax yellowish red, median stripe reddish brown extending over anterior declivity, lateral stripes reddish brown, reaching the lateroventral margin of the thorax, white tomentose laterally over stripes and posteriorly; bristles pale; scutellum blackish, white tomentose; pleura yellowish anteriorly, brown below wing bases, white tomentose.

Abdomen dark reddish brown, tergite 2 with median yellow band and posterior margin yellow, tergite 3 with yellow bands on anterior and posterior margins, tergite 4 with narrower yellow bands; tergites with brown semirecumbent hair; epandria apically tapering to point and curving upward.

Wings slightly brownish.

Hind femora reddish brown, clavus with yellow band basally and yellow spot apicoposteriorly, hind tibia reddish brown, yellow basally, tapering gradually from clavus to base.

Holotype male, ARGENTINA RD., TUCUMAN, DIOVO CODILLAL, ARGENTINA, 16 January, 1929 (R. Golbach) (Universidad Nacional de Tucuman). Allotype, female, V. Padre, R. A. Tucuman-Burruyacu, 17 January, 1948 (R. Golbach) (Universidad Nacional de Tucuman). Paratype male, same data as allotype (Coll. Charles H. Martin).

LITERATURE CITED

MARTIN, C. H. 1971. A review of the genus Leptopteromyia in the western Hemisphere (Diptera: Leptogastridae). Pan-Pac. Entomol., 47: 264–270.

THE PAN-PACIFIC ENTOMOLOGIST 48: 270. OCTOBER 1972

Notes on the Biology and Larval Morphology of *Stenodynerus canus canus*

(Hymenoptera: Eumenidae)

STEPHEN L. CLEMENT
University of California, Davis, 95616

Stenodynerus canus canus R. Bohart is a small wasp about 8–9.5 mm long and has been recorded from northwestern United States (Idaho, Washington, Oregon, Nevada, Utah, Wyoming, Montana, Colorado) and British Columbia (Bohart, 1966). The present paper includes some fragmentary information on the biology of this species and a description of the larva.

Markin and Gittins (1967) reviewed the biological information on the North American species of *Stenodynerus.* Since their publication, Krombein (1967) and Evans (1970) have added biological information on the group.

Six nests of *S. c. canus* were discovered during summer 1971 at a site (2,395 meters) about 0.6 km west of West Thumb, Yellowstone National Park, Wyoming. Nests were separated from each other by at least 0.3 m but were all found in an area of about 2.5 × 6 m.

Natural crevices within a few volcanic outcroppings housed the nests. The narrow linear crevices ranged from 4–7 mm in width and 1–7 cm in length. Although there appeared to be no preference for crevices which faced a particular direction, wasps all selected crevices which were more or less on a horizontal plane. Each nest entrance was surmounted by a curved mud turret 10–12 mm long and 3.5 mm wide (Fig. 1).

Personal communication with R. M. Bohart and a review of the literature reveal that this is the first reported instance of a species of *Stenodynerus* using natural crevices of rocks for nest sites (Fig. 1). Other species construct turrets but all known species which do so nest in the ground.

Three female wasps were observed in the act of constructing their turrets, two on 3 July and one on 15 August. Each wasp spent a few seconds searching for a dirt particle before transporting it in the mandibles a few centimeters to the nest. The mandibles, legs, and the tip of the abdomen were used to incorporate the dry particles into and around the edge of the turret openings. The female wasps apparently mixed small quantities of water with the dry particles as they were added. Fin-

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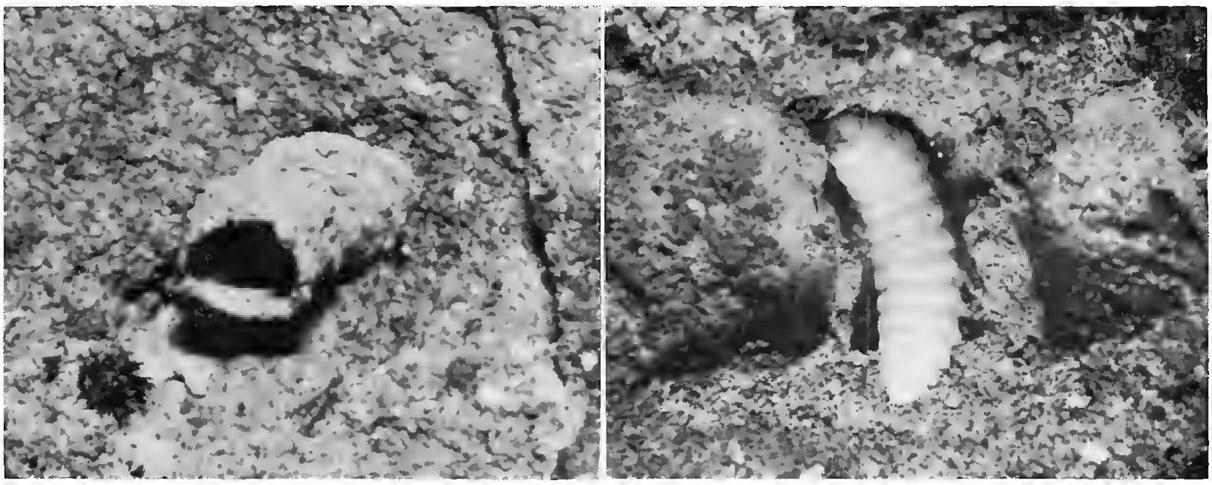


FIG. 1. Upper left.—A partially constructed turret of *Stenodynerus canus canus* protruding from a narrow linear crevice. Upper right.—A section of rock showing the placement of cells and one prepupa in situ.

ished turrets angled upwards 20–40° before curving so that the openings faced downwards.

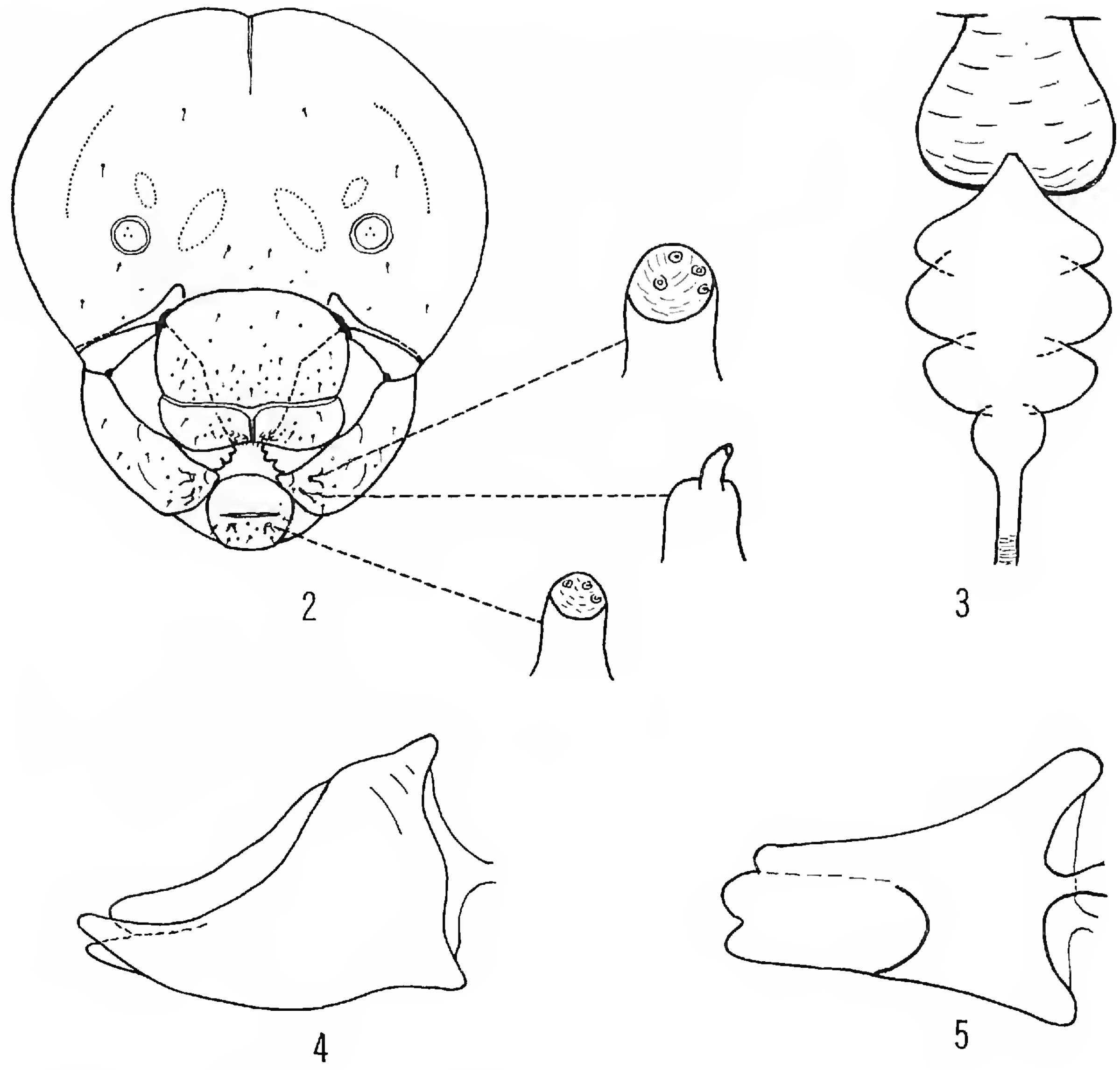
One of the wasps observed on 3 July took about two hours to add 5 mm to the length of her turret. The wasp observed on 15 August was adding material to her partially constructed turret at 11:15 a.m. (RMDT). At this time the turret measured 4.5 mm in length. Approximately four hours later this wasp had finished the turret, which measured 10 mm. Up to two minutes was spent by each wasp adding a single particle to the turret.

Nests were excavated on 26 June, 3 July, 10 July, and 28 August. Two completed nests found on 26 June produced one and two cells respectively. A completed nest with four cells was found on 3 July. These three nests all yielded prepupae. Two nests excavated on 10 July each produced a completed inner cell with a feeding larva and a partially provisioned outer cell. The 28 August nest contained a prepupa, inner cell; a late feeding larva; and an outer cell being actively provisioned.

The length of a crevice may influence the number of cells constructed by a wasp within it. The completed nest with four cells was housed in a crevice 7 cm long while the other five nests were found in shorter crevices.

Widths of each of 11 completed cells coincided with the varying tunnel widths of the crevices. Four cells provisioned in a crevice with a diameter ranging from 5.5 mm to 7 mm had corresponding widths. The shorter lengths of these four cells ranged from 4–5 mm. The other cells varied from 6–7.5 mm in length and 3.5–5 mm in width.

Eggs are apparently laid before provisioning of the cell commences. An unhatched egg was found at the base of each of the three partially



FIGS. 2–5. Prepupa of *Stenodynerus canus canus.* FIG. 2. Head capsule, frontal view. FIG. 3. Spiracle, optical section. FIG. 4. Right mandible, ventral view. FIG. 5. Right mandible, inner view.

provisioned cells examined. Most reports on the biology of the genus *Stenodynerus* mention the attachment of eggs by slender filaments to cellular walls. I did not observe this characteristic in this study but future observations of *S. c. canus* nests may reveal such egg attachments. My excavations through the rocks housing the nests damaged two of the observed eggs and in so doing, destroyed any evidence of egg attachments. The third egg could easily have been loosened from a suspended position during the course of my digging. Subsequent development of this one viable egg in a gelatin capsule failed.

Prey of this wasp consisted of small caterpillars of the families Gelechiidae and Gracilariidae, although only one larva of the latter family was found in a cell. The number of caterpillars found in the partially provisioned cells were one, four, and eleven.

After provisioning, the cell is sealed with a mud partition about 0.5 mm thick. The cap of the outer-most cell of two of the completed nests was flush with the base of the mud turret. The completed nest with four cells had a vestibular cell about 3 cm long. A separate mud cap about 0.5 mm thick plugged this nest at the base of the turret. The provisioned cells examined were flush with one another. Summer rains partially destroyed completed turrets and in so doing, separately plugged completed nests.

Postdefecating larvae line their cells with a thin layer of silk before entering the prepupal stage. On 3 July two prepupae were transferred from their cells to gelatin capsules. These were subsequently kept at room temperature. Later in the laboratory, a male emerged on 23 November and a female on 3 December. The pupal stage of both lasted about 12 days.

Grandi (1937) figured and described the larva of *Ancistrocerus parietum* (Linnaeus) (as *Odynerus*), a species introduced to northeastern United States and Canada from the Palaearctic. It appears, however, that to date no larvae of eumenids endemic to North America have been described.

Larvae of *S. c. canus* (Figs. 2–5) conform to the main characters used by Reid (1942) to separate eumenid larvae from other vespoid larvae. The width of the labrum in this species is as great as the width of the clypeus where the two join, and secondly, the distance from the antenna to the nearest mandible is less than the distance from the midpoint on the anterior margin of the labrum to a line drawn between the bases of the mandibles. Prepupae of *S. c. canus* also exhibit a median groove dividing the labrum into two lateral lobes and a membranous area between the anterior margin of the clypeus and the posterior margin of the labrum (Fig. 2). Both of these characters are mentioned by Reid as constituting additional eumenid characters but expressed in varying degrees of constancy within the group. The following description employs, in part, the terminology and organization used by Torchio (1970) in his larval descriptions of two species of the family Masaridae.

Prepupa.—Head: Integument sclerotized; mandibular apices and articulation, maxillary and labial palpi, salivary lips, and anterior tentorial pits heavily pigmented; antennae, posterior tentorial pits, pleurostomal and hypostomal thickenings, and posterior thickening of head capsule lightly pigmented; head capsule and mouthparts with few small setae and scattered sensoria; epicranial suture distinct, incomplete, terminating well above clypeus; parietal bands narrow, feebly developed; antennae located low on head, each with three sensoria, pair of small moderately deep pits positioned above antennae; pair of larger shallow indentations on frons above epistomal suture; epistomal suture well developed, indicated by slightly arched line between anterior tentorial pits; clypeus moderately protuberant with sensoria more numerous on lower half; labroclypeal suture distinct, indicated by narrow membranous area between anterior border of clypeus and posterior margin of labrum; labrum divided by heavily pigmented, median sulcus into two lateral lobes, distal margin strongly emarginate and minutely spinulate centrally; mandibles robust, sclerotized, apices tridentate, inner apical surface concave and limited basally by transverse carina; maxillae distinct, galea and palpi subapical and conspicuous, palpi with four sensoria; labium with prementum and postmentum distinct, palpi subapical and conspicuous, each with three sensoria; salivary opening transverse with sclerotized lips projecting slightly above prementum. *Body*: Slightly bent anteriorly, head not touching any abdominal sternum; 6.5–8 mm long; intersegmental lines complete, fairly conspicuous; dorsolateral tubercles slightly elevated; spiracles not elevated above body, peritreme present, atrium slightly sclerotized, lacking spines or ridges, primary tracheal opening with narrow collar, without spines, subatrium expanded with diameter equal to that of atrium, posteriorly constricted into primary trachea; anus transverse slit approximately at midline.

No parasites or other insects were associated with the six nests, although one nest was found adjacent to the nest of a bee, *Dianthidium heterulkei heterulkei* Schwarz.

ACKNOWLEDGMENTS

Dr. R. M. Bohart determined the *Stenodynerus* and Mr. M. R. Gardner (California Department of Agriculture) identified the lepidopterous prey. I am grateful to Professors R. M. Bohart, R. W. Thorp, and A. A. Grigarick for their advice concerning the text of the manuscript. Permission to carry on this study was granted by authorities of Yellowstone National Park.

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BOOK REVIEW

How to Know the Spiders (2nd edition). By B. J. Kaston. Wm. C. Brown Co., Dubuque, Iowa. x + 289 pp. + 15 pp., 647 figs. 1972. $5.25.

Dr. Kaston's original "How to Know the Spiders" has been widely used by both amateur and student for twenty years. Now in its 2nd edition, this book is even more useful and informative. As in the 1st edition, the keys are not overly difficult and are liberally illustrated (with 95 more figures). Unfortunately, the pictures of the webs did not reproduce satisfactorily, but, a 15-page errata sheet is included with each book. The introduction is essentially the same, with the addition of some information on the various numbers of eggs laid and an explanation of the pit-fall trap method of collecting.

Additions include a short section on parasites and other enemies of spiders and a list of the families of spiders indicating which of them occur in America north of Mexico. The section on venoms has been expanded, including a discussion of the effects of the venom of the brown recluse, *Loxosceles reclusa.*

The 2nd edition covers four more families, 40 more genera, and 134 more species than the first, which, along with more distribution data, gives a better coverage of the western states. Also, the number of species now known from each genus is indicated in the keys. Finally, name changes or changes in placement have been indicated by a list in the back of the book. All things considered, those interested in spiders will find this book very useful and at a price they can afford.—John T. Hjelle, *California Academy of Sciences, San Francisco, 94118.*

BOOK NOTICE

Manual of Medical Entomology. By Deane P. Furman and Elmer P. Catts. National Press Books, Palo Alto, California. 163 pages, 356 figs., 3rd edition 1970, $5.45 [paperback].

This third edition of a standard medical entomology manual has been thoroughly revised and updated. The total number of illustrations has been increased, but with some loss in quality (e.g. Blattaria, Mallophaga, immature insects, etc.). Some keys have been shortened (Coleoptera) and others expanded (immature insects) and an entirely new chapter on spiders has been added. This new edition should prove very useful in laboratory courses oriented toward the identification and recognition of medically important groups of arthropods.—R. W. Thorp, *University of California, Davis, 95616.*

SCIENTIFIC NOTE

Additional prey records for the forest-dwelling spider wasp, *Priocnemis oregona* (Hymenoptera:Pompilidae).—The range of spiders used by *P.* (*Priocnemissus*) *oregona* Banks is of interest because this wasp, while widespread on the Pacific Coast, generally lives in mesic, forested habitats. As a result its activities take place mainly on shaded ground covered by leaf litter and have rarely been observed. Until comparatively recently nothing was known of the nesting behavior, but three species of prey, all primitive burrowing spiders, *Actinoxia versicolor* Simon (Ctenizidae), *Atypoides riversi* P. -Cambridge (Antrodiaetidae), and *Brachythele* sp. (Dipluridae), were recorded by Hurd and Wasbauer (1956, J. Kans. Entomol. Soc., 29: 169) and Wasbaucr and Powell (1962, *ibid.*, 35:394). We speculated then that a wider taxonomic spectrum of spiders might be expected for *P. oregona* because the closely related *P.* (*Priocnemissus*) *minorata* Banks of eastern North America and European species of *Priocnemis* use a variety of wandering ground spiders. However, in recent years additional captures of the same kind of prey previously associated with *P. oregona* tend to confirm the possibility that this pompilid displays restricted hunting behavior, specializing on burrowing Orthognatha.

On two occasions field course groups from the Department of Entomology, University of California, Berkeley, have discovered prey associated with *P. oregona* (female wasps identified by M. S. Wasbauer, California State Department of Agriculture, Sacramento). The habitat in both instances was quite similar: a partially open area in mixed forest of *Lithocarpus*, *Arbutus*, *Ceanothus*, *Pseudotsuga*, and *Sequoia*, marginal to more dense redwoods and a few meters above a creek. The first was near Alpine Dam, Marin County, where on 10 April 1968, H. V. Daly, members of the Immature Insects class, and I found a female *P. oregona* with a paralyzed, mature female of *Antrodiaetus pacificus* (Simon) adjacent to a burrow entrance which was located on a rocky, north-facing, shaded slope. The second discovery occurred quite fortuitously, on 24 April 1970, at Bates Creek, about three miles NNE of Soquel, Santa Cruz County, when E. I. Schlinger and members of the Field Entomology class were excavating trapdoor spider nests at night. A female *P. oregona* was unearthed several cm deep within a burrow, along with a paralyzed spider, a female of *Actinoxia versicolor.* The burrow entered a nearly vertical roadbed bank which had many nests of orthognathous spiders. M. M. Bentzien, who identified both prey spiders and assisted us with the excavation at Bates Creek, suggested that in all probability the burrow was that of this or a similar spider.

Thus, there are conflicting possibilities as to whether *P. oregona* digs her burrow or appropriates that of the spider. Moreover, it is unknown if the prey is usually stung within its own nest or is enticed or dragged from the tunnel, but these spiders are nocturnal and do not normally wander from the nest even at night. If the wasp digs her own burrows and cells, the question remains as to whether the nest consists of one or more cells, but the chance of discovery of a pompilid and its prey in a single cell burrow is highly improbable. In New York, *Priocnemis minorata*, which uses wandering ground spiders (not Orthognatha), constructs a nest with up to seven sequentially provisioned cells (Yoshimoto, 1954, Bull. Brooklyn Entomol. Soc., 49: 130). Although tunnel digging was not observed by Yoshimoto and abandoned holes could be appropriated by *P. minorata*, use of primitive spiders and their burrows would be a remarkably divergent adaptation by *P. oregona.*

Multi-cellular nests have been described only for the genus *Priocnemis* among North American Pompilidae, and use of abandoned arthropod or vertebrate burrows is known for this and related genera in Europe and South America (Yoshimoto, *ibid.*: 138). On the basis of the description of the unnamed wasp, the locality (Brookdale, Santa Cruz County), and the season (April), the curious account by F. A. Leach (1921, *Wild Life in California,* Tribune Publ. Co., Oakland.: 99) appears to refer to *P. oregona.* In this case the wasp provisioned a "bulky" spider about twice her own size in a burrow located about 18 inches up from the base of a nearly vertical, root-choked roadbed bank. The wasp did not fill the tunnel following deposition of the spider (at 3:15 p.m.), and then continued to occupy the burrow over a five day period of inclement weather. This tends to support the suggestion that sequential cell occupancy of the nest is practiced by *Priocnemis oregona* in a manner similar to its eastern congener.—J. A. POWELL, *University of California, Berkeley, 94720.*

SCIENTIFIC NOTE

Synonymy of the pselaphid beetles *Actium retractum* and *A. hatchi* (Coleoptera:Pselapidae).—In our revision of *Actium* Casey and *Actiastes* Casey (1971, Univ. Calif. Publ. Entomol., vol. 67) we indicated that *Actium retractum* Casey was probably the same species as *A. hatchi* Park and Wagner but were unable to locate the type specimen of *A. hatchi.* Dr. H. S. Dybas, Field Museum of Natural History, located the specimen and kindly brought it to our attention. Examination of this type confirmed the suspected synonymy.

Actium retractum Casey, 1908. Can. Entomol., 40(8): 270. Holotype ♂, Queen Charlotte Islands, Canada (U. S. National Museum—38643).

Actium hatchi Park and Wagner, 1961. Univ. Wash. Publ. Biol., 16: 20. Holotype ♂, Snoqualmie Pass, Washington, U.S.A. (Field Museum of Natural History, Chicago). NEW SYNONYMY—ALBERT A. GRIGARICK AND ROBERT O. SCHUSTER. *University of California, Davis, 95616.*

SCIENTIFIC NOTE

New Synonymy in the genus *Meloe* (Coleoptera:Meloidae).—In their recent revision of the North American species of *Meloe,* Pinto and Selander (1970, Illinois Biol. Monogr., No. 42) tentatively treated *Meloe* (*Meloe*) *quadricollis* Van Dyke as a distinct species. They recognized that individuals associated with this name were almost identical to those of *M. californicus* Van Dyke, differing but slightly in coloration and minor details of pronotal punctation. However, only three females, including type material, were available for study at that time. Since females of some distinct species of *Meloe* are almost impossible to distinguish, *M. quadricollis* was allowed to stand pending the discovery of males.

A male specimen collected at Davis, California, 9 February 1931 by C. C. Wilson, with the characteristics of *M. quadricollis* was recently sent to me by Dr. Fred Andrews of the California Department of Agriculture. As with the females previously studied, this specimen differs from typical, completely black, individuals of *M. californicus* by the faint metallic green body color, and the slightly coarser pronotal punctae only. All other traits, including antennal and genitalic structure, agree perfectly with those of *M. californicus* (see Pinto and Selander, Figs. 120 and 178). Considering these important similarities, and the fact that coloration and punctation are highly variable within species of *Meloe*, *M. quadricollis* should now be treated as a junior synonym of *M. californicus*.—JOHN D. PINTO, *University of California, Riverside, 92502.*

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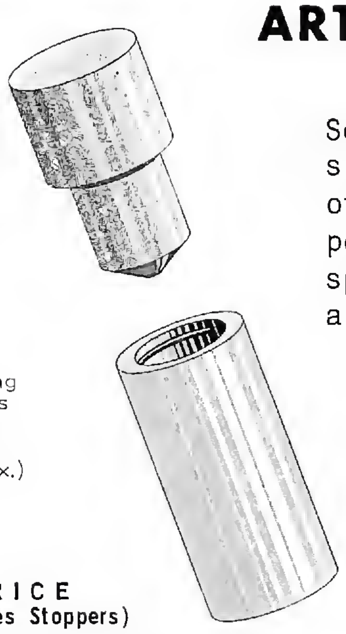

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Essig, E. O. 1926. A butterfly migration. Pan-Pac. Entomol., 2: 211–212.
1958. Insects and mites of western North America. Rev. ed. The Macmillan Co., New York. 1050 pp.

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