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A New Genus and a New Species of Dobsonfly from the Far Western United States (Megaloptera: Corydalidae)[1]

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During my study of the Megaloptera of the Pacific Coastal Region of the United States, a new species of dobsonfly was discovered and a previously described species was found to form a monotypic genus (Evans, 1972). I later noted that this situation existed in this group of aquatic animals (Evans, 1978).

Orohermes, NEW GENUS

Forewings with median vein 2-branched; posterior branch of radial sector forked in both wings; hind wings with median vein 3-branched; wing expanse less than 110 mm. Larvae with ventral abdominal gill-tufts absent; last pair of abdominal spiracles lateral and sessile, located above and slightly anterior to base of lateral filaments.

Etymology.—From the Greek *oros,* mountain + *Hermes,* Greek God.

Type of genus.—*Dysmicohermes crepusculus* Chandler, 1954:107–110.

Chandler (1954) provisionally placed *O. crepusculus* in *Dysmicohermes* Munroe and noted that it was not closely related to the other two species in this genus which are larger in size and have the median vein of the hind wings four-branched. These two genera differ from the other Chauliodinae which have the posterior branch of the radial sector in both wings simple. Later, Chandler (1956) recognized this larvae which is unique among the Chauliodinae with the last pair of abdominal spiracles being lateral, instead of dorsal and raised or extended as in all other known species of this subfamily.

The larvae of *O. crepusculus* are usually found in permanent, cold water streams and rivers in the Sierra Nevada Mountains or the northern coast range of California and in the Cascade Mountains of Oregon.

Protochauliodes cascadius, NEW SPECIES

Male.—Wings and body similar to *P. spenceri* Munroe, alar expanse 67 mm; genitalia with short, stubby claspers, less than twice as long as broad, convex dorsally and ventrally, indented apically; aedeagus flattened in lateral view (Fig. 1); aedeagus in dorsal view narrowly notched apically, markedly expanded laterally to about mid-point and sharply constricted basally (Fig. 2).

Female.—Similar to male, alar expanse 71 mm; claspers triangular shaped in lateral view, slightly convex dorsally and ventrally (Fig. 3), trichobothrium slightly raised, light in color and occupying most of clasper lateral surface. Claspers of *P. spenceri* more elongate with basal width shorter than sides.

The claspers of the short, stubby male genitalia of *P. cascadius* resemble those

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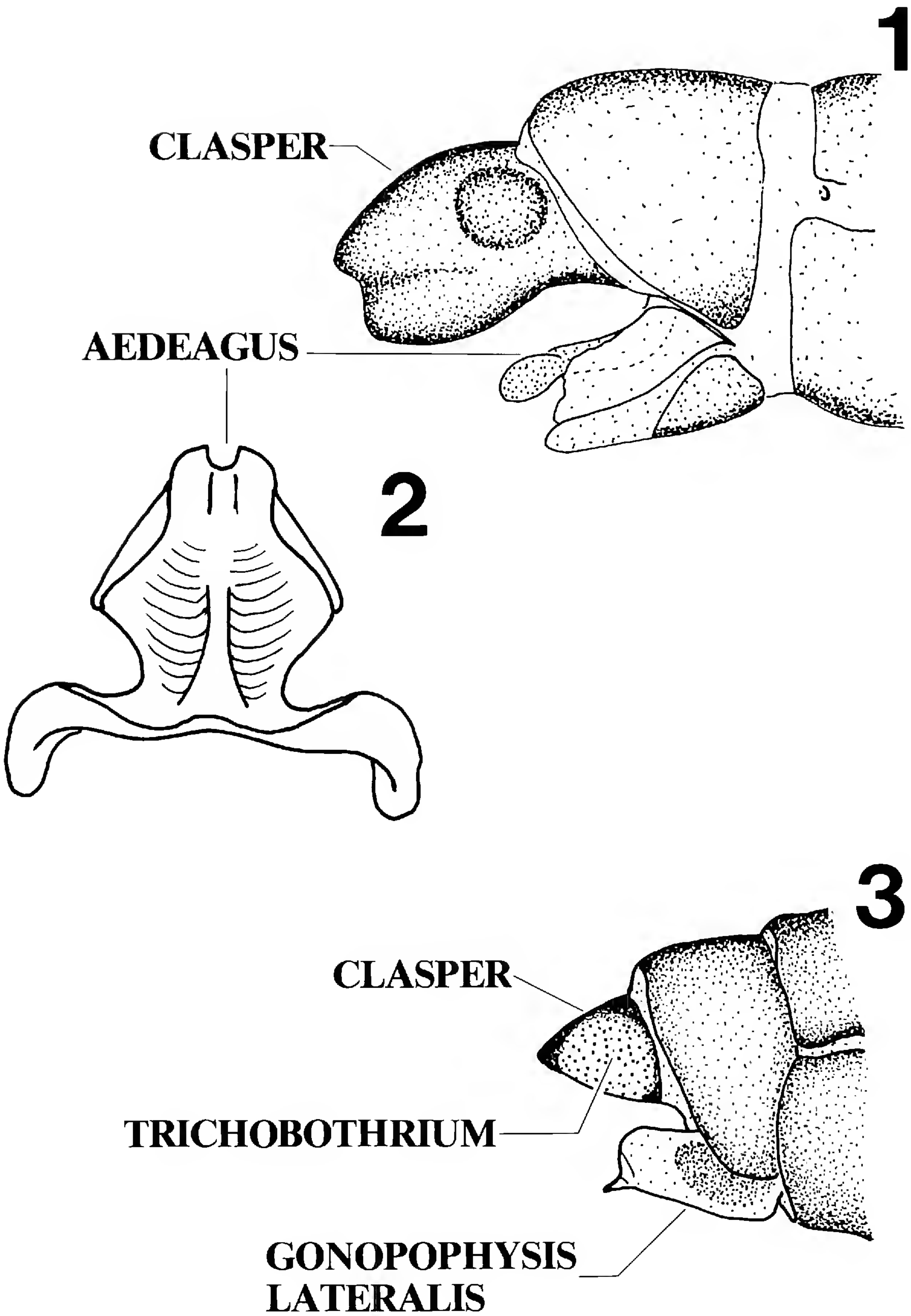
[1] Collected with *P. spenceri.*



Figures 1–3. 1. *Protochauliodes cascadius*, lateral view of male genitalia. 2. *P. cascadius*, dorsal view of aedeagus. 3. *P. cascadius*, lateral view of female genitalia.

of *P. montivagus* Chandler, another mountain species to the south in the Sierra Nevada Mountains. Claspers of the males of other species of *Protochauliodes* Weele in western North America have elongate genital claspers. The aedeagus of *P. cascadius* with its apical notch and constricted base is distinct from that of *P. montivagus* which is not constricted basally and is broadly indented apically.

Holotype.—Male, ca. 8 mi W Mill City, along Little Santiam R., Marion Co., Oregon, 26 July 1963 (S. Jewett). California Academy of Sciences.

Allotype.—Same as holotype.

Twenty paratypes.—All from Oregon as follows: Marion Co. ♂, Silver Falls State Park, 22 May 1957 (S. Jewett); Lane Co. ♂, 40 mi E Eugene, 30 July 1965 (K. Goeden); ♂, 4 mi S Mackenzie Bridge, Horse Ck. (J. Bedea); Clackamus Co. 6 ♂, vic. Firwood Rd., 4 mi W Oregon City, 5 August 1974[1] (S. Jewett); ♀, 10 August 1974 (S. Jewett); ♀, 30 July 1972 (S. Jewett); ♀, 10 August 1972[1] (S. Jewett); ♂, 5 August 1972[1] (S. Jewett); 3 ♂, ♀, 4 August 1974 (S. Jewett); ♂, ♀, 17 July 1972 (S. Jewett); ♂, 14 July 1972[1] (S. Jewett).

Paratypes will be distributed to the California Academy of Sciences, San Francisco, California; Oregon State University Entomological Collection, Corvallis, Oregon; United States National Museum, Washington, D.C.; Stanley G. Jewett Collection, Rt. 1, Box 399, West Linn, Oregon and my personal collection.

This species is sympatric with *P. spenceri,* in the foothills of the Cascade Mountains of Oregon. The larval habitat of *P. cascadius* is unknown although adults have been collected along permanent streams.

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Campyloneura virgula, a Predacious Miridae Not Previously Recorded from the United States (Hemiptera)[1]

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Abstract.—Campyloneura virgula (Herrick-Schaeffer), a European species, is recorded from the United States, based on specimens from western Washington and Oregon and northwestern California. *C. virgula* is predacious on small arthropods and is found on a variety of trees and shrubs including alder, filbert and rhododendron.

Campyloneura virgula (Herrick-Schaeffer) is a predacious species of Miridae whose natural range includes Europe, North Africa, Asia Minor and Turkestan (Wagner and Weber, 1964). It has been reported from a variety of trees and shrubs including *Alnus, Corylus, Crataegus, Fagus, Fraxinus, Quercus* and *Tilia* (Wagner and Weber, 1964; Southwood and Leston, 1959). The latter authors report that *C. virgula* overwinters as an egg on the British Isles, whereas the adult overwinters on the continent of Europe. Males are very rare and it is assumed that parthenogenesis is the usual mode of reproduction. The food of this species includes spider mites, Psocoptera, greenflies and occasionally honeydew (Southwood and Leston, 1959).

Downes (1957) reported *C. virgula* from Vancouver Island and the lower mainland of British Columbia, Canada. His earliest collections were made in 1949. Specimens were collected on alder, poplar, nettles and other plants. He mentioned the potential value of this species as a predator, especially of mites. Scudder (1960) again referred to this species while discussing various introduced Hemiptera.

The present paper was prompted by the submission of a specimen for identification by Duane Hatch, County Agent for Lane County, Oregon. The bug had bitten a person on the ankle, raising a hard welt. Rykman (1979) reviewed the literature on Hemiptera and Homoptera bites. He cited a number of references for Miridae but *C. virgula* was not included.

All of the specimens we have examined from the United States were females, further supporting the likelihood of parthenogenetic reproduction being the normal mode. Specimens examined include: CALIFORNIA: Humboldt County: Shiveley, 4 August 1964, pear and apple (T. K. Haig, F. Spallini) (USNM). OREGON: Benton County: Corvallis, 11 August 1962; Corvallis, 21 July 1968 (Evans); Corvallis, 30 July 1968, at light (Lattin); Corvallis, 24 June 1979, *Quercus garryana* Dougl., *Corylus cornuta* Marsh., *Ulmus* sp., apple (Stonedahl) many specimens (all OSU); Lobster Valley, 15 mi SW Alsea, 24 July 1979, *Alnus rubra*

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[1] Oreg. Exp. Sta. Paper No. 5837.

Bong., *Corylus cornuta* (Lattin) (OSU); 4 mi W Philomath, Hwy 20, 26 July 1979, *Quercus garryana* (Stonedahl) (OSU); Rock Creek, nr. Philomath, 23 August 1961, *Ribes* sp. (Lattin) (OSU); Curry County: Alfred A. Loeb State Park, 10 August 1979, *Lithocarpus densiflora* (H. & A.) Rehd., *Umbellularia californica* (H. & A.) Nutt. (Stonedahl) (OSU); Little Redwood campground, T39S-R12W-S29-NW¼, 11 August 1979, *Lithocarpus densiflora, Umbellularia californica* (Stonedahl) (OSU); Linn County: 2 mi NE Green Peter Dam, 15 July 1979, *Castanopsis chrysophylla* (Dougl.) A. DC. (Stonedahl) (OSU); Polk County: 6 mi E Independence, 10 July 1957, apple, (Lattin) (OSU). WASHINGTON: King County: Seattle, Shipcanal, 4 August 1977 (Leffler) (Leffler Collection); Seattle, U. Wash. Campus, 14 July 1977, leaves of *Corylus* sp. (Leffler) (Leffler Collection); Lewis County: Chehalis, Urquhart Rd., 22 July 1979, *Corylus cornuta* (Stonedahl) (OSU); Clark Co.: Vancouver, 20 July 1975 (Oman) (OSU); Whatcom County: Bellingham, 19 July 1979, *Alnus rubra, Rhododendron* sp. (Stonedahl) (OSU); 4 mi NE Welcome, N. Fork Rd., 22 July 1979, *Corylus cornuta, Alnus rubra, Acer macrophyllum* Pursh, *Acer circinatum* Pursh, *Rubus spectabilis* Pursh, *Rubus parviflorus* Nutt. (Stonedahl) (OSU).

Campyloneura belongs to the tribe Dicyphini of the Bryocorinae (Schuh, 1976). The genus may be recognized as a member of the subtribe Dicyphina by the following characters: (1) setiform parempodia, (2) anterior pronotal margin in the form of a well developed, rounded collar, (3) pseudopulvilli present, (4) parallel-sided tarsi and (5) two cells in the membrane of the forewing.

This genus runs to couplet 160 (*Cyrtopeltis*) in Slater and Baranowski (1978). The eyes are contiguous with the anterior margin of the pronotum in *Campyloneura,* while the eyes are removed from the anterior margin by a distance equal to or greater than the thickness of the second antennal segment in *Cyrtopeltis* Reuter, *Dicyphus* Fieber and *Macrolophus* Fieber. Other distinctive features of *C. virgula* include a bright yellow cuneus with a red apex and a large brown spot on either side of the ninth abdominal segment. The accompanying figure shows the habitus of the species. The nymphs are yellow with the wing pads and sides of the pronotum red, while the antennae are banded with red.

In June 1980, nymphs, and later adults of *C. virgula* were abundant on a deciduous species of rhododendron heavily infested with the aphid *Illinoia* (*Masonaphis*) *lambersi* (MacGillivary) (determined by D. Hille Ris Lambers, June 1980). As indicated in the information on specimens examined, this mirid occurs on a variety of trees and shrubs. Where observed, it appears to be a common associate of a variety of species of Aphidae. On filbert this species is part of a rather substantial complex of predatory Miridae (5 spp.) and Anthocoridae (3 spp.).

Campyloneura virgula is a useful addition to our western mirid fauna. Its predacious habits, its occurrence on a variety of economically important plants, and its reproduction via parthenogenesis all are beneficial attributes. Since so many of our introduced species of Hemiptera occur on both coasts, it seems likely that *C. virgula* will be collected on the east coast as well. Other introduced species of predacious Miridae known to occur in the Pacific Northwest include: *Blepharidopterus angulatus* (Fallén), *Campylomma verbasci* (Meyer), *Heterotoma meriopterum* (Scopoli), and *Phytocoris tiliae* (Linn.). A species of *Hyaliodes* occurs in western Oregon and may represent an introduction from eastern North America.

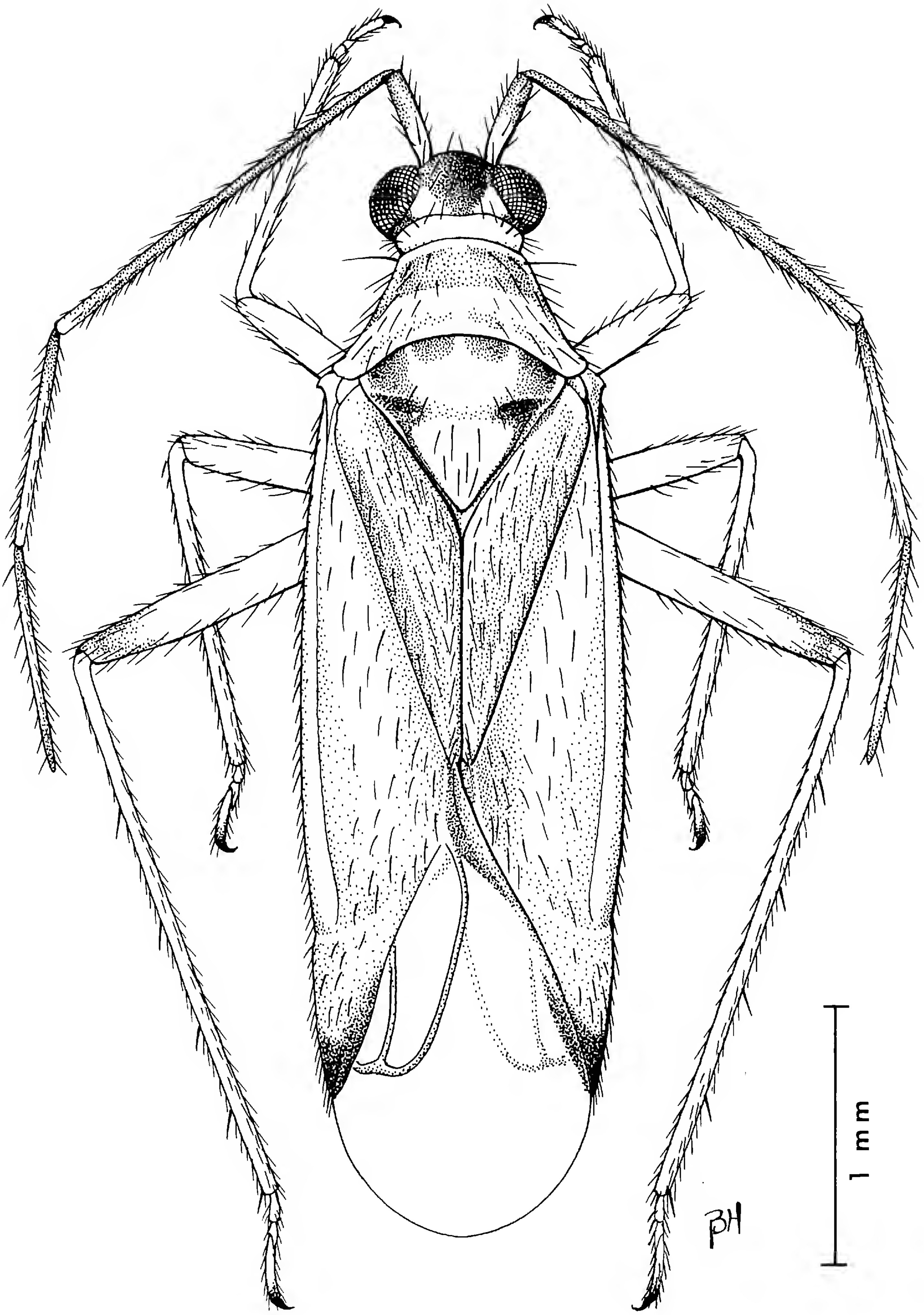

Figure 1. Adult female *Campyloneura virgula* (Herrick-Schaeffer).

Based upon collection records most of the introductions into the Pacific Northwest appear to be relatively recent. As the landscape becomes more disturbed, the likelihood of successful colonization by selected species from other regions seems to increase. Thus, we may look forward to additional adventitious species being found here.

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Our thanks to Bonnie B. Hall for the fine illustration of the adult, to the General Research Fund, Oregon State University, for the funds for the illustration, to Dr. Richard C. Froeschner of the Smithsonian Institution for assistance in examining specimens under his care, to Dr. S. Leffler, Seattle, Washington, for the opportunity of examining specimens in his collection, and to Dr. D. Hille Ris Lambers, Bennekom, The Netherlands, for the identification of Aphidae.

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A New Species of *Dendrocoris* Bergroth from Mexico (Hemiptera: Pentatomidae)

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The genus *Dendrocoris* Bergroth was most recently revised by Nelson (1955). That revision provided keys, descriptions, and figures of the male genitalia for the eight known species. A review of the literature and a discussion of the biology of the species was also included. In a subsequent article (Nelson, 1957), a ninth species was added.

Rolston (1978) discussed the position of *Dendrocoris* in relation to some other pentatomine genera and provided a key for its separation. *Dendrocoris* is related to *Odmalea* Bergroth, *Brepholoxa* Van Duzee, and *Thoreyella* Spinola. From these, *Dendrocoris* is distinguished by the combination of an elongated ostiolar canal and obtuse femoral apices.

A new species is described here based on two specimens from Jalisco, Mexico. It is readily distinguished from all other species of *Dendrocoris* by the presence of spots on the legs. The description below follows Nelson's format except that the terminology for the genitalic structures follows McDonald (1966). All measurements are from the holotype male.

Dendrocoris maculosus, New Species
(Figs. 1–5)

Appearing dull gray in dorsal view, with alternate connexivum. Distinctive features: legs maculate; spiracles ringed with black. Related to *D. variegatus* Nelson.

Color.—Pale ochraceous dorsally; yellowish tan ventrally. Posterolateral angles of abdominal sternites with broad, black blotch. Spiracles ringed with black. Legs pale yellow except tarsi and apical sixth of tibiae orange; femora and tibiae densely black maculate. Antennae orange. Eyes reddish-brown; ocelli clear, transparent; an irregular, short, black, supra-antenniferal vitta present beginning at anterior margin of each eye. Each connexival segment with broad, posterior, marginal, black stripe and an anterior, submarginal stripe; stripes connected along mesial border by narrow, irregular band of black punctures. Hemelytral membrane infuscated, translucent, veins reticulate.

Punctations dense dorsally; black, except those on discs of coria and pronotum which are dark brown. Ventral punctures concolorous with surface except for row of 6–7 black punctures near lateral margin of each propleura and short coalescent series near lateral margin of each metapleura.

Structure.—Length 7.4, width 4.5 mm; widest point of abdomen and humeral width subequal. Head flat dorsally; vertex and posterior half of tylus weakly tumid. Sides of jugae edentate, parallel for short distance before apex; apices overlapping tylus and contiguous anteriorly. Length of head 1.2, width 1.2 mm. Antennifers prominent and distinctly visible from above. Antennal segments III, IV, and V

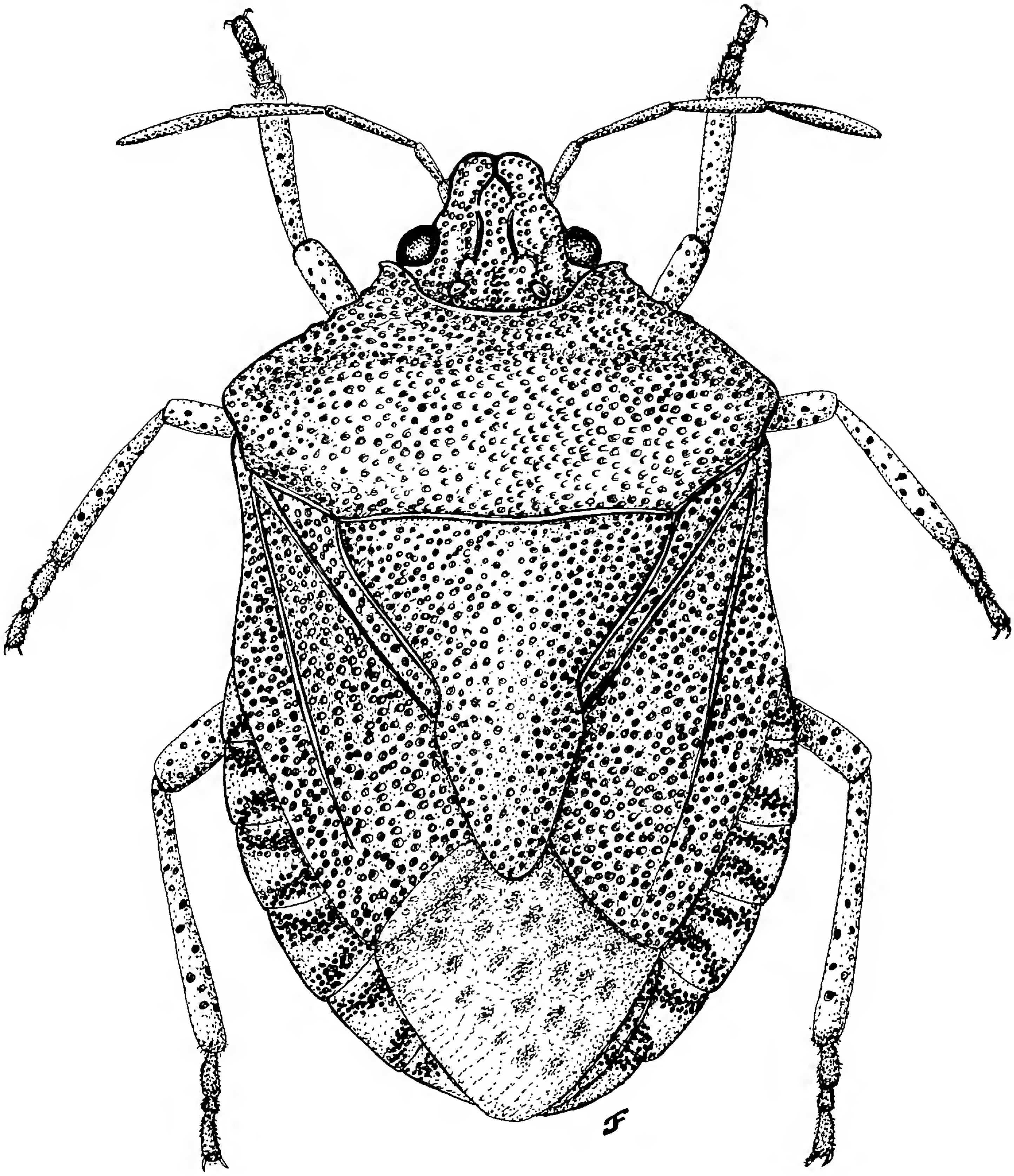


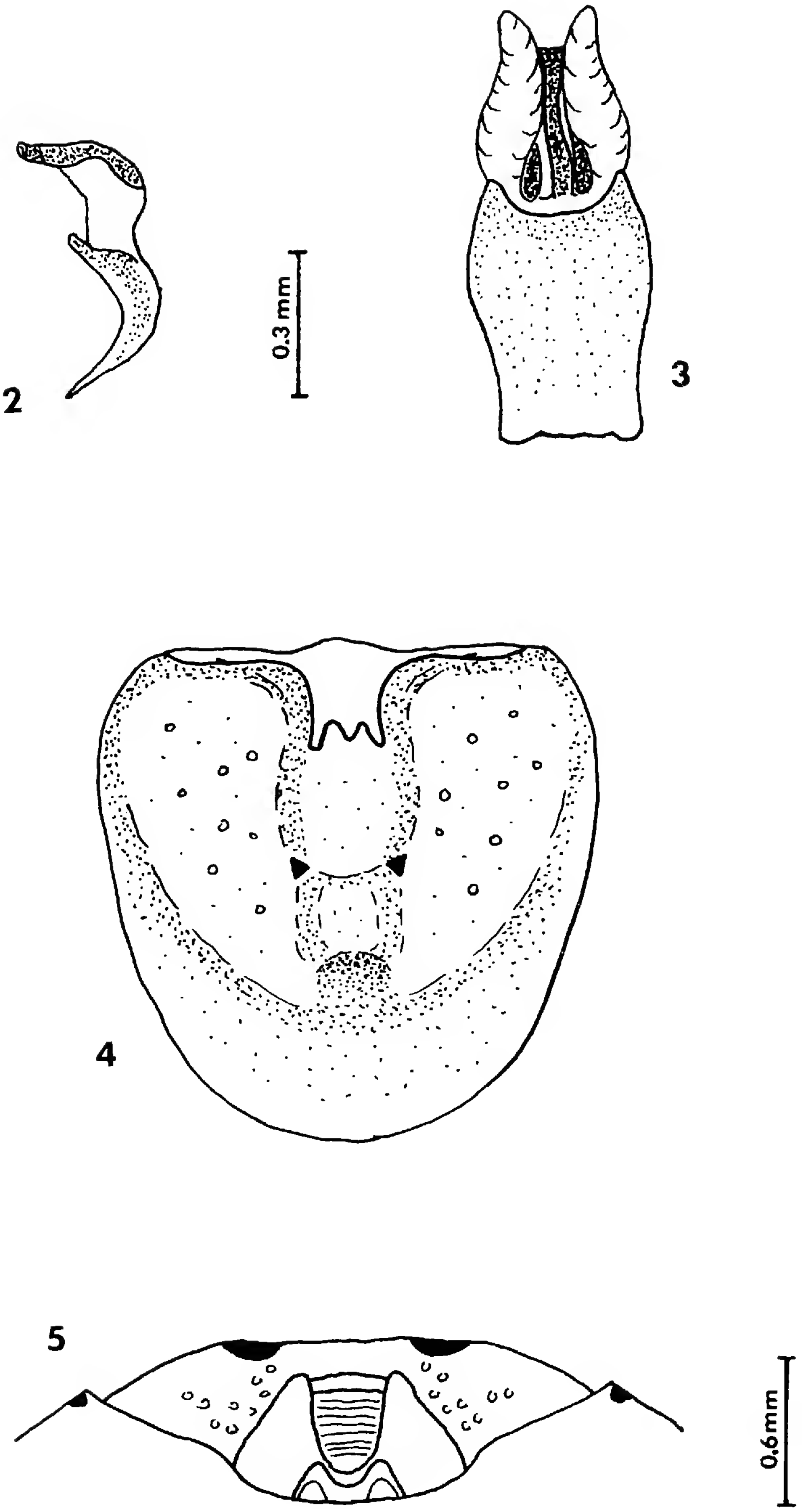
Figure 1. *Dendrocoris maculosus* Thomas, n. sp. dorsal aspect.

with short, dense pilosity; I and II glabrous; segmental ratios 10:11:24:22:24. Rostrum in repose just attaining metacoxae; bucculae longer than first rostral segment, lobed posteriorly.

Pronotum broad, flat, somewhat explanate laterally; humeri prominent but not as produced as in *D. humeralis* (Uhler); anterolateral margins irregularly subrectilinear in dorsal view. Thoracic width 4.5, mesial length 1.6 mm. Hemelytral coria reach to middle of connexival segment VI.

Abdominal tubercle vestigial in male.

Male genitalia.—Pygophore similar in structure to *D. variegatus.* Posterolateral



Figures 2–5. *D. maculosus* genitalia. 2. Left paramere, ental aspect. 3. Aedeagus, ventral view. 4. Pygophore, caudal view. 5. Female terminalia, ventral view.

"hypopygial" plates fused with sides of pygophore; ventral margin deeply, rectangularly emarginate mesially; nadir of emargination with pair of rounded cusps either side of median; pygophoral rim either side of mesial emargination with black, spinose, laterally directed tooth. Posteroventral face with pair of black, triangular teeth either side of middle near end of carinae contiguous with margins of mesial emargination; a shallow concavity subtending emargination; weak carina connecting triangular teeth, below this another shallow concavity subtended by a darkened tumescence (Fig. 4).

Parameres terete basally; abruptly flattened and flared apically; very apex tapering to digitiform process (Fig. 2). A finely shagreened, irregular tumescence located anterolaterad of each paramere; tumescence stalked and its basal ligaments attached to base of paramere. Aedeagus simple in structure; theca with prominent, subapical, mesial tubercle dorsally; penisfilum elongate, strongly sinuately curved; slightly flared apically (Fig. 3). Proctiger broad, inornate.

Female genitalia.—First gonocoxites small, widely separated. Triangulum broadly, sinuately emarginate. Fused second gonocoxites shallowly transversely strigose. Eighth paratergite with large marginal blotch either side of each ninth paratergite (Fig. 5).

Holotype.—♂; labeled: mtns. N. Ajijic, Jalisco, Mexico. 5200–7600′ 9 July 1964. W. L. Nutting and sons. Deposited U.S. National Museum.

Allotype.—Labeled as holotype. Deposited U.S. National Museum.

Comments.—As in some other species of *Dendrocoris, D. maculosus* exhibits a characteristic pattern of sexual dimorphism. The mesial abdominal tubercle is well developed in the female, vestigial in the male. The second antennal segment is proportionately longer in the female. The female is slightly larger.

D. maculosus has a pair of teeth on the posterior face of the pygophore, a character shared with *D. variegatus* and *D. reticulatus* Barber. It also has the hypopygial plates (the posterior visible portion of the pygophore) fused with the sides of the pygophore as in *D. variegatus* to which the new species is obviously related. *D. maculosus* differs from this latter species in having the head edentate, the connexivum alternated, the spiracles ringed with black and the legs maculated.

KEY TO THE MEXICAN SPECIES OF *DENDROCORIS*

1. Femora and tibiae maculate (Jalisco) .... *maculosus,* n. sp.
   Femora and tibiae immaculate 2
2. Dorsum ochraceous with anterior pronotum contrastingly dark brown (Sonora, Coahuila, Baja) .... *contaminatus* Uhler
   Anterior pronotum concolorous with dorsum 3
3. Spiracles ringed with black (Chiapas, Morelos, Zacatecas, Guerrero) .... *suffultus* (Distant)
   Spiracles pale (Oaxaca, Mexico, Guerrero, Chiapas, Sinaloa, Michoacan, San Luis Potosi) .... *variegatus* Nelson

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Gastrodynerus, a New Genus of Eumenidae from Western North America (Hymenoptera: Eumenidae)

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The inclusion of "*Stenodynerus*" *vanduzeei* in that genus has never been satisfactory because the faint dimples on the polished front face of the pronotum are unlike the pair of pits so characteristic of *Stenodynerus.* Likewise, an assignment to *Cephalodynerus* is ruled out by the asulcate sternum II and unmarked ocular emargination of *vanduzeei.* With the finding of two additional species from Mexico it now seems appropriate to establish a new genus.

Abbreviations used throughout the paper are T-I, T-II etc. for terga and S-I, S-II etc. for sterna. Types of the new species are in the University of California at Davis Entomology Museum (UCD).

Gastrodynerus Bohart, New Genus
(Gr.: gaster + Odynerus)

Generotype.—Stenodynerus vanduzeei Bohart, 1948.

Diagnosis.—Medium sized, 5–8 mm long, palpi 6–4, mandibles evenly 5-dentate in female, 5-dentate in male with subbasal one a little prominent, F-I 1.5–2.0 times as long as broad, male antennal hook small and slender, clypeus apically incised, vertex with strong tubercles or at least faint traces, female vertex pits indistinct between postocellar tubercles or in a weak median postocellar depression. Pronotum with a hardly visible pair of dimples on polished front face, transverse carina weak and effaced toward middle, length of pronotal dorsum at middle less than antennal socket diameter, no pretegular sulcus and following carina, humeral angles moderate; notauli and parapsidal furrows weakly impressed in posterior half, parategula slender and incurved, scutellum conspicuously flattened, metanotum flattened and not raised above level of scutellum, tegula slender and with outer edge evenly curved to posterior point, omaulus undeveloped, sternaulus absent, submarginal cell II narrowly truncate anteriorly, submarginal III longer posteriorly than anteriorly, prestigmal radial stem short (Fig. 8), male midleg relatively unmodified; propodeum without superior teeth or ridges, no lateral tooth or carina, a sharp uptilted membranous projection laterally below, valves connected but deeply incised (Fig. 1), median sulcus deep and sharp. T-I moderately rounded at summit, about as long as broad, with a slightly raised and smooth apical border; T-II sharply rounded (bent) in profile at basal fourth to fifth (Fig. 1), apical margin convex and slightly to strongly reflexed, T-II basally with a series of pits or ridges; S-II without a median sulcus, basal third nearly flat and rather sharply bent out in profile (Fig. 1); S-III with massive punctures in middle third (Fig. 9); genitalia relatively simple (Figs. 4, 5).

Discussion.—The combination of polished front pronotal surface, pitted base of T-II, and asulcate as well as bent S-II distinguish *Gastrodynerus* from such related genera as *Stenodynerus* and *Cephalodynerus.* The former has distinct pronotal pits, and the latter has S-II with a median sulcus toward the base, and teeth or carinae on the propodeum above. Further, *Gastrodynerus* differs in having three lower propodeal projections (inferior membranous tooth and two valves) instead of two (valves only). The genus is also rather unusual in having the ocular emarginations dark. Three species are known, *vanduzeei* and two new ones described below.

KEY TO SPECIES OF *GASTRODYNERUS*

1. T-II hardly reflexed at apex (Fig. 1) hind margin of pronotum yellow at least posteriorly (Fig. 6), T-I coarsely punctate and with a shallow groove across summit (Fig. 1) vertex with only traces of polished tubercles (Fig. 6) .... *searsi* Bohart
   T-II reflexed at apex about 2–3 times median ocellus diameter, margin of pronotum dark (Fig. 7), T-I rather evenly and moderately punctate across summit, vertex various 2
2. Vertex with large round polished postocellar tubercles (Fig. 7), interocellar tubercles present, upper mesopleural spot well developed, usually a free spot on T-II .... *vanduzeei* (Bohart)
   Vertex with insignificant or small and oblique tubercles, interocellar tubercles absent, upper mesopleural spot absent or rarely present and small, no free spot on T-II .... *stangei* Bohart

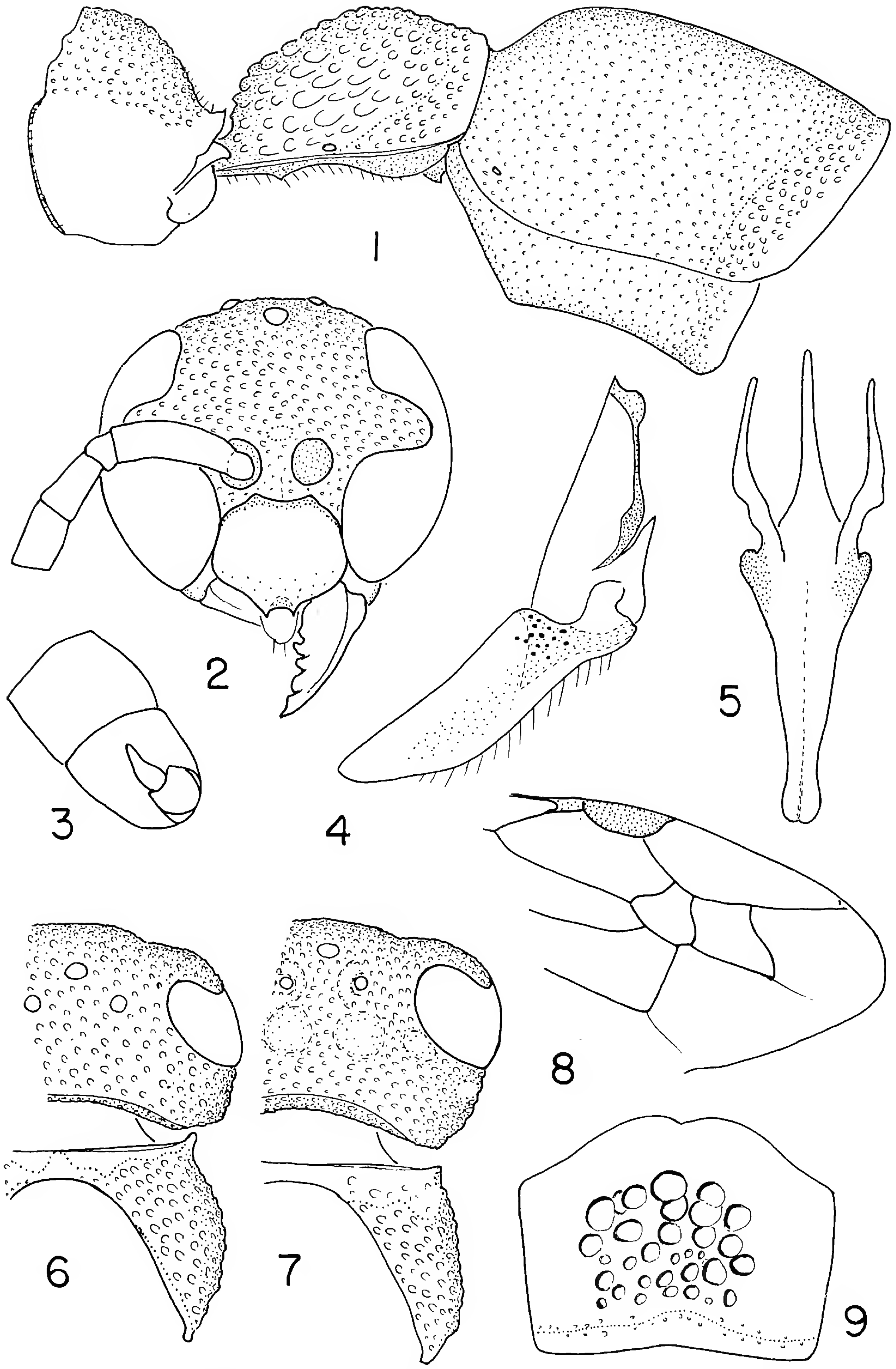
***Gastrodynerus searsi* Bohart, NEW SPECIES**
(Figs. 1–6)

Male holotype.—Length 6.5 mm, forewing 5.5 mm. Black with pale yellow as follows: clypeus, inside of scape, interantennal dot, postocular dot, narrow and irregular humeral margin, hind margin of pronotum narrowly in posterior two thirds (Fig. 6), metanotal band, propodeum toward abdominal insertion, apical dot on midfemur, T-I laterally and posteriorly, T-II posterior band, T-III–VII banded, S-I mostly, S-II–V narrowly across apex; reddish yellow are: flagellomeres inside but not including hook, legs partly; wings smoky, stigma brown. Pubescence inconspicuous. Punctures of frons, vertex, and notum moderately coarse and close, clypeus nearly impunctate, punctures of T-I coarse and close, those of T-II fine to medium and mostly 2–3 puncture diameters apart, those of S-I coarse and close, of S-II medium and well spaced. Face as in Figure 2, antennal apex Figure 3, traces of postocular and postocellar polished welts, T-I a little longer than broad, and with a slight depression across summit, T-II as long as broad and faintly reflexed apically (Fig. 1), genitalia relatively simple (Figs. 4, 5).

Female.—Length 7 mm, forewing 6 mm. Clypeus with lateral and subapical dots, sometimes a tiny mesopleural dot, midfemur dark.

Holotype male.—Santo Niño, Chihuahua, Mexico, September 1, 1968 (T. A. Sears, R. C. Gardner, C. S. Glaser, UCD). Paratypes, 19 males, 3 females, same data as holotype, 4 females, 4–6 mi nw. Choix, Sinaloa, Mexico, August 6–September 5, 1968 (T. A. Sears, R. C. Gardner, C. S. Glaser, UCD).

Discussion.—The weakly developed vertex tubercles, yellow hind pronotal margin, absence of a free spot on T-II, somewhat flattened as well as coarsely punctate T-I, and practically no apical reflex on T-II distinguish the species. It is named for Terry Sears who collected a great many Mexican eumenids in 1968.



Figures 1–6. *Gastrodynerus searsi.* 1. Propodeum and abdominal segments I–II, lateral. 2. Male face. 3. Tip of male antenna, ventral. 4. Volsella. 5. Aedeagus. 6. Male head and prothorax, dorsal. Figure 7. *Gastrodynerus vanduzeei,* male head and prothorax, dorsal. Figures 8, 9. *Gastrodynerus stangei.* 8. Forewing apex. 9. Male sternum III.

Gastrodynerus stangei Bohart, New Species
(Figs. 8, 9)

Male holotype.—Length 7 mm, forewing 6 mm. Markings as given above for *searsi* except: clypeus with median dark spot, pronotum narrowly banded in front only, tegula with two dots, yellow streaks on tibiae, forewing stigma orange (not brown), S-I half dark, S-III banded, other segments with faint apical bands. Punctures of frons, vertex and notum medium and close, clypeus nearly impunctate, punctures of T-I medium and somewhat spaced across summit, those of T-II medium and 1–2 puncture diameters apart except coarse and close before apical reflex. Face and antennal apex much as in Figures 2, 3, postocellar polished tubercles weak and punctate, no interocellar tubercles, T-I longer than broad, more strongly convex than Figure 1, T-II as long as broad and with an apical reflex of 2 MOD, genitalia about as in Figures 4, 5.

Female.—Length 8.5 mm, forewing 7.5 mm. About as in male, no markings on abdominal segments after II.

Holotype male.—Three mi n. Petlalcingo, Puebla, Mexico, August 3, 1963 (F. D. Parker, L. A. Stange, UCD). Paratypes, 6 males, same data as holotype, 1 male, Zimapan, Hidalgo, Mexico, June 11, 1951 (H. E. Evans, Cornell), 1 female, Chapala, Jalisco, Mexico, July 6, 1952 (A. E. Michelbacher, UCB on loan to CAS).

Discussion.—As indicated in the key, *stangei* is most similar to *vanduzeei.* The absence of a free spot on T-II distinguishes *stangei* from *vanduzeei* in southwestern U.S. but not from all Mexican specimens. However, the weak postocellar tubercles and absence of interocellar ones in *stangei* are adequate for separation. Another, more subtle, distinction is the less strongly rounded T-I in side view. In this respect *stangei* is halfway between *vanduzeei* and *searsi.* The species is named for my friend, the well known Neuropterist and Hymenopterist, Lionel Stange.

Gastrodynerus vanduzeei (Bohart)
(Fig. 7)

Stenodynerus vanduzeei Bohart, 1948, Proc. Calif. Acad. Sci. (4)24:327.

Holotype male, Baboquivari Mts., Arizona (CAS).

Male.—About as described above for *searsi* except: length 8.0 mm, forewing 6.5 mm, a broad pale yellow band across pronotum anteriorly, tegula yellow with a central reddish dot, parategula and a mesopleural spot yellow, legs more extensively yellow, forewing stigma orange, an attached lateral spot on T-I and usually a free spot on T-II, S-I dark, abdomen dark beyond second segment, punctures of T-I medium coarse and about a puncture diameter apart across evenly rounded summit, postocellar polished tubercles large and round (Fig. 7), postocular ones smaller, T-I and T-II about as long as broad, T-II with an apical reflex of 2–3 times median ocellus diameters, male genitalia about as in Figures 4, 5.

Female.—Length 9.0 mm, forewing 7.5 mm. About as in male.

Distribution.—Mostly mountainous areas in S Arizona, S New Mexico, W Texas, Baja California, Sonora, Nuevo Leon, Sinaloa, and Zacatecas.

Discussion.—The main structural features were illustrated by Bohart in Figures 9–12 of the original description. This is the only known *Gastrodynerus* in the U.S., where its slender form, pronounced postocellar polished knobs, interocellar swellings, asulcate and bent S-II, dark ocular emarginations, and polished pronotal front margin make it easy to recognize. Most Mexican specimens lack the free lateral spot on T-II but are quite similar otherwise.

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Is *Drosophila pseudoobscura* a Garbage Species?

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An enormous amount is known about the genetics of natural populations of *Drosophila pseudoobscura* and its sibling species *D. persimilis.* Spatial and temporal patterns of the frequencies of allozymes, lethal genes, and third-chromosome inversions have been studied in detail by Dobzhansky, his students, and colleagues (Dobzhansky and Epling, 1944; Dobzhansky, 1970; Lewontin, 1974; Anderson et al., 1975). In many instances, however, the interpretation of these patterns has been hampered by our ignorance of the ecology of these flies. Very little is known about where these species live, feed, and breed in nature. We report here findings which suggest that they are at least partial human commensals and can be frequently found breeding in agricultural refuse.

There are only a few reports of immature stages of *D. pseudoobscura* and *D. persimilis* in nature. Carson and his colleagues (1951, 1956) discovered a large number of larvae and pupae in slime fluxes of the California black oak (*Quercus kelloggii*) and one larva in a flux on white fir (*Abies concolor*) in the Sierra Nevada. Additional larvae were found in black oak fluxes in the San Jacinto mountains of California (Carson, 1978). Dobzhanksy and Epling (1944) describe two additional slime flux breeding sites: one on the introduced deodar cedar (*Cedrus deodara*) in Beverly Hills, California, and the other on an injured California grapevine (*Vitis californica*) in Sonoma, California. However, Carson (1978) reported that adult *D. pseudoobscura* and *D. persimilis* could be found in areas with no apparent slime fluxes. This suggests that the fluxes may not be the major breeding site—or even an important one.

Implicit in many studies, and in much written about these species, is the assumption that they breed only in natural substrates and are not associated with human activity. However, there has been sporadic evidence that they may be partial human commensals. Noting that *D. pseudoobscura* could be collected around human habitation, Dobzhansky (1965) and Carson (1965) suggested that the species had the potential to become a domestic colonizer. In addition, H. Ikeda and H. Carson found young *D. pseudoobscura* adults in an isolated garbage can in Malibu, California, although the flies were not observed hatching directly from the garbage (Carson, 1971). Finally, Spencer (1944) reared 10 *D. pseudoobscura* from 27,805 *Drosophila* pupae collected in a citrus dump near Azusa, California. Despite these observations, the conventional wisdom appears to be that these species are largely confined to natural habitats.

The possibility of human association and transport is nevertheless worth considering since it may help explain certain genetical phenomena, especially the synchronous rise and fall of inversion frequencies in many populations (Anderson

Table 1. *Drosophila* flies reared from agricultural refuse.

Location	Date collected	Substrate	*Obscura* group flies reared	*Obscura* group flies identified	Other species reared[1]
Riverside, CA					
Biocontrol citrus grove	May 1970	oranges	325	—[2]	me, si, im, re
		grapefruit	503	—[2]	me, si, im, re
	March 31, 1971	grapefruit	4781	—[2]	me, si, im
	April 4, 1981	oranges	51	—[2]	me, si, im, re, bu
	April 5, 1982	oranges	305	—[2]	me, si, im
Mill Valley, CA					
Residence	Sept. 14, 1979	compost	7	1 pe, 6 az	me, si
Winters, CA					
Fruit orchard	Nov. 1, 1979	pomegranates	1	1 pe	me, si
	June 15, 1980	peaches	122	39 ps	me, si, im, re
		cherries	83	26 ps	me, si, im, re
	March–May 1982	oranges	139	52 ps	me, si, im
		grapefruit	602	22 ps, 1 pe	me, si, im, re
		tangerines	5	5 ps	si
		lemons	246	75 ps	me, si, im, re
	July 29, 1982	figs	63	33 ps	me, si
Camino, CA					
Fruit orchard	Nov. 4, 1979	pears	47	47 ps	me, si, im
		prunes	62	43 ps	me, si, im
		apples	33	29 ps	me, si
Fruit warehouse	Jan.–Feb. 1980	apples	16	16 ps	—
Pompano State Beach, CA					
Garbage can	March 8, 1980	orange peel	275	76 ps, 6 pe	—
Furnace Creek Ranch, Death Valley, CA					
Date grove	March 30, 1980	dates	2	2 ps	me, si
	Jan. 17, 1981	dates	6	6 ps	me, si
	April 2, 1982	dates	18	18 ps	me, re

[1] Key to species of *Drosophila*: az, *azteca;* bu, *busckii*; im, *immigrans*; me, *melanogaster*; pe, *persimilis*; ps, *pseudoobscura*; re, species of the *repleta* group (probably *D. hydei*); si, *simulans.*

[2] Probably both *D. pseudoobscura* and *D. persimilis* (both species present in the grove).

et al., 1975), the homogeneity of allozyme frequencies among populations (Lewontin, 1974), the reappearance of flies in desert oases following supposed summer extinction (Jones et al., 1981), and the recent appearance of *Drosophila pseudoobscura* in New Zealand (Parsons and Stanley, 1982). Turner and Jeffrey (1980, p. 777) find human transport an objectionable explanation since "it can be used to explain almost any changes in chromosome arrangement patterns observed," but we do not think facts should be ignored because they suggest untestable hypotheses.

Table 1 shows our breeding records of *D. pseudoobscura* and *D. persimilis* from fruit and garbage. Rotting fruit or compost was collected from the ground in areas where these species come to banana traps. The citrus fruit from the 1970 and 1971 collections in Riverside, California was artificially injured and placed on the ground in a citrus orchard harboring fly populations. All material was brought back to the laboratory and placed in jars or rearing cages containing damp sand. Eclosing flies were counted, and samples of *obscura* group *Drosophila* flies were identified by electrophoresis or karyotyping of larvae from females mated to laboratory stocks (Anderson et al., 1977).

These records substantially increase the known breeding substrates of these species, and show that they can indeed be reared from a variety of human-generated substrates from different localities. The association of these species with agriculture appears to be a widespread and not merely a casual phenomenon. In addition, *D. pseudoobscura* and *D. persimilis* are often reared out with the other well-known "garbage" species *D. melanogaster, D. simulans, D. immigrans, D. busckii,* and *D. hydei.* These species are among those drosophilids most easily reared in the laboratory, probably because of their polyphagy in nature. The rearing of *D. azteca* from compost appears to be the first breeding record of this species.

It is worth noting that a large number of flies can sometimes be bred from a small amount of material: the piece of orange peel from Pompano State Beach which produced 275 *D. pseudoobscura* and *D. persimilis* measured only 7 × 10 cm.

Drosophila pseudoobscura and *D. persimilis* thus appear to be facultative garbage species, partially associated with human activity. This association may play some role in the genetic patterns described above, since agricultural cultivation is widespread in the western United States. The remarkable appearance of *D. pseudoobscura* in New Zealand could, for example, be the result of the importation of citrus from the United States.

We should emphasize that we do not believe that all individuals of *D. pseudoobscura* and *D. persimilis* derive from human refuse. They can often be collected in areas far removed from human settlement, though not in the profusion found in orchards. There may be some natural breeding sites besides slime fluxes, which remain unknown despite the intensive work of Carson and his colleagues and our own futile efforts to rear *D. pseudoobscura* and *D. persimilis* from "natural" substrates (leaf litter, fungi, berries, animal feces, etc.). Further work must demonstrate what proportion of flies in the field originate from "domestic" versus "natural" breeding sites.

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Further Data on *Mucrochernes hirsutus* (Banks) (Pseudoscorpionida, Chernetidae)

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Mucrochernes hirsutus was redescribed and placed in the new genus *Mucrochernes* on the basis of a single individual, the holotype female of *Atemnus hirsutus* Banks, which was "found 10 ft. from ocean. No trees near." at Laguna Beach, Orange County, California (Muchmore, 1973). More recently I have received from Kenneth W. Cooper, University of California, Riverside, additional material which sheds more light on the nature of this very interesting species.

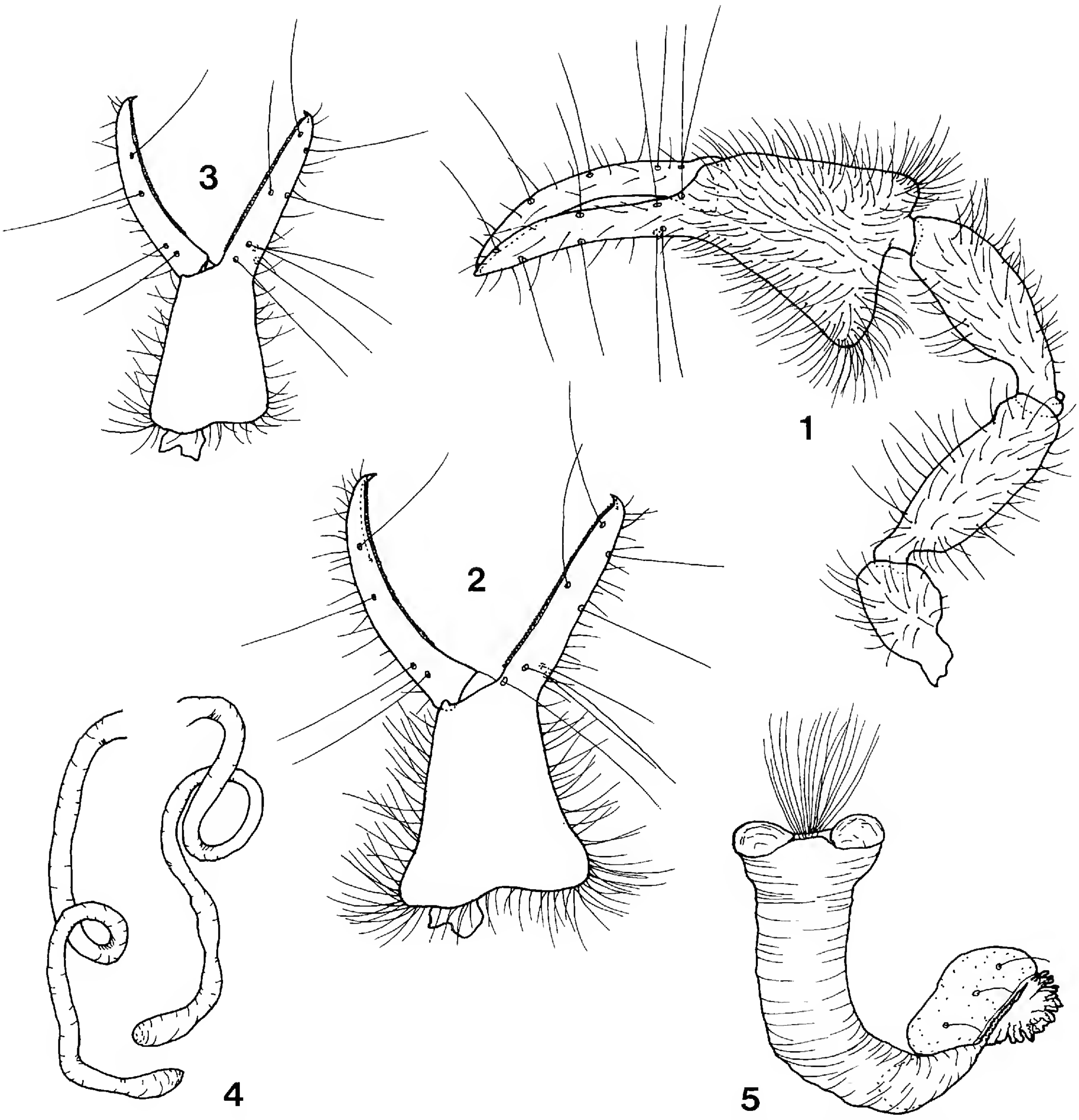
Mucrochernes hirsutus (Banks)
(Figs. 1–5)

Material.—Three males and 3 females "from between splits in intertidal rocks," at San Pedro, Los Angeles County, California, 14 October 1975, K. W. and R. Cooper. Two males and 2 females have been mounted on slides and studied in detail.

Supplemental description.—The males are generally similar to the females except for genital features and slightly deeper palpal chelal hands in some males (Figs. 1–3). There is considerable variation in size and proportions in both sexes and usually the larger specimens are the more robust.

As in the holotype, all setae long, thin, and completely simple or with a single lateral spinule. Carapace with about 200 setae. Abdominal tergal chaetotaxy of largest male 25:29:32:43:48:53:57:53:57:57:T43T:2. Sternal chaetotaxy of same 57:(2)[4-3]/42(3):(3)28(3):47:61:59:56:50:47:T39T:2; anterior genital operculum with 10 long setae flanked by 47 shorter ones; posterior operculum with two groups of very small setae, [4-3], at middle of anterior margin and 42 setae scattered over face and along posterior margin. Internal genitalia of male rather compact, but with no outstanding features. Spermathecae of female as shown in Figure 4, somewhat longer and more convoluted than was noticed in the holotype. Though not mentioned earlier, the anterior tracheal trunks are greatly expanded anteriorly (Fig. 5). Cheliceral galea variously branched in different specimens, but seems equally developed in males and females. Palps of the newly collected females essentially like those of holotype (Muchmore, 1973: Figs. 4, 5); it appears, therefore, that distortion of the holotype was not serious. For the 4 mounted specimens (males and females), palpal femur 2.95–3.1, tibia 2.6–2.9, and chela 3.1–3.2 times as long as broad; hand 1.1–1.35 times as long as deep; movable finger 1.15–1.25 times as long as hand. Chelal fingers with 50–60 marginal teeth and 4–8 internal and external accessory teeth. Leg IV with entire femur 4.0–4.3 and tibia 4.7–5.5 times as long as deep.

Measurements (mm).—Body length 2.75–3.65. Carapace length 0.89–1.10. Chelicera length 0.32–0.41. Palpal femur 0.77–1.04 by 0.25–0.34; tibia 0.755–1.00 by 0.28–0.36; chela (without pedicel) 1.42–1.89 by 0.45–?; hand (without pedicel)



Figures 1–5. *Mucrochernes hirsutus* (Banks). 1. Right palp of largest male, dorsal view. 2. Left chela of largest male, lateral view. 3. Left chela of smallest male, lateral view. 4. Spermathecae of female. 5. Spiracle and anterior tracheal trunk.

0.66–0.86 by 0.49–0.78; pedicel about 0.12 long; movable finger 0.77–1.0 long. Leg IV: entire femur 0.67–0.92 by 0.17–0.215; tibia 0.53–0.74 by 0.11–0.135.

Remarks.—This species is apparently well adapted for life on the seashore, where it may be periodically covered by water: 1) The general hairiness probably serves to keep the surface of the animal dry by trapping air between the bases of the setae. A similar, but not so great, increase in numbers of setae is seen in *Pachyolpium atlanticum* Mahnert and Schuster (1981), a species which inhabits the tidal zone in Bermuda. 2) The expanded anterior tracheal trunks appear admirably suited to hold air during the time the pseudoscorpion is covered by water. No other instance is known of this phenomenon. 3) The galea is very well developed in both male and female, suggesting that both sexes of the adults spin silken cocoons, possibly to protect them from the tides. A similar situation was noted with respect to the littoral *Epactiochernes tumidus* (Banks) in southeastern United States (Muchmore, 1974). 4) The genera *Corosoma* Karsch and *Dasychernes* Chamberlin are also characterized by having very large numbers of vestitural setae (cf. Mahnert, 1982). These two genera are, however, apparently modified for quite a different function from *Mucrochernes,* namely for protection (?) in the hives of meliponine bees. Also, in these forms, while the vestitural setae are long and thin, many are finely denticulate toward the tips (Mahnert, and personal observation).

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World Synopsis of the Riffle Beetle Genus *Leptelmis* Sharp, 1888, with a Key to Asiatic Species and Description of a New Species from India (Coleoptera, Dryopoidea, Elmidae)

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Abstract.—The genus *Leptelmis* is close to *Stenelmis,* but more similar to *Stethelmis.* Citations for each known species of *Leptelmis* (15 Asiatic, 8 African) include reported distribution, all known illustrations, and location of holotype. A key to Asiatic species is based primarily upon the literature. *Leptelmis* ***philomina***, n. sp. from the Western Ghats of southern India is described and figured (habitus, aedeagus).

Sharp (1888) created the genus *Leptelmis* upon the basis of one mutilated specimen from Tokyo, Japan. He wrote: "This insect, though allied to *Stenelmis,* cannot be placed in that genus; it differs in several respects, more especially in the great separation of the hind legs and the very dependent front of the prosternum. The form is different from that of *Stenelmis,* and the sculpture is not similar to that of any other Elmid known; the eyes, too, are much smaller than in *Stenelmis,* and the terminal joint of the maxillary palpus more slender." Sharp did not mention that a major feature linking *Leptelmis* to *Stenelmis* was the lack of a fringe of hairy tomentum on the inner margin of the anterior tibia, a character that separates *Stenelmis* from virtually all other elmine riffle beetles. More surprising is the fact that he did not mention the most conspicuous feature separating *Leptelmis* from *Stenelmis*: the anterior portion of the pronotum is set off from the rest of the pronotum by a broad transverse impression, giving an appearance reminiscent of a turtleneck sweater—in fact, the anterior portion of the pronotum often appears at first glance to be part of the head (Fig. 1). Furthermore, the pronotum lacks the median longitudinal impression so characteristic of *Stenelmis,* the legs are quite long, and the tarsal claws are large and with basal teeth. All of these latter characters not mentioned by Sharp are shared by *Stethelmis* (Hinton, 1945), which occurs in Chile and Argentina. The general aspect of *Leptelmis* is also reminiscent of *Ancyronyx* in North America (see Brown, 1976 for illustration), of *Hintonelmis* in South America (Spangler, 1966; Hinton, 1971), and of *Onychelmis* in Central and South America (Hinton, 1941).

Bollow (1941) added to the characterization of the genus that the tarsi are 4-segmented, but he had apparently seen specimens only of *L. flavicollis.* His Figure 2 shows this feature; however, it is not characteristic of the genus. Most, if not all, other species have the usual 5 tarsal segments. In contrast with Sharp, Bollow characterized the eyes as larger than those of *Stenelmis.* Actually, the eyes vary considerably in size, depending upon the species.

Nothing is known about the immature stages of *Leptelmis,* and very little about the habitat, habits, or behavior of the adults. The little that has been published is entirely from Delève (1966). Most specimens are presumably from streams, but even this is seldom stated in the literature. The holotype of *L. fragilis* was found on vegetation in a flowing stream. From the morphology of *Leptelmis,* this is the habitat we would expect, especially in view of the nature of the legs and tarsi. Other elmids with similar structure, such as *Ancyronyx* and *Hintonelmis,* are typically found clinging tenaciously to waterlogged wood or other submerged vegetation, and it is a good guess that *Leptelmis* exhibits similar behavior. Two of the paratypes of *L. major* were taken from forest humus. We can only wonder how they happened to be there and how far they were from water, e.g., it would be of interest to know whether the site had been inundated a few weeks earlier. Delève (1945, 1966) reported that both macropterous and brachypterous individuals occur within the same species (e.g., *L. fragilis* and *L. orchymonti*). Only macropterous forms, of course, have been taken at lights, but the fact that some come to lights informs us that *Leptelmis* can utilize flight as a means of dispersal—a common ability among elmids just after emergence from pupation.

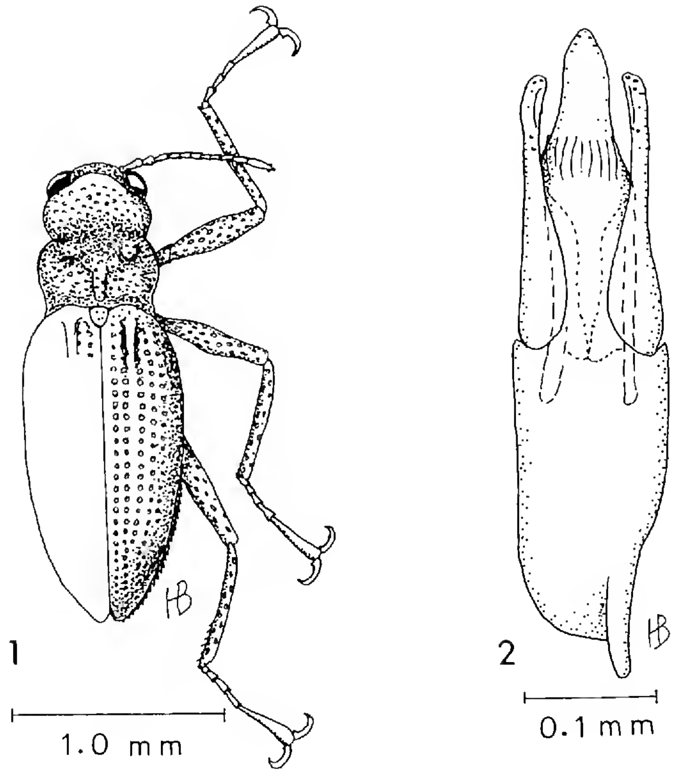
Of the 117 known genera of elmids, only *Leptelmis* and *Stenelmis* occur in both Africa and the Orient (Brown, 1981). *Leptelmis* is also unusual in being the largest elmid genus for which the larva is unknown. Perhaps our pointing out the large gaps in our knowledge of this group will stimulate investigators to fill the gaps.

While collecting in streams of the Western Ghats (Sahyadri Mountains) of South India, one of us (M. P. Thobias) obtained two specimens of *Leptelmis* that apparently represent a new species, which we here describe.

Leptelmis philomina, New Species

(Figs. 1, 2)

Holotype male.—Length 2.15 mm, width 0.75 mm. Subparallel, convex. Cuticle tuberculate, feebly shining; brown, with pronotum and head darker than elytra; anterior margin of pronotum, antennae, palps and legs testaceous (somewhat darker in paratype). *Head* retractable within pronotal collar; visible portion without distinct impressions; on vertex and in a band tapering on each side toward but not reaching antennal base covered by ashen white plastron studded with small granules separated by about their own diameters; frons, clypeus and labrum black, rather finely punctate; circumocular area black. Eyes rather small, their greatest dimension being less than interocular distance. Antennae barely reaching elytral humeri, slender, with segments 3–11 progressively longer. Frontoclypeal suture indistinct. Maxillary palp with apical segment elongate and somewhat larger than apical antennal segment. *Pronotum* slightly longer than broad, 0.625: 0.575 mm; widest at basal $^2/_5$; width at base 0.550 mm; width at transverse impression 0.465 mm; width at apex 0.50 mm. Sides conspicuously bisinuate; anterior angles broadly rounded as seen from above, posterior angles subacute; apical margin arcuate and projecting over the head; lateral borders feebly margined, most noticeably so in posterior third; lateral margins not perceptibly crenate. Surface rather coarsely granulate or tuberculate, the flattened granules on disk separated



Figures 1, 2. *Leptelmis philomina* n. sp. 1. Dorsal aspect of adult. 2. Aedeagus, ventral aspect.

by about their own diameters. Without sublateral carinae. Transverse impression at anterior third broad and deep, giving the appearance of a bottleneck. With prominences as follows: a feeble, flattened, median longitudinal ridge in the basal quarter suggests a rather long, narrow human nose with the scutellum representing a small chin; continuing the comparison with a human face, each "cheek" is low and composed of a doubled or divided very feeble prominence, and the "eyes," though small, bulge rather prominently; each "eye" is located half way between the midline and lateral margin on the posterior edge of the major transverse impression and anterolateral to the anterior end of the "nose"; between the "nose" and each "eye" there is also a minor elevation. *Scutellum* small (0.075 mm across), about as long as wide, with sides rounded. *Elytra* more than twice as long as pronotum (1.5 mm); humeri not prominent, but distinctly broader than pronotum; sides subparallel in anterior half, then tapering arcuately in posterior half to rounded apex. Strial punctures on disk rather large, subcircular, and separated from one another by slightly less than their own diameters; punctures smaller and shallower on apical declivity. Strial intervals rather flat, none genuinely carinate, but third somewhat elevated at base and intervals 6–8 fused basally and slightly elevated basally; intervals 2 and 3 merge on apical declivity. Lateral borders very feebly margined and finely serrate. Epipleura narrowed gradually toward apex. *Venter* and legs (except tarsi) covered with flattened granules separated by less than to about twice their own diameters and suggestive of a medieval coat of mail; each granule bearing an inconspicuous, short, decumbent seta. Although we have not observed living specimens under water, apparently the plastron covers the entire ventral surface, entire pronotum, vertex of head, and all of the legs except the tarsi. *Prosternum* rather long anterior to procoxae, deflected in such a way as to permit retraction of head until only frons, clypeus, and labrum are exposed, together with eyes and antennae; granules on deflected portion smaller and sparser; prosternal process without carinae, about equal in width to diameter of globular procoxa, slightly longer than wide, broadly rounded at apex, feebly margined, coarsely granulate. *Mesosternum* short, coarsely granulate, with a shallow anteromedian excavation to accommodate prosternal process. *Metasternum* with a bare area between mesocoxae and anterior to median impressed line. *Abdomen* without carinae or other conspicuous features; cuticular granules very coarse on segment 1, progressively less coarse posteriorly; segment 1 longest, 2–4 progressively shorter, but 5 almost as long as 1; posterior margins of segments 1–4 straight to broadly emarginate, but 5 sinuate laterally and rather narrowly rounded at apex. Sternita without conspicuous teeth or other projections for attachment to elytra. *Legs* long and slender, especially the tibiae and tarsi; tibiae almost straight and cylindrical, without tomental brushes, spines, or other conspicuous features but with small inner apical projections and inconspicuous rows of small setae along inner margins distally. Tarsi 5-segmented, that of foreleg shortest and that of hind leg longest, each with the segments progressively longer from base to apex, the apical segment of each being longer than the other 4 combined; segments 1–4 each with a short apical tuft of pale setae on ventral surface; claws large, each with a basal tooth and curved ca. 90 degrees. *Genitalia* (Fig. 2) rather standard in general aspect, 0.50 mm in length; basal piece 0.26 mm; penis or median lobe 0.30 mm; parameres 0.23 mm. As viewed dorsally or ventrally, the parameres are slender distally with bluntly rounded apices and the relatively broad penis projects beyond them, tapering to a blunt point.

Female.—Unknown.

Type.—Male to be deposited in the British Museum (Natural History), London; South India: Western Ghats, leg. M. P. Thobias. Genitalia mounted in Hoyer's medium on slide #Lpp-Agm-1, at BMNH.

Paratype.—One male with same data as type, in Stovall Museum of Science and History, University of Oklahoma, Norman, Okla., U.S.A.

Etymology.—This species is named in honor of the beloved mother of the junior author.

Comments.—As shown in the list below, only one species of *Leptelmis, L. fracticollis* Champion, has previously been reported from India, that being from the Haldwani Division of Kumaon, far to the north (in the foothills of the Himalaya Mountains north or northeast of Delhi. Much closer geographically is the island of Sri Lanka (Ceylon), from which two species of *Leptelmis* have been described: *L. nietneri* Champion and *L. cederholmi* Delève. *L. philomina* n. sp. differs from *L. fracticollis* in pronotal sculpture, in being less broad across the humeri, and in having the cuticle granulate or tuberculate ventrally rather than punctate. From *L. nietneri,* the new species differs in being considerably larger (2.15:1.5 mm), in lacking elytral maculae, and in having a much deeper transverse prothoracic impression. *L. philomina* differs from *L. cederholmi* in having the venter granulate rather than punctate and in aedeagal structure: in *L. cederholmi* the basal piece is proportionately shorter, the parameres broader, the penis longer and parallel-sided with a subapical denticulate collarette. Differences from and among other Asiatic species are indicated in the key below, which is based largely upon characters extracted from the literature. It includes 13 of the 15 known Asiatic species, *L. parallela* and *L. formosana* being omitted because we cannot distinguish them from *L. gracilis* by the descriptions.

Key to Asiatic Species of *Leptelmis* (Except *L. parallela* from Japan and *L. formosana* from Taiwan)

1. Elytra maculate 2
Elytra essentially uniform in color or with the humeri lighter 5
2. Each elytron with 5 yellow spots (Viet Nam) . . . . *L. signata*
Elytron with fewer than 5 spots or markings 3
3. Very small (1.5 mm); each elytron with an oblique testaceous streak (Sri Lanka) . . . . *L. nietneri*
Larger than 1.5 mm; elytral markings not oblique 4
4. Small (1.8 mm); elytral vitta in apical half on intervals 2 and 3 (Philippine Islands) . . . . *L. tawitawiensis*
Larger (2.3 mm); elytral vitta in apical half on intervals 3 and 4, and expanded apically (Viet Nam) . . . . *L. basalis*
5. Elytra expanded posteriorly, much wider than pronotum; 2.5–2.8 mm (Japan) . . . . *L. gracilis*
Elytra not expanded posteriorly 6
6. Tarsi 4-segmented, head as broad as pronotum; 2.4 mm (South China) . . . . *L. flavicollis*
Tarsi 5-segmented 7
7. Large (3 mm); pronotum with anterior transverse impression indistinct medially; cuticle very shiny (Sumatra) . . . . *L. stricticollis*
Smaller; pronotum with transverse impression complete and distinct . . 8
8. Venter granulate; 2.15 mm (South India) . . . . *L. philomina,* n. sp.
Venter punctate rather than granulate 9
9. Antennae reddish 10
Antennae yellow or yellowish at least at base 11
10. Penis parallel-sided, with subapical collarette of denticles; parameres tapering from near base (Sri Lanka) . . . . *L. cederholmi*
Penis constricted near middle, without denticles; parameres subparallel in apical half (Sumatra, Java) . . . . *L. sulcata*
11. Smaller (2 mm) (North India) . . . . *L. fracticollis*
Larger (2.2 mm or more) 12
12. Elytra with strial interval 3 raised from base to apex; aedeagus with parameres (in ventral aspect) tapering from base almost to apex (Viet Nam) . . . . *L. obscura*
Elytra with strial interval 3 feebly raised at base only; parameres subparallel in apical half (Viet Nam) . . . . *L. vietnamensis*

World Checklist of the Species of *Leptelmis*

Zaitzev (1910) cited the type species and emended the generic name to *Lephthelmis.* Since this emendation was unjustified by the rules of zoological nomenclature, it has been quietly dropped, except by Bollow (1941). Satô (1960) published a world checklist which at that time included a total of only 8 species, compared with the present 23.

To be as helpful as possible to others, we indicate in the list below, after the name and citation, reference to published illustrations, location of holotype, and reported distribution. Location of holotype is placed in parentheses, with abbreviations as follows: BMNH = British Museum (Natural History), London; FCM = Frey Collection, Munich; LMS = Lund Museum, Sweden; MNHB = National Hungarian Museum, Budapest; MPF = Museum of Paris, France; MPSA = Museum of Pretoria, South Africa; MRAC = Musée Royal de l'Afrique Centrale; MRHNB = Musée Royal d'Histoire Naturelle de Belgique, Brussels; NSMT = National Science Museum, Tokyo; ZMUC = Zoological Museum, University of Copenhagen, Denmark.

Leptelmis Sharp

Sharp, Ann. Mag. Nat. Hist. (6) II, 1888, p. 243.
Lephthelmis Zaitzev, Coleop. Cat., Pars 17, Dryopidae, etc., 1910, p. 21.
Type Species: *L. gracilis* Sharp, 1888.

amoena Delève, 1966, p. 8, f. 15. (MRAC) AFRICA: CÔTE D'IVOIRE, GHANA.
basalis Delève, 1968, p. 155, no figs. (MNHB) VIET NAM.
cederholmi Delève, 1973a, p. 11, f. 23. (LMS) SRI LANKA (CEYLON).
collarti (as *Stenelmis*) (Delève), 1937, p. 152, f. 3. Transferred to *Leptelmis* by Delève, 1938, p. 364. Genitalia in Delève, 1966, f. 2–4. (MPF) AFRICA: CONGO (ZAIRE), GABON, CONGO (BRAZZAVILLE).
costulata Delève, 1942, p. 1, f. 1 (habitus); genitalia in Delève, 1966, f. 1. (MRHNB) AFRICA: CONGO (ZAIRE), CONGO (BRAZZAVILLE).
flavicollis Bollow, 1941, p. 86, T. 7, f. 2 (habitus). (FCM) SOUTH CHINA.
formosana Nomura, 1962, p. 48, no figs. (NSMT?) TAIWAN.
fracticollis Champion, 1923, p. 167, f. 3 (habitus). (BMNH) NORTH INDIA.
fragilis Delève, 1966, p. 7, f. 13, 14. (MPSA) SOUTH AFRICA: VAAL.
gracilis Sharp, 1888, p. 244; habitus, hind tarsus, maxillary palp, prosternal process, and male genitalia in Satô 1960, f. 1, 2. (BMNH) JAPAN: HONSHÛ, SHIKOKU, KYUSHÛ.
major Delève, 1966, p. 4, f. 8–10. (MRAC) AFRICA: CONGO: ELIZABETHVILLE, KIVU; TANGANYIKA.
nietneri Champion, 1923, p. 168, no figs. (BMNH) CEYLON (SRI LANKA).
obscura Delève, 1968, p. 153, f. 6. (MNHB) VIET NAM.
orchymonti Delève, 1942, p. 3; genitalia in Delève, 1966, f. 5–7. (MRHNB) AFRICA: CONGO: ELIZABETHVILLE; RUANDA; SOUTHERN RHODESIA.
parallela Nomura, 1962, p. 46, no figs. (NSMT?) JAPAN: HONSHÛ, SHIKOKU, KYUSHÛ.
philomina Brown and Thobias, n. sp. (BMNH) SOUTH INDIA.
seydeli Delève, 1966, p. 6, f. 11, 12. (MRAC) AFRICA: CONGO: ELIZABETHVILLE.
signata Delève, 1968, p. 152, f. 5. (MNHB) VIET NAM.
sobrina Delève, 1974, p. 272, f. 1. (MNHB) AFRICA: GHANA.
stricticollis (as *Stenelmis*) (Grouvelle), 1896, p. 45, no figs. Transferred to *Leptelmis* by Hinton, 1941, p. 88. (syntypes in BMNH, MPF) SUMATRA, PALEMBANG.
sulcata (as *Stenelmis*) (Grouvelle), 1892, p. 188; genitalia in Delève, 1970, f. 1, 2. Transferred to *Leptelmis* by Delève, 1970, p. 236. (MPF) SUMATRA, JAVA.

tawitawiensis Delève, 1973, p. 28, f. 20. (ZMUC) PHILIPPINES: TAWI TAWI.
vietnamensis Delève, 1968, p. 154, f. 7. (MNHB) VIET NAM.

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Capnia hornigi, a New Winter Stonefly from the Western Great Basin (Plecoptera: Capniidae)

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During a recent study on the distribution of stonefly species in the Great Basin ranges of Nevada (Sheldon, 1979) a previously undescribed *Capnia* species was discovered. The faunal affinities of this species are not with the Rocky Mountain fauna (Baumann et al., 1977) but are with the Sierra Nevada fauna (Jewett, 1960).

Capnia hornigi Baumann and Sheldon, New Species

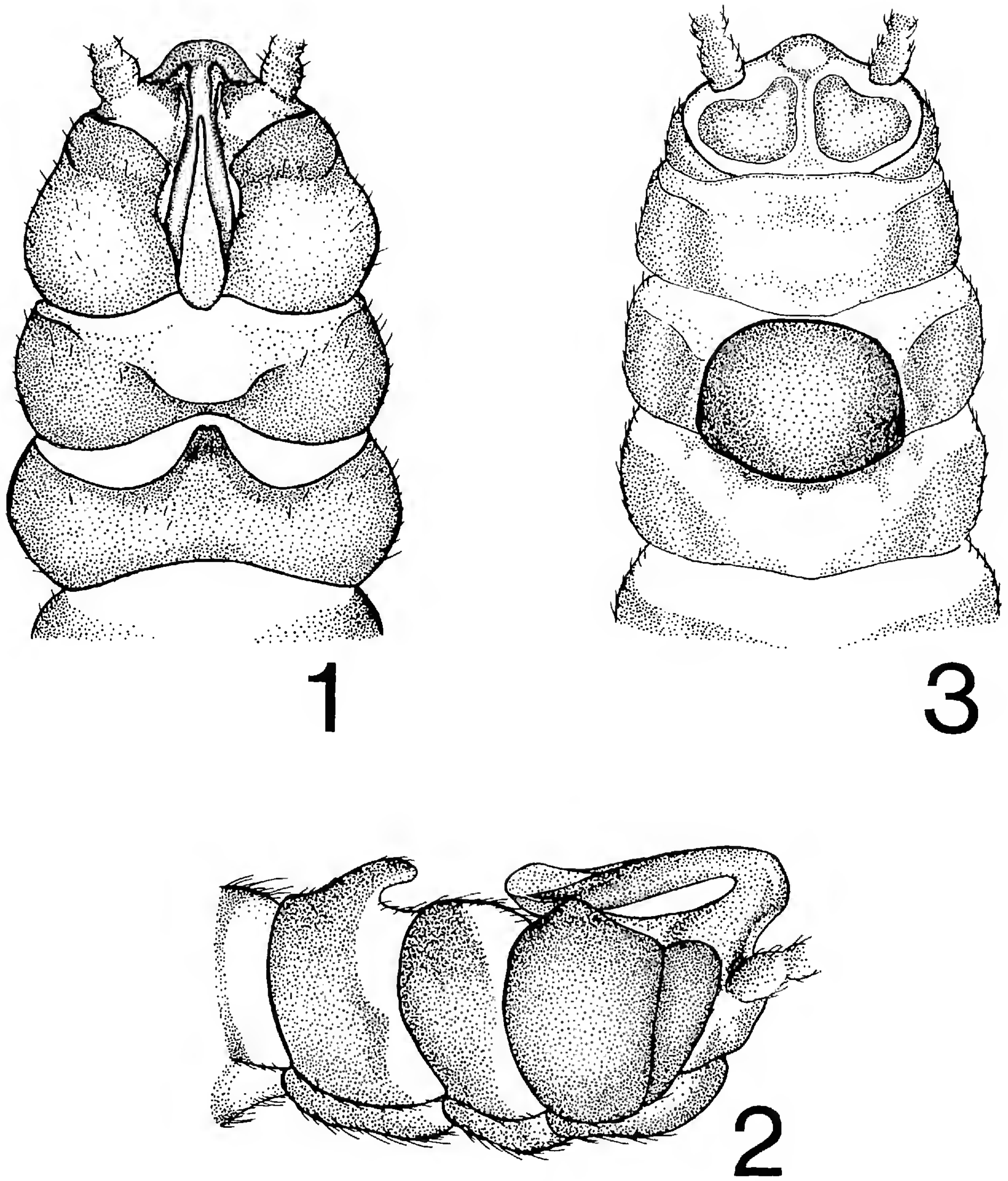
Male.—Wings macropterous. Length of forewing 4–5 mm; length of body 4–6 mm. Body and appendages dark brown; wings hyaline except for fumose area in costal space beyond cord. Abdominal segments one to six without special modifications. Seventh tergum with median posterior portion modified as large posterior directed process, apex of process darkly sclerotized and narrowly rounded. Eighth tergum reduced to narrow sclerotized band, posterior portion of tergum membranous. Ninth tergum produced dorsally into low bifurcate ridge upon which epiproct rests. Tenth tergum with large reflexed epiproct which extends forward to posterior margin of ninth tergum; base of epiproct stout laterally, slightly narrowed at bend, becoming gradually broader anteriorly with rounded apex, small membranous area visible at apex, bordered by narrow triangular pointed process on each side dorsally; dorsal aspect of epiproct with narrow base, becoming abruptly broader toward apex, base sclerotized but with membranous area appearing slightly anterior to base which becomes increasingly larger until it covers the complete apex, much like in the genus *Paracapnia* (Figs. 1, 2).

Female.—Wings macropterous. Length of forewing 6–7 mm; length of body 6–8 mm. General appearance similar to male. Dorsal broad membranous stripe extends from abdominal terga one to eight, with sclerotized triangular patch at base of eighth tergum. Subgenital plate well developed and very darkly sclerotized encompassing entire eighth sternum, plate flat at base and broadly rounded at apex, not extending over ninth sternum, joined broadly to seventh sternum with no apparent separation except coloration. Oblong, sclerotized patches present on lateral posterior margins of eighth segment, bordering subgenital plate (Fig. 3).

Material.—Holotype male, #76499, allotype and two male and seven female paratypes, Middle Creek, White Mountains, Esmeralda Co., Nevada 10-II-1977, A. L. Sheldon. Types deposited at the U.S. National Museum, Washington, D.C. Additional paratypes: Nevada, Esmeralda Co., Middle Creek, White Mountains, 4-III-1979, C. E. Hornig, 14 males, 17 females.

Etymology.—This species is named for Evan Hornig who collected some of the paratypes of this new species. Evan is an avid student of aquatic insects and has collected many interesting specimens in Nevada and surrounding states.

Diagnosis.—*Capnia hornigi* is the sister species of *Capnia barberi* Claassen from



Figures 1–3. *Capnia hornigi.* 1. Male genitalia, dorsal. 2. Male genitalia, lateral. 3. Female genitalia, ventral.

the Sierra Nevada. The projection on the male seventh tergum is much more massive in *C. hornigi.* The epiproct is more rounded in lateral view and apically in dorsal view in *C. hornigi. Capnia barberi* has an epiproct which is much more angular and pointed at the apex. The processes on the dorsal lateral areas of the epiproct near the apex are larger and much more distinctive in *C. barberi.*

The female subgenital plate is broadly rounded apically in *C. hornigi* where in *C. barberi* it is flat with sharply angled corners.

Ecology.—Adults of *Capnia hornigi* were collected at three locations (2160–2470 m) on Middle Creek. No adults were collected at the highest station sampled (2590 m) but capniid nymphs were present. *Capnia utahensis* was the only capniid emerging on nearby Chiatovitch Creek (2100 m) and no capniids were collected on the open bajada (1950 m) below the confluence of Middle and Chiatovitch creeks. Collections made at other times may, however, extend the altitudinal range of *C. hornigi.*

Middle Creek originates at 3650 m on the east side of the White Mountains on the slopes of the Jumpoff and Mt. Montgomery (4097 m). At the collecting sites, the substrate is dominated by shifting granitic sands while stable gravels and cobbles are rare. Channel structure is regulated to a considerable extent by roots and limbs of cottonwood and water birch (*Betula occidentalis*). Leaf packs and debris dams are common.

Associated species (collected in Middle Creek) were *Zapada cinctipes, Yoraperla brevis, Frisonia picticeps, Sweltsa townesi* and *Triznaka diversa.* Most of these species are common in the Sierra Nevada and *C. hornigi* may occur there also.

ACKNOWLEDGMENTS

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The drawings were made by Connie A. Bevan Bhagat.

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A New Species of *Dichaetocoris* Knight from the Western United States, with Notes on Other Species (Hemiptera: Miridae)

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Collections made in western Colorado and southeastern Utah over the past several years have turned up many specimens of the poorly known genus *Dichaetocoris.* Among these was a new species, *D. anasazi,* described herein. The material reported here is held in the J. T. Polhemus collection (JTP) unless otherwise noted.

Measurements are given in units, with 40 units = 1 mm, unless otherwise noted.

Dichaetocoris anasazi, New Species

Description.—Male: Small, ovate; length 2.87 mm; maximum width 0.91 mm. Coloration yellowish orange, occasionally tinged with green on venter and along anterior angles of pronotum.

Head yellowish orange, eyes black; frons set with erect black setae intermixed with fine recumbent silky pubescence; gula with a patch of pale erect setae; vertex with erect black setae; width of vertex over twice the dorsal width of an eye. Antennae amber brown, clothed with short stiff setae; segment I with three stout setae; antennal proportions I–IV: 8; 27; 25; 9.

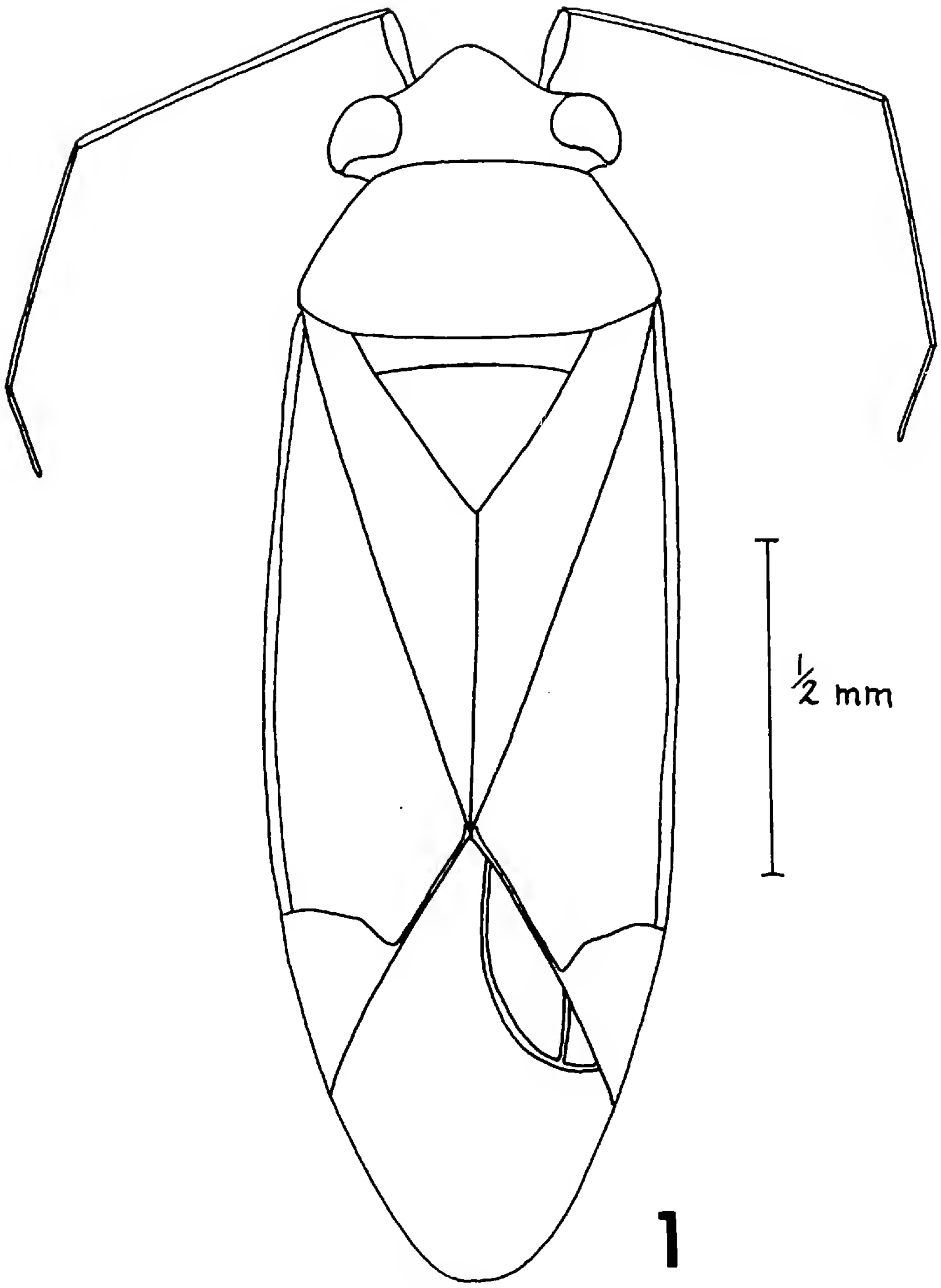
Pronotum yellowish orange, smooth, shining, width/length = 36/16; margins set with dark pubescence; calli indistinct; posterior angles rounded. Scutellum amber, smooth, wider than long, width/length = 23/17; mesoscutum broadly exposed.

Hemelytra yellowish orange, semi-transluscent, surface faintly rugulose; set with black recumbent setae interspersed with fine, pale, recumbent silky pubescence; margins nearly parallel; cuneus with anterior margin weakly sinuate; wing membrane dusky grey, veins gold.

Venter light gold, often shaded with green along femora and posterior margin of genital segment; rostrum gold, tip infuscated, length 1.30 mm, reaching well beyond tips of hind coxae. Legs golden brown, covered with short erect setae; tibiae armed with stout brown spines; tips of tarsi infuscated. Abdomen sparsely covered with fine pallid hairs; genital segment with bifurcate tergal process (see Fig. 3); left clasper slender, curving, acuminate; right clasper broadly bifurcate, multispinose, distinctive (see Fig. 4).

Female: Similar to male in structure and pubescence, coloration often lighter; length 3.09 mm; maximum width 1.00 mm.

Material examined.—Holotype, male, and allotype: UTAH, San Juan Co., White Canyon at Soldier's Crossing, approx. 5 miles N of Fry Canyon Store, 1219 m (4000′), V-29-78, D. A. & J. T. Polhemus (JTP). Paratypes: 7 ♂, 5 ♀, same data as types, all taken on *Pinus edulis* (Pinyon Pine) (JTP); 15 ♂, 9 ♀, UTAH, San Juan Co., Grand Flat nr. Collins Canyon, VI-1-82, D. A. & J. T. Polhemus (JTP);



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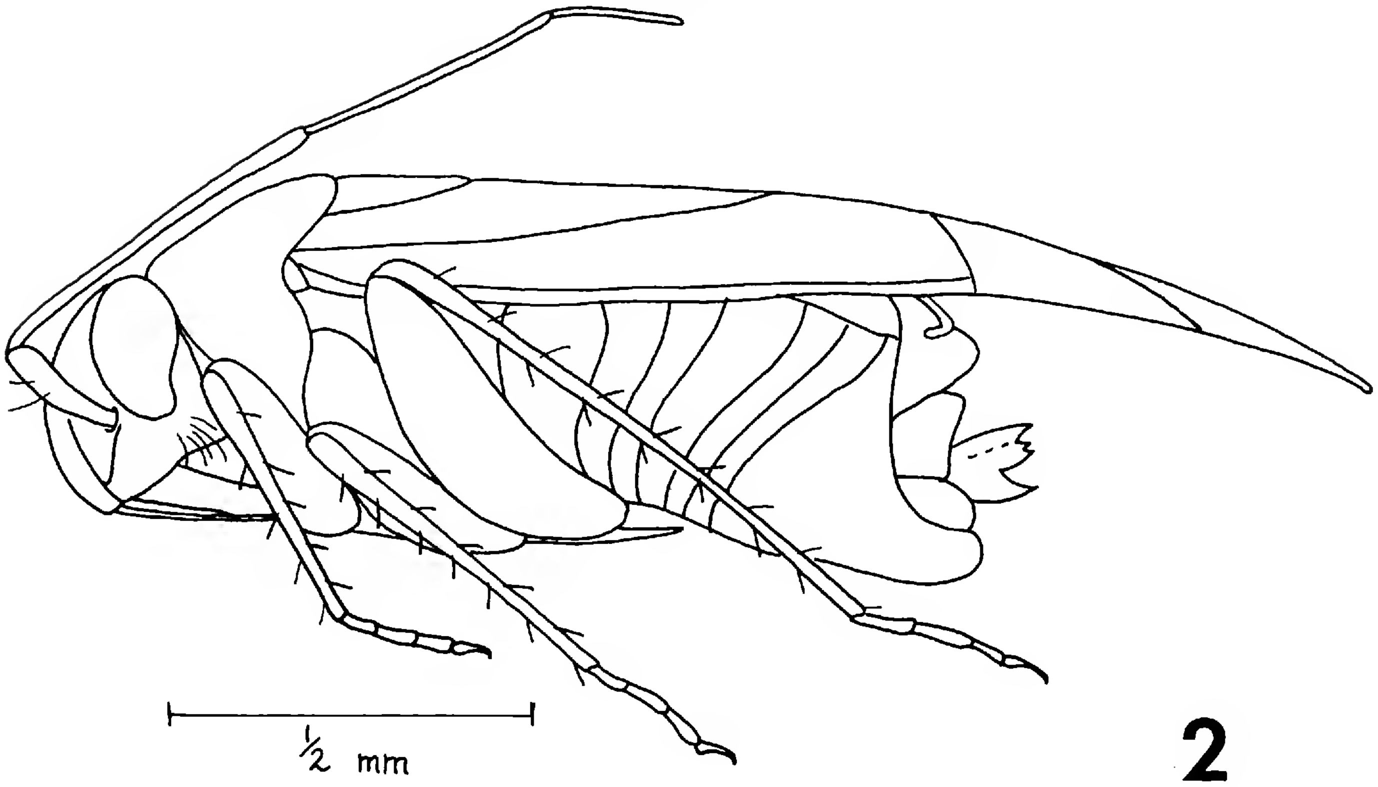

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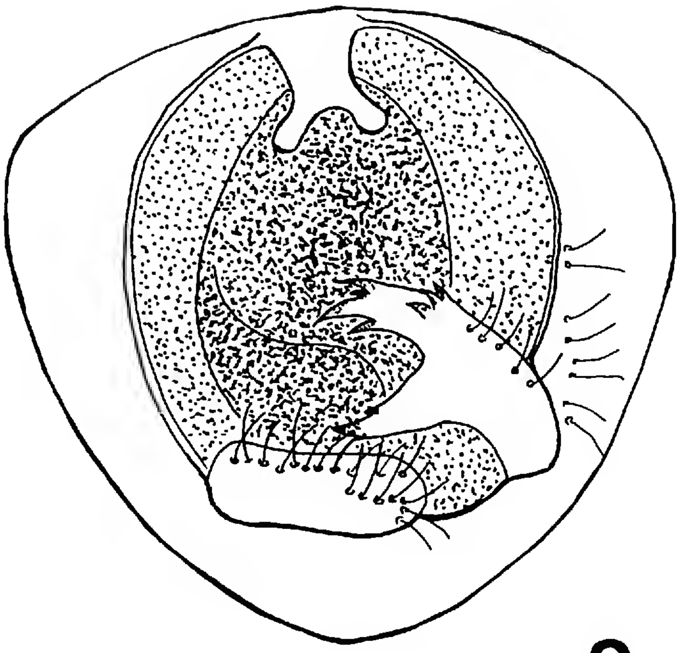
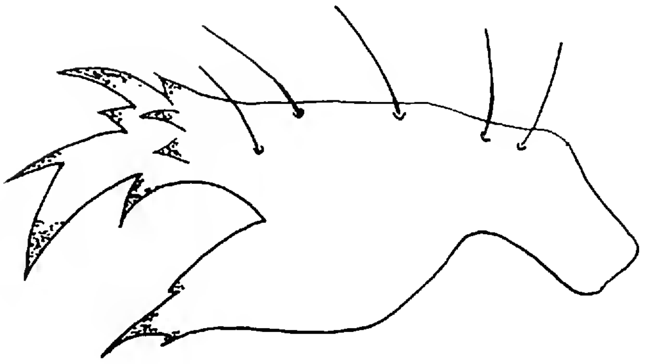
Figure 1. *Dichaetocoris anasazi,* n. sp. Male, dorsal view.

Figure 2. *Dichaetocoris anasazi,* n. sp. Male, lateral view.





Figures 3, 4. *Dichaetocoris anasazi,* n. sp. 3. Male genital segment, posterior view, showing positions of male claspers and bifurcate tergal process. 4. Male right clasper.

1 ♂, COLO., Montrose Co., 10 miles W of Montrose, VII-8-81, D. A. & J. T. Polhemus, on *Pinus edulis* (JTP).

Etymology.—The name *anasazi* is a Navajo word meaning "ancient ones" and refers to the prehistoric cliff dwellers who once inhabited the canyons of the Southwest.

DISCUSSION

Dichaetocoris anasazi, n. sp. runs to couplet 11 in Knight's (1968) key, where it may be immediately distinguished by the bifurcate tergal process on the male genital segment and by the distinctive male right clasper. The right clasper is characterized by a deep bifurcation dividing two multispinose processes, and may be easily viewed without dissection (see Figs. 3, 4). The left clasper is similar to those of several other species, notably *D. pinicola* Knight, and is thus not diagnostic. No other known species of *Dichaetocoris* possesses a bifurcate tergal process.

The following records are noted for other species in this genus:

Dichaetocoris utahensis Knight: UTAH, San Juan Co., head of Lake Canyon along the Nokai Dome road, 4200′ (1280 m), V-29-78, 1 ♂, D. A. & J. T. Polhemus; Garfield Co., Hog Spring in North Wash, near Hite, 5300′ (1615 m), V-30-78, 1 ♂, D. A. & J. T. Polhemus (JTP).

Dichaetocoris nevadensis Knight: UTAH, San Juan Co., White Canyon at Soldier's Crossing, approx. 5 miles north of Fry Canyon Store, 4000′ (1219 m), V-29-78, 5♂, 1 ♀, D. A. & J. T. Polhemus; Grand Co., 5 miles south of Moab along U.S. 163, 4000′ (1219 m), V-27-80, 2 ♂, D. A. & J. T. Polhemus (JTP).

These records represent the first instances in which either of these species have been recorded outside the Great Basin. It is likely that these species, and others of the same genus, occur widely in the pinyon-juniper woodlands across southern Utah, but have been generally overlooked due to the remote nature of the country and the fact that these insects mature in late May and early June, well before most collectors visit the region.

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Distribution and Seasonal Abundance of Brine Flies (Diptera: Ephydridae) in a San Francisco Bay Salt Marsh

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Abstract.—Spatial and temporal distribution patterns of adult brine flies (Diptera: Ephydridae) were examined in Petaluma Marsh, San Francisco Bay, California. Biweekly D-vac samples (November 1977–1978) were collected along three strata located 1 m, 3 m, and 10 m from three sites, a 2- and a 5-yr-old mosquito control recirculation ditch and a natural channel. Adults were also collected weekly (March–December 1980) from ethylene glycol pan-traps designed to simulate pond and pothole habitats. Of the 28 species collected, 22 occurred in D-vac samples. Distribution patterns of five were analyzed statistically: three species [*Scatella* (*Scatella*) *stagnalis* Fallen, *Scatophila* sp., and *Atissa litoralis* (Cole)] exhibited similar patterns at ditches and natural channels and two species exhibited dissimilar patterns [*Scatella* (*Neoscatella*) *setosa* Coquillett and *Psilopa* (*Ceropsilopa*) *coquilletti* (Cresson)]. Of 23 species collected in pan-traps, *Ephydra millbrae* Jones accounted for 95.5% of the total catch.

As part of a study to evaluate the impact of mosquito control recirculation ditches on San Francisco Bay marshlands, the arthropod fauna of selected salt marshes has been examined in terms of community structure and biomass and the response of selected populations to ditches (Resh and Balling, 1979). The insect family Ephydridae has been of particular interest since it is one of the most abundant and species-rich arthropod families collected in these marshlands. The Ephydridae occur in a variety of aquatic and semi-aquatic environments, but are most remarkable for their ability to exist in "unique" habitats (e.g., oil pools [Crawford, 1912], inland saline lakes [Aldrich, 1912], and hot springs [Wirth and Mathis, 1979]). The purpose of this study has been to examine the seasonality and distribution of ephydrid adults associated with man-made and natural watercourses in a hypersaline Pacific coast salt marsh.

MATERIALS AND METHODS

Study site.—This study was conducted at Petaluma Marsh, Sonoma Co., California, a 1145-ha salt marsh located in the Petaluma River basin. The marsh flora is dominated by pickleweed, *Salicornia virginica* Linnaeus.

A variety of natural aquatic habitats occurs throughout the marsh, e.g., ponds (10 m–100 m in diameter), potholes (≈3 m), sloughs (≈10m), and natural channels (≈3 m). In addition, man-made recirculation ditches have been constructed to connect a variety of ponds and potholes with natural channels to allow for tidal flushing, which results in effective mosquito control. Natural channels and recirculation ditches examined in this study were similar in width (40 cm), although natural channels in general are deeper than ditches (100 cm cf. 60 cm).

Experimental design.—The influence of mosquito control recirculation ditches and natural watercourses on the distribution of adult brine flies was examined from two approaches:

1) Are distributions influenced by distance from a watercourse?
2) Does watercourse type (recirculation ditches or natural channels) influence distribution patterns?

Three watercourses were chosen as study sites, a 2-yr-old ditch, a 5-yr-old ditch, and a natural channel. At each site, three parallel strata at distances of 1 m (stratum 1), 3 m (stratum 2), and 10 m (stratum 3) from the watercourse were designated (Fig. 1). Stratum 3 served as a control for intra- and inter-site comparisons since a variety of physical factors exhibited gradients that occur only within 3 m of either watercourse type. For example, standpipes placed perpendicular to both ditches and natural channels indicated that tidal depression and recharge of the water table are limited to a 3-m distance. Also, groundwater salinity and soil surface salinity increased with distance from the channel, both becoming asymptotic before 10-m distance (Balling and Resh, 1982).

Collecting methods.—Adult brine flies were sampled at approximately biweekly intervals during late morning hours from November 1977 through November 1978 using a gasoline-powered suction device, the D-vac (Dietrick et al., 1959), which collected insects into a 0.25-mm nylon mesh bag. All 9 strata (3 sites, each with 3 strata) were sampled over a distance of 30 m by placing the suction cone onto the substrate for 5 sec at approximately 1-m intervals. Samples were then placed in Berlese-Tullgren funnels for 24 hr with the brine flies being collected directly into 70% ethanol.

Seasonal occurrence of brine fly adults was also determined from ethylene glycol pan-traps that were designed to simulate small ponds or potholes in the marsh. This artificial habitat consisted of 16 aluminum roasting pans (0.3 m × 0.6 m) arranged in a rectangular 4 × 4 grid (Fig. 2). Samples were taken at weekly intervals from March 1980 (after the last heavy rain of the wet season) to December 1980 (prior to the first heavy rain of the subsequent wet season). Since periodic examination of all 16 pans indicated no inter-pan difference in species or their abundances, only flies from the four interior pans were identified and enumerated.

Data analysis.—Due to fluctuations in brine fly abundance throughout the study, it was necessary to remove the seasonal variation in the D-vac samples to equally weight all sampling dates. This was done by converting the number of each species in a sample to a percentage of that species total collected at all sites and distances on the same date. An arc-sine square-root transformation was used to normalize the percentages for parametric statistical analysis. Comparisons between distances and between sites for each species were made with one-way ANOVA and Student-Neuman-Keuls multiple range tests (SNK).

RESULTS

The fauna.—During this study 28 species of brine fly adults were collected in Petaluma Marsh with 22 species recorded from D-vac and 23 species from pan-

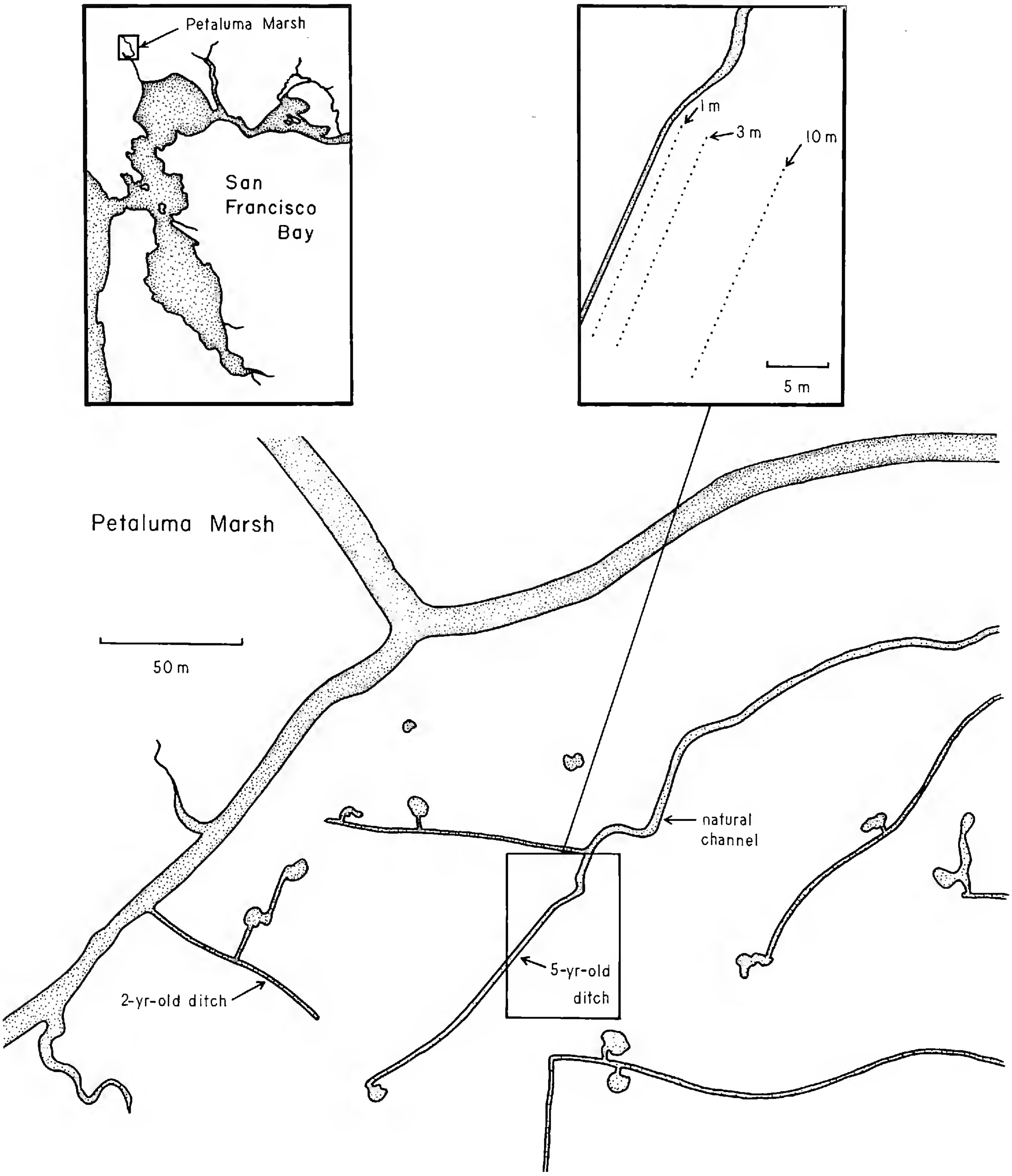

Figure 1. Location of study sites (2-yr-old ditch, 5-yr-old ditch, and natural channel) and sampling strata (1 m, 3 m, 10 m) in the Petaluma Marsh.

trap samples (Fig. 3). Of these, 11 species were not included in Simpson's (1976) list of marine species [*Limnellia sejuncta* (Loew), *Napaea socia* Cresson, *Pelina truncatula* Loew, *Hydrina nigrescens* Cresson, *Ilythea caniceps* Cresson, *Ilythea spilota* (Curtis), *Nostima picta* (Fallen), *Psilopa* (*Psilopa*) *olga* Cresson, *Psilopa* (*Psilopa*) *compta* (Meigen), *P. coquilletti, Lytogaster gravida* (Loew)]. Although several of these new records occur in low numbers and possibly reflect their transient status in the marsh, the repeated occurrence and abundance of some species (*H. nigrescens, N. picta, P. truncatula, P. compta,* and *P. coquilletti*) in 1977 and 1980 suggests the presence of established populations.

Figure 2. Ethylene glycol pan-traps used to collect adults associated with potholes in Petaluma Marsh.

Total numbers of adult brine flies collected with both sampling methods was 43,271. D-vac samples contained 11,343 individuals with five species comprising >98% of the total: *S. stagnalis* (11.5%), *S. setosa* (25.7%), *Scatophila* sp. (5.2%), *P. coquilletti* (17.9%), and *A. litoralis* (38.1%). Pan-traps produced 31,928 individuals with 95.5% (30,505) represented by one species, *E. millbrae.* Of the remaining 22 species sampled by pan-traps, 6 species comprised 4%: *S. stagnalis* (0.5%), *Scatella (Scatella) paludum* (Meigen) (0.7%), *Lamproscatella muria* Mathis (1.2%), *P. coquilletti* (0.5%), *A. litoralis* (0.7%), and *Polytrichophora* sp. (0.4%).

Seasonal occurrence and abundance.—Scatella stagnalis adults were common from March to mid-June in D-vac samples, and to a lesser extent in pan-trap samples (Fig. 3). Other workers have collected this species from a variety of Holarctic locations throughout the warm periods of the year and in a variety of freshwater and maritime habitats, usually along mud and sand shores (Dahl, 1959; Williams, 1938; Deonier, 1965, 1972; Eastin and Foote, 1971; Scheiring and Foote, 1973; Simpson, 1976; Miyagi, 1977; Zack, 1979). Foote (1979:65) considered *S. stagnalis* to be a "fugitive, nonequilibrium species" common in unstable habitats that are frequently flooded. Both larvae and adults are polyphagous, feeding on algae, diatoms, and decaying material (Simpson, 1976; Scheiring and Foote, 1973; Foote, 1977, 1979), although certain food items may be preferred since development time appears to be sensitive to diet (Zack and Foote, 1978).

Scatella paludum adults were abundant from mid-March to early-June in pan-trap samples. D-vac samples contained fewer adults, but they were found during approximately the same season (Fig. 3). Dahl (1959) collected adults from beds

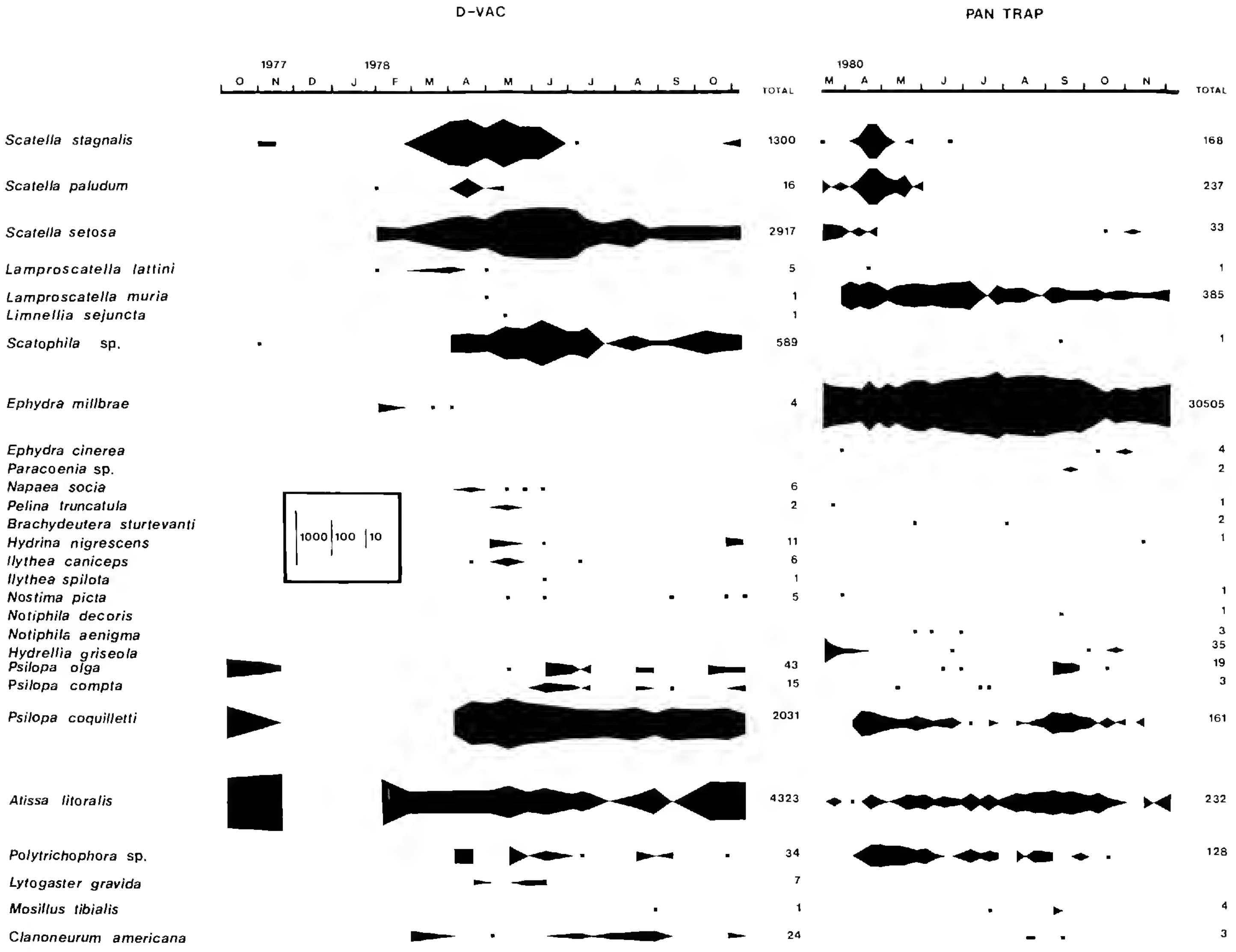

Figure 3. Abundance (as $\log_{10}$) of brine fly adults from 1977–1978 D-vac samples and 1980 pan-trap samples.

of decaying seaweed and from freshwater and maritime sand beaches in Scandinavia from May to October. Zack (1979) near Mt. Rainier, Washington, recorded adults from sandy beaches along the Tahoma River from June through August. Similar to their close relative *S. stagnalis,* they most likely feed on a variety of algal species (Foote, 1979).

Scatella setosa adults were found throughout the year in D-vac samples with their peak abundance occurring from spring through mid-summer (Fig. 3). Adults were sampled in lower numbers in the pan-traps, primarily during the early spring. Cameron (pers. comm.) found this species in the fall and winter months in a nearby San Francisco Bay salt marsh. The habits of both larvae and adults are reported as similar to *S. stagnalis* (Wirth and Stone, 1956).

Lamproscatella muria adults were abundant in pan-trap samples beginning in late-March and extending into autumn; however, only one specimen was recorded from the D-vac samples (Fig. 3). This species is known to occur primarily in saline habitats along both eastern and western North American coasts, although it has been found occasionally in freshwater environments (Sturtevant and Wheeler, 1954) and in alkaline ponds (Mathis, 1979). Also, Scheiring and Foote (1973) have reported adults from saline waters in Ohio during late summer.

Scatophila sp., possibly a complex containing more than a single species (W. Mathis, pers. comm.), was found from early spring to autumn in D-vac samples

(Fig. 3) although only one specimen was found in pan-trap samples. *Scatophila* adults have generally been found to occur from July to September in a variety of freshwater and maritime habitats including mud and sand shores, glacial river beds, manure heaps, salt and freshwater meadows, seeps, spoil banks, and in greenhouses (Bolwig, 1940; Dahl, 1959; Deonier, 1965, 1974; Scheiring and Foote, 1973; Harris and Deonier, 1979; Zack, 1979). Their diet consists of blue-green algae, diatoms, and gram-positive bacteria (Bolwig, 1940; Deonier, 1974).

Ephydra millbrae, collected only rarely in the D-vac samples, was by far the most abundant species collected in the pan-traps (Fig. 3). All life stages commonly occur throughout the year, with abundant numbers observed each year since 1977 in Petaluma Marsh. Adults of *E. millbrae* are known to frequent calm, saline pools where they feed, mate, and oviposit into the larval habitat. Jones (1906) first described this species from salt marshes along South San Francisco Bay, although his illustration of the egg resembles that of the hemipteran waterboatman *Trichocorixa reticulata* (Guerin-Meneville), a common coexisting species. Depending on the availability of suitable habitat, *Ephydra* adults have been collected year round (e.g., Ping, 1921; Dahl, 1959; Kelts, 1979) and Foote (1979) considered species in this genus to be oligophagous in algal food selection.

Psilopa coquilletti adults occurred from early spring to autumn in both D-vac and pan-trap samples (Fig. 3). The habits and seasonality of *P. coquilletti* have not been previously described, although closely related species are known to be scavengers (Simpson, 1976) and some freshwater *Psilopa* are leafminers (Hennig, 1943).

Atissa litoralis adults were found throughout most of the year (Fig. 3). *A. litoralis* has been found along the eastern U.S. seashore (Sturtevant and Wheeler, 1954) and in the midwestern U.S. where they occur in both freshwater and saline habitats (Deonier, 1965; Scheiring and Foote, 1973; Steinly, 1978). Cresson (1942:110) considered it a "scarce western species", but in Petaluma Marsh it was the second most abundant ephydrid collected. Its larval biology is unknown.

Polytrichophora sp. adults occurred from spring through the summer in the pan-trap samples. In D-vac samples, adults occurred sporadically and in low numbers during the spring and summer (Fig. 3). Adults of *Polytrichophora* sp. have been collected along mud and sand shores in Washington (Zack, 1979), Ohio (Scheiring and Foote, 1973), and Iowa (Deonier, 1965). Diatoms and other algae are utilized as food items by species in this genus (Deonier, 1972).

Seasonal abundance of the other 19 ephydrid species in Petaluma Marsh are presented in Figure 3.

Distribution of species in relation to watercourses.—Five of 23 species collected in D-vac samples were sufficiently abundant to statistically analyze their distribution patterns in relation to recirculation ditches (2- and 5-yr-old ditches) and natural channels (Table 1).

Psilopa coquilletti adults showed no consistent trends within sites. A significantly higher number of adults occurred away (i.e., at the 10-m distance) from the 2-yr-old ditch ($P = 0.01$), yet the natural channel displayed a different trend ($P = 0.03$), with significantly fewer adults at the 10-m cf. the 3-m distance ($P = 0.03$). Comparing sites, the 1-m and 3-m distances at the natural channel had significantly higher numbers of adults than either ditch ($P = 0.01$), whereas for the 10-m distance densities at the 2-yr-old ditch were significantly higher than at either the

Table 1. Distribution of adult brine flies in relation to man-made (2- and 5-yr-old ditches) and natural (channel, NC) watercourses; cell values are mean percents of adults/sample and * and † refer to horizontal rows and vertical columns, respectively. Within any row (e.g., NC), two cells marked with * are significantly different from one another, as determined from SNK multiple range tests. If only one cell is marked with *, that cell is significantly different from the other two cells. Vertical columns are marked in an identical manner, except for the use of †.

	P. coquilletti					*S. setosa*			
	1 m	3 m	10 m	*P*		1 m	3 m	10 m	*P*
2-yr	13.3	14.6	23.3†*	0.01	2-yr	11.7	5.0	16.9	0.10
5-yr	10.7	11.9	12.2	0.88	5-yr	8.3	5.9	11.7	0.62
NC	20.7†	26.5†*	14.4*	0.03	NC	36.8†*	1.8	14.9	0.01
P	0.01	0.01	0.01		*P*	0.01	0.44	0.76	
	Scatophila sp.					*S. stagnalis*			
	1 m	3 m	10 m	*P*		1 m	3 m	10 m	*P*
2-yr	0.7†*	5.5	11.8*	0.04	2-yr	17.2	8.6	16.6	0.57
5-yr	25.9†	12.4	21.1	0.39	5-yr	21.0	9.6	13.2	0.18
NC	19.6	10.0	6.4	0.20	NC	31.8*	7.2*	13.4	0.04
P	0.04	0.45	0.10		*P*	0.36	0.93	0.86	
	A. litoralis								
	1 m	3 m	10 m	*P*					
2-yr	17.5	10.6	14.6	0.33					
5-yr	13.3	6.0*	22.5*	0.02					
NC	14.1	11.8	21.8	0.11					
P	0.69	0.24	0.36						

5-yr-old ditch or the natural channel ($P = 0.01$). Thus, even though the densities at the natural channel appear to be significantly different from those at the 1-m and 3-m distances of either ditch, the significant differences between sites at the 10-m distance (i.e., the control—see Experimental design) indicate that factors other than those associated with presence of watercourses may be affecting the distribution of this species.

Scatophila sp. distribution similarly displayed no consistent trends within sites. The 2-yr-old ditch had significantly fewer adults at the 1-m distance cf. the 10-m distance ($P = 0.04$), but different patterns were evident at the other two sites. Comparing sites, the only significant difference occurred between the 2-yr-old ditch and the 5-yr-old ditch at the 1-m distance ($P = 0.04$). The 5-yr-old ditch and the natural channel had similar abundances at both the 1-m and 3-m distances.

Scatella setosa adults were more abundant at the 1-m distance than at the 3- and 10-m distances from the natural channel ($P = 0.01$), a pattern not repeated at either ditch site. Likewise, a significant difference existed between the 1-m distance strata at the natural channel and either ditch site ($P = 0.01$). Therefore, *S. setosa* distribution patterns at ditches did not appear to be similar to those at natural channels.

Scatella stagnalis adults at the natural channel were significantly more abundant at 1-m distance cf. the 3-m distance ($P = 0.04$). While similar distribution patterns occurred at both ditched sites, neither was statistically significant. Also, comparisons between sites revealed no significant differences. From this we conclude that ditches and the natural channel were not dissimilar with respect to the distribution of this species.

Atissa litoralis adults occurred in significantly greater numbers at the 10-m distance cf. the 3-m distance at the 5-yr-old ditch ($P = 0.02$). Although the same pattern was present, no statistically significant trends were detected at either the 2-yr-old ditch or the natural channel. No significant differences were found between sites at any distance. Thus, the ditches and the natural channel did not appear to affect distribution patterns of *A. litoralis* dissimilarly.

Discussion

Of the five species which accounted for >98% of the total specimens collected with the D-vac in 1977–1978, all were found to occur in the same season in the 1980 pan-trap samples. *Scatophila* sp., *L. muria,* and *E. millbrae* were sampled predominantly by one method (*Scatophila* sp. from the D-vac, the other two from the pan-traps). Two possible reasons may account for this: 1) a difference in actual population abundance between years, i.e., *Scatophila* sp. populations may have declined drastically sometime between 1977–1978 and 1980 and *L. muria* and *E. millbrae* densities increased; or 2) the two methods (D-vac/Berlese-Tullgren funnels cf. pan-traps) sampled selectively. For *E. millbrae* and *L. muria,* this second explanation is far more likely since the larvae are aquatic and the adults occur almost exclusively on pond rather than ditch or natural channel surfaces. Also, both species have been observed on potholes and ponds in rather large numbers since 1977. In the case of *Scatophila* sp., insufficient information is available to determine why only one individual was sampled in 1980 pan-traps.

The distribution of salt marsh arthropods has been observed to vary with distances from natural channels, marsh ponds, and other water bodies (e.g., Hull et al., 1934; Williams, 1938; Rockel, 1969; Evans et al., 1971; Garcia and Schlinger, 1972; Freeman and Hansens, 1972; Foster and Treherne, 1975, 1976a, 1976b; Magnarelli and Anderson, 1978) and results of this study clearly indicate that population distribution patterns of some species can be related to distance from man-made ditches and/or natural channels. Whether the addition of recirculation ditches produces the same results as increasing the number of natural channels also depends on the species involved. At man-made and natural watercourses different distribution patterns were found for two species, *S. setosa* and *P. coquilletti.* For *P. coquilletti,* factors other than those associated with presence of a watercourse are apparently affecting its distribution, since abundances at the control distance (10-m) of the sites were significantly different. Of the remaining three species, no significant differences were noted between the natural and man-made watercourses at any distance.

Differences in natural and man-made watercourses may have varied and complex effects on the adult brine fly populations. For example, greater woody (i.e., perennial) biomass of *Salicornia* in Petaluma Marsh occurs at 1-m distance from the natural channels than at the same distance from ditches (Balling and Resh, 1983). This increase in woody material may afford adult brine flies better protection against inundating tides, predators, and extreme temperature fluctuations. These factors may be more important to some species than others and thus produce the different distribution patterns observed for the Petaluma Marsh brine flies.

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Two New Conifer-Inhabiting *Phytocoris* from Western North America (Hemiptera: Miridae)

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Abstract.—The new plant bug species *Phytocoris nobilis* and *P. occidentalis* are described from western North America. *Phytocoris nobilis* was collected on *Abies* spp. and *P. occidentalis* was taken on several species of *Pinus* and also collected at light. The adult male of *P. nobilis* and male genitalia of both species are illustrated.

Relatively little is known about the plant bug fauna of the northwestern United States. A recent survey of the *Phytocoris* species that occur in this region has revealed the presence of several undescribed species. *Phytocoris nobilis* and *P. occidentalis* are described to provide names for a forthcoming study of the Miridae of Oregon. *Phytocoris nobilis* was taken at several localities in the Coast and Cascade Ranges of Oregon on *Abies* spp. *Phytocoris occidentalis* occurs throughout much of coastal western North America on pines and also has been taken at light.

The following abbreviations are used for specimen depositories cited in the locality data: American Museum of Natural History (AMNH); California Academy of Sciences (CAS); California State Department of Food and Agriculture (F&A); Los Angeles County Museum (LACM); Oregon State University (OSU); San Diego Natural History Museum (SDNH); University of British Columbia (UBC); University of California, Berkeley (UCB); University of California, Riverside (UCR); National Museum of Natural History, Smithsonian Institution (USNM).

Phytocoris nobilis, NEW SPECIES
(Figs. 1, 2–4)

Male (Fig. 1).—Length 7.68–8.85 mm, width 2.50–2.74. Head: width across eyes 1.20–1.27, vertex 0.36–0.39; dark reddish brown to nearly black; frons, gula, and ventral margin of lorum marked with white or pale yellow; base of jugum with conspicuous pale spot; vertex and frons with scattered, erect, black bristles. Rostrum: length 3.36–3.69, extending to 6th or 7th abdominal segment. Antennae: dark brown or black; with closely appressed, recumbent, light setae; I, length 1.50–1.71, with scattered, pale, often indistinct spots, and stout erect black bristles; II, length 3.46–3.93, narrowly pale at base; III, length 1.86–2.18; IV, length 1.14–1.27. Pronotum: mesal length 1.12–1.18, posterior width 1.98–2.05, white or pale yellow, lateral margins broadly fuscous. Scutellum: moderately convex, white or pale yellow, pale midline bordered by broad fuscous band. Hemelytra: opaque white, densely marked with small to large fuscous patches, particularly along

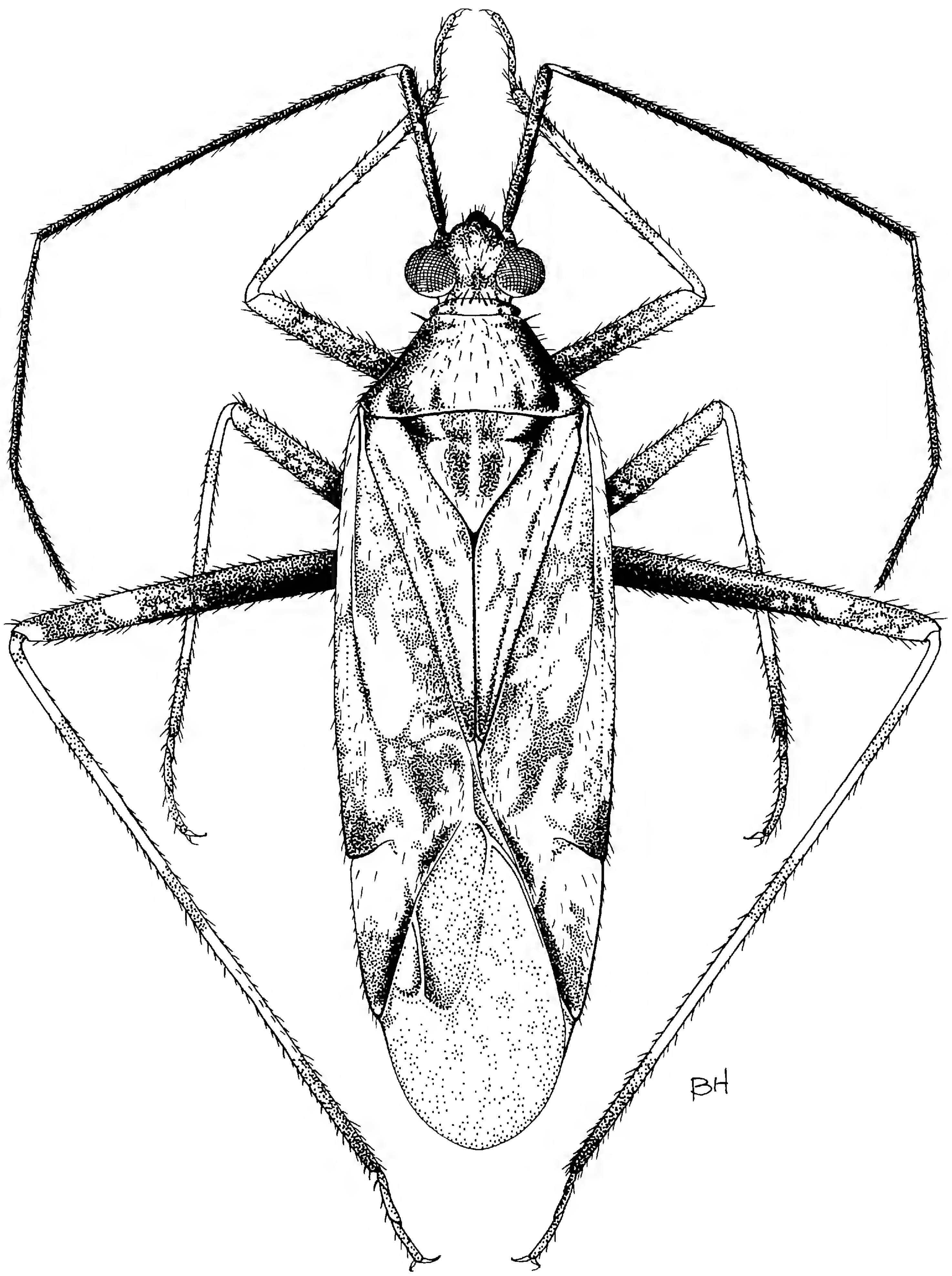
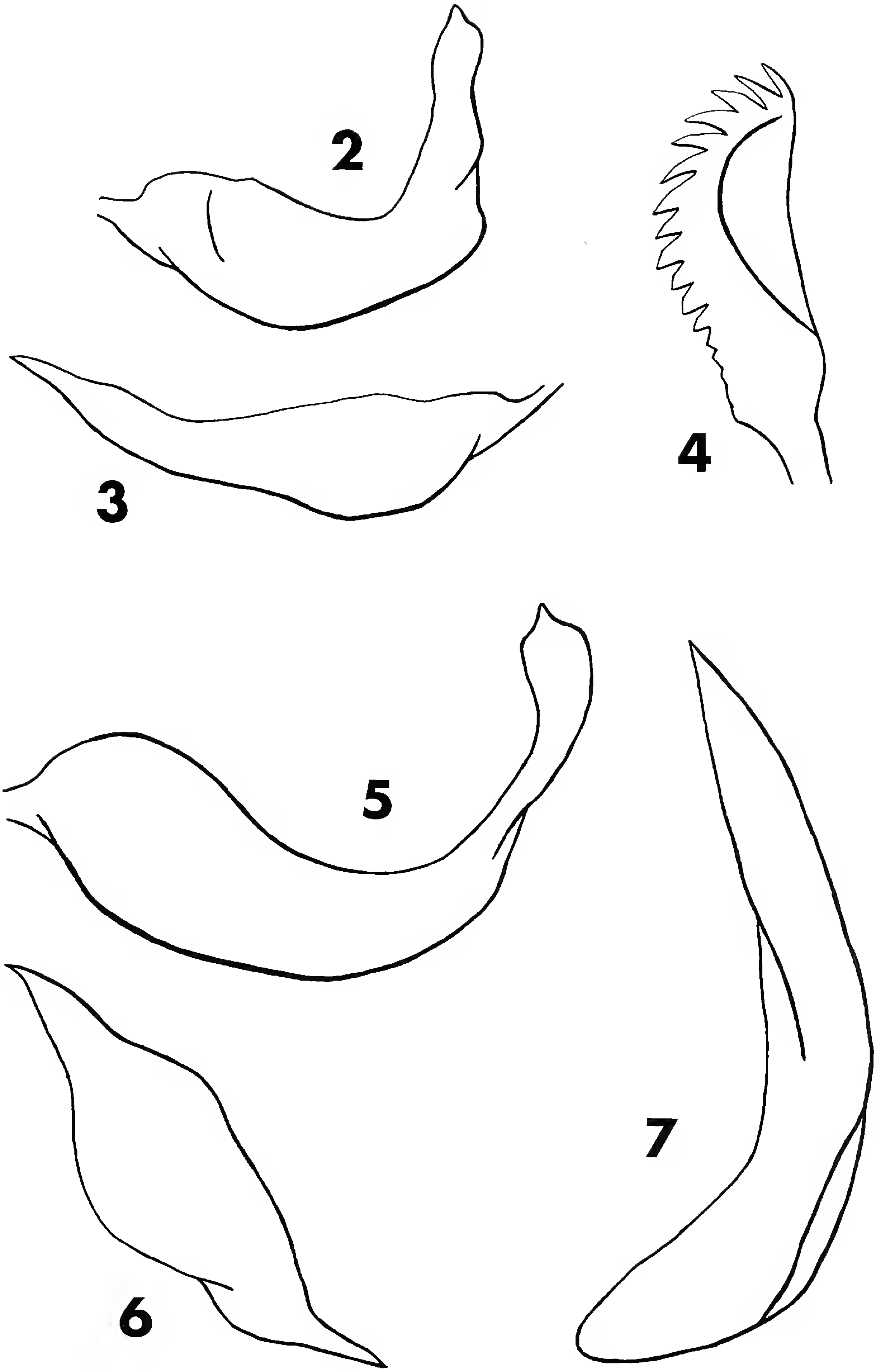


Figure 1. *Phytocoris nobilis*, n. sp., adult male.

claval, cubital and radial veins; apices of clavus and cuneus, posterolateral angle of corium, and posterior margin of paracuneus fuscous; membrane conspurcate, veins dark, becoming pale posteriorly. Venter: dark brown or black, shining, with scattered pale setae. Legs: coxae white or pale yellow; femora fuscous, apical half



Figures 2–4. *Phytocoris nobilis*. 2. Left paramere. 3. Right paramere. 4. Sclerotized process of vesica. 5–7. *Phytocoris occidentalis*. 5. Left paramere. 6. Right paramere. 7. Sclerotized process of vesica.

marked with scattered pale spots, metafemora with preapical, transverse, pale band; tibiae fuscous, triannulate with white; tarsi fuscous; tarsal claws yellowish brown. Vestiture: pronotal disk, scutellum, and hemelytra with semierect, black setae intermixed with recumbent, silvery setae. Genitalia: Figures 2–4. Genital segment with large, broad tubercle at base of left paramere, and similar but smaller tubercle at base of right paramere. The male description is based on the examination of nine specimens.

Female.—Similar to male in color and vestiture; hemelytra with fewer fuscous patches, often nearly entirely white. Length 6.78–7.26 mm, width 2.32–2.60. Head: width across eyes 1.12–1.20, vertex 0.44–0.47. Rostrum: length 3.63–3.82, extending to base of ovipositor. Antennae: I, 1.46–1.63; II, 3.19–3.57; III, 1.67–2.05; IV, 0.95–1.18. Pronotum: mesal length 1.01–1.12, posterior width 1.79–1.98. The female description is based on the examination of 12 specimens.

Type data.—HOLOTYPE male, Oregon, Lane Co., H. J. Andrews Experimental Forest, T15S, R6E, Sec. 29, NW ¼, 1450 meters, July 31, 1979 (G. M. Cooper; USNM). PARATYPES: OREGON. Benton Co.: 2 males, Marys Peak, T12S, R7W, Sec. 21, SW ¼, 1097 meters, Aug. 6, 1975 (J. D. Lattin; OSU); 1 male and 3 females, Marys Peak, T12S, R7W, Sec. 20, SW ¼, 1070 meters, July 25–Aug. 17, 1979 (G. M. Cooper; OSU); 1 male and 2 females, Marys Peak, T12S, R7W, Sec. 21, SW ¼, 1097 meters, Aug. 3, 1979 (G. M. Cooper; OSU). Lane Co.: 1 female, same data as holotype (G. M. Stonedahl; USNM); 2 males and 5 females, H. J. Andrews Experimental Forest, T15S, R6E, Sec. 29, SW ¼ and SE ¼, 1480 meters, July 20 & 31, 1979 (G. M. Cooper, G. M. Stonedahl; AMNH, OSU); 1 male and 1 female, same data as above but July 13, 1980 (G. M. Cooper; CAS); 1 male, H. J. Andrews Experimental Forest, T15S, R6E, Sec. 7, SW ¼, 1329 meters, July 31, 1979 (G. M. Stonedahl; OSU).

Specimens were collected on noble fir, *Abies procera* Rehd. and silver fir, *Abies amabilis* (Dougl.) Forbes.

Remarks.—This species belongs to the *junceus* species group formed by Knight (1974) and discussed by Kelton (1979) and Henry (1979). *Phytocoris nobilis* keys to *P. rainieri* Knight in Knight (1974:126) based on the predominantly white pronotal disk and hemelytra, and the relatively short first antennal segment. The two species can be separated on the basis of color and vestiture of the dorsum, legs, and antennae. The dorsum of *P. nobilis* has a lighter, grayish white cast compared to the reddish brown cast of *P. rainieri*. The hind femora of *P. nobilis* are fuscous with scattered pale spots that are largely restricted to the apical half of the femur. In *P. rainieri*, the hind femora are pale yellow with a reticulate, reddish brown pattern that extends to the base of the femur. The tibiae of *P. nobilis* are clearly triannulate with white, but banding is indistinct or lacking in *P. rainieri*. The femora and first antennal segments of *P. rainieri* are more densely set with erect, black, bristle-like setae than are those of *P. nobilis*. Male genitalia were not compared since the male of *P. rainieri* is unknown.

***Phytocoris occidentalis,* New Species**

(Figs. 5–7)

Male.—Length 4.43–5.83 mm, width 1.53–1.71. Head: width across eyes 0.90–0.94, vertex 0.29–0.32; pale yellow to testaceous; buccula, lorum, jugum, and clypeus marked with red or reddish brown; frons with 6–8 fuscous striae each side of midline. Rostrum: length 1.89–2.30, extending to 5th or 6th abdominal segment. Antennae: dark reddish brown to fuscous; I, length 0.68–0.79, with recumbent, black setae and 10–12 erect, pale bristles; II, length 1.78–2.03, narrowly pale at base; III, length 1.03–1.30, narrowly pale at base; IV, length 0.68–0.90. Pronotum: mesal length 0.71–0.81, posterior width 1.28–1.42; testaceous or grayish yellow, collar and calli marked with red; posterior submargin with 4–6 slightly elevated tubercles outlined posteriorly by a wavy, fuscous band. Scutellum: testaceous or grayish yellow; frequently marked or tinged with red, especially along midline. Hemelytra: testaceous or grayish yellow with distinct reddish cast, areas bordering claval suture darker brown; cuneus deeper red; membrane translucent, confusedly sprinkled with fuscous spots which often coalesce to form larger fuscous patches, veins pale, usually tinged with red and sometimes infuscated basally. Venter: testaceous or grayish yellow, extensively mottled with red or reddish brown; base of 9th abdominal segment broadly fuscous. Legs: coxae pale yellow with scattered, reddish patches; femora pale yellow, reticulated with red or reddish brown so that pale areas appear as spots, metafemora more extensively infuscated apically; tibiae reddish brown to fuscous with scattered, pale spots, pale markings on front tibiae often appearing as three distinct bands; tarsi testaceous to fuscous; tarsal claws testaceous. Vestiture: pronotal disk, scutellum, and hemelytra with semierect, black setae intermixed with brown or black, scale-like setae and white, scale-like setae. Genitalia: Figures 5–7. Genital segment with a finger-shaped tubercle at bases of left and right parameres. The male description is based on the examination of 46 specimens.

Female.—Very similar to male in color, vestiture, and size. Length 4.37–5.29 mm, width 1.51–1.71. Head: width across eyes 0.80–0.95, vertex 0.33–0.41. Rostrum: length 1.98–2.47, extending to 5th or 6th abdominal segment. Antennae: I, 0.68–0.80; II, 1.76–2.11; III, 1.12–1.30; IV, 0.76–0.94. Pronotum: mesal length 0.70–0.86, posterior width 1.19–1.49. The female description is based on the examination of 29 specimens.

Type data.—HOLOTYPE male, Oregon, Josephine Co., 4 mi NE Cave Junction on US 199, Aug. 8, 1979, ex *Pinus ponderosa* Dougl. (G. M. Stonedahl; USNM). PARATYPES: OREGON. 3 males and 1 female, same data as holotype (OSU); 9 males and 3 females, same data as holotype but Aug. 24, 1979 (AMNH, CAS, OSU).

Additional specimens.—CANADA. BRITISH COLUMBIA. Goldstream, Aug. 4, 1927 and Aug. 16, 1929 (W. Downes; UBC). UNITED STATES. CALIFORNIA. Alameda Co.: Berkeley, Aug. 28 and Oct. 1, 1965, at light (R. L. Langston; UCB). Butte Co.: Oroville, July 13, 1926 (H. H. Keifer; CAS). Contra Costa Co.: Moraga, July 24 and Sept. 23, 1976 (D. G. Denning; AMNH); San Pablo Dam Res., June 29, 1978, ex *Pinus radiata* D. Don (C. P. Ohmart; OSU); Walnut Crk., Aug. 20, 1969, at blacklight (J. A. Powell; UCB). Mariposa Co.: Feliciana Mtn., July 26, 1946, ex *Pinus attenuata* Lemmon (R. L. Usinger; UCB). Plumas Co.: Johnsville, Sept. 2, 1967, light trap (H. Pini; F&A). Sacramento Co.: Sacramento, June 15–26, 1968 (R. A. Belmont; F&A). San Bernardino Co.: San Bernadino Mts., Mill Crk., 1829 meters, Sept. 2, 1950, at light (Timberlake; UCR); San Bernardino Mts., South Fork Camp, 1890 meters, Sept. 10, 1944, ex *Pinus ponderosa* (Timberlake; UCR); San Bernardino Mts., Camp O-Ongo nr. Running Springs, 1920 meters, Aug. 31, 1971 (C. L. Hogue; LACM); 4 mi S Twentynine

Palms, March 30, 1970, ex *Yucca schidigera* Roezl (UCB). San Diego Co.: Laguna, Aug. 21, 1927 (SDNH). Shasta Co.: Lakehead, 350 meters, June 26, 1981, ex *Pinus sabiniana* Dougl. (J. D. Lattin; OSU). Siskiyou Co.: McCloud, 1073 meters, Aug. 9 & 20, 1980, ex *Pinus attenuata* (G. M. Stonedahl; OSU). Yolo Co.: 5 mi N Rumsey, May 2, 1973 (J. C. Miller; OSU). OREGON. Grant Co.: Malheur Nat. For., Dixie Campground, Aug. 24, 1981, ex *Pinus ponderosa* (G. M. Stonedahl; OSU). Hood River Co.: Mt. Hood, Cloud Cap, 1829 meters, Sept. 5, 1979, ex *Pinus contorta* Dougl. (G. M. Stonedahl; OSU); T1S, R10E, Sec. 31, Sept. 13, 1979, ex *Pinus contorta* (G. M. Stonedahl; OSU); T3S, R9E, Sec. 18, 1311 meters, Sept. 13, 1979, ex *Pinus contorta* (J. D. Lattin; OSU). Josephine Co.: O'Brien, Aug. 2, 1968 (P. Oman; OSU); 2 mi W O'Brien, Aug. 10, 1979, ex *Pinus ponderosa* (G. M. Stonedahl; OSU). Linn Co.: 1 mi W jct. State Hwy. 22 on US 20, Sept. 19, 1979, ex *Pinus contorta* (G. M. Stonedahl; OSU); 0.5 mi N jct. US 20 on State Hwy. 22, 1158 meters, Sept. 1, 1977, ex *Pinus contorta* (J. D. Lattin; OSU).

Remarks.—Phytocoris occidentalis will key to *P. miniatus* Knight in Knight (1968:219) but is easily separated from *miniatus* by the submarginal, fuscous band on the pronotal disk and the black, scale-like setae on the dorsum. *Phytocoris occidentalis* is much larger than *P. miniatus* which has an average size of only 3.4 mm. The geographic ranges of these two species also are different. *Phytocoris miniatus* is known only from Arizona and Utah.

Phytocoris occidentalis is superficially similar to another pine-inhabiting *Phytocoris* species, *P. stellatus* Van Duzee. *Phytocoris stellatus* is easily separated from *occidentalis* by the absence of black, scale-like setae on the dorsum and the structure of the male genitalia, particularly the absence of the genital tubercles.

ACKNOWLEDGMENTS

I wish to thank John D. Lattin (OSU), Paul W. Oman (OSU), and Thomas J. Henry (USDA, SEL, % USNM) for reviewing the manuscript; and special thanks to Richard C. Froeschner (USNM) for loaning type specimens of *P. abiesi* Knight and *P. rainieri* Knight for comparison. I also thank Bonnie B. Hall for the fine illustration of *P. nobilis* and Julie A. Stonedahl for help in preparing the manuscript. The Theodore Roosevelt Memorial Fund (AMNH) and the Oregon State University Foundation provided funds to study additional type material at the USNM.

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Description of the First Central American Species of *Stenopogon* Loew (Diptera: Asilidae)

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Abstract.—A new species of *Stenopogon* Loew from La Pacifica in Costa Rica is described. This represents the first Central American record for this genus.

Stenopogon setosus, NEW SPECIES

Male.—Length 12 mm. Head black; face silvery tomentose, frons and occiput golden tomentose. Mystax composed of strong white bristles extending halfway to antennae; white hairs subequal in length to antennal segment 1, extending $\frac{4}{5}$ the distance from upper edge of mystax to antennal bases; occipital bristles brown; bristles of frons and ocellar tubercle dark-brown. Antennae (Fig. 1) dark-brown, bristles whitish; segments 11-6-20-11.

Mesonotum black, humeri dark-reddish, tomentum light-brownish, central stripes and intermediate areas darker. Hairs numerous, brownish, anteriorly as long as antennal segment 1, becoming longer and whitish posteriorly. Bristles whitish; 3 humeral; 3–4 strong post-humeral; 4 strong, 1 weak presutural; 5 supraalar; 3 postalar; 3 strong dark-brown, 1 strong white anterior and 4 white posterior dorsocentral. Pleurae and coxae black, golden-brown tomentose, hairs and bristles white. Entire scutellum light-golden tomentose; 4 long white marginal bristles.

Abdomen dark-brownish, silvery tomentose dorsally, becoming brownish tomentose laterally. Hairs white, longer laterally on 1–3; 4 white lateral bristles on 1. Sternites dark-brownish, brown tomentose; hairs erect white on 1–7. Genitalia dark-brownish; hairs white (Figs. 2–4).

Legs black; tibiae and tarsi dark-brownish. Hairs and bristles white; a few dark-brown bristles on the tibiae and tarsi.

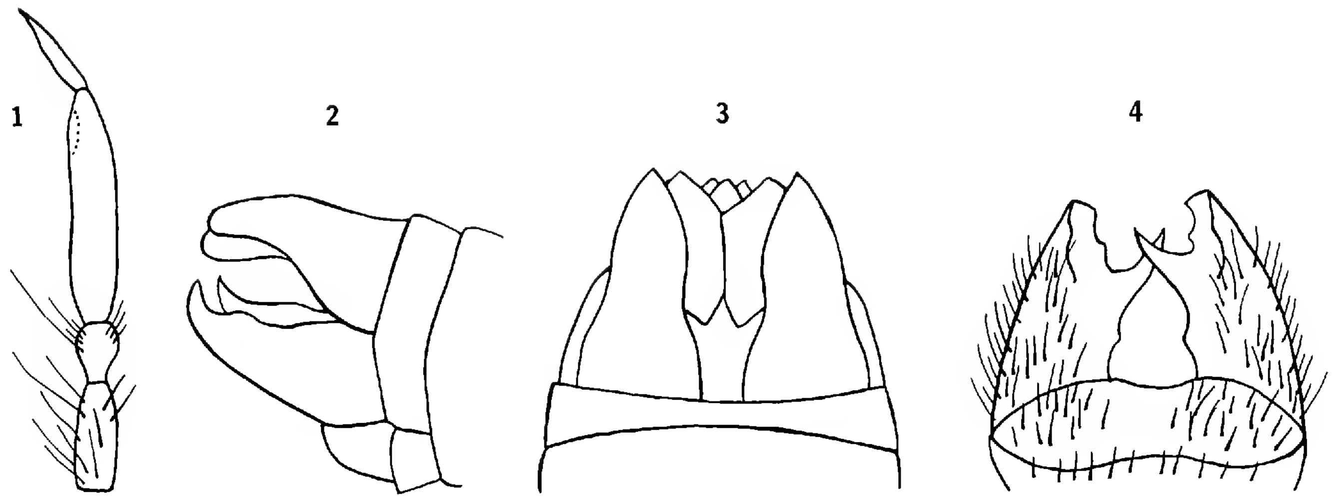
Halteres pale-brown. Wings very lightly infuscated; posterior cell 1 open; posterior cell 4 closed and petiolate; anal cell closed at wing margin.

Female.—Unknown.

Holotype.—Male, La Pacifica, 4 km NW of Canas, Gte Province (Guanacaste), Costa Rica. Dec. -22/27-73, P. Opler. Deposited on indefinite loan in the collection of the California Academy of Sciences.

Paratypes.—3 males, same data, except: Jan. -23-74. Specimens deposited in the collections of the Essig Museum of Entomology, Berkeley and the author.

Stenopogon setosus belongs to the Albibasis Group as defined by Wilcox (1971). It differs from the other known species of this group by the presence of long hairs above the mystax which extend nearly to the antennal bases, and by the closed



Figures 1–4. *Stenopogon setosus*, n. sp. 1. Antenna. 2–4. Male genitalia, lateral, dorsal, and ventral views.

and petiolate 4th posterior cell. The presence of long anterior dorsocentral bristles will separate it from the remainder of the Albibasis Group species except for *S. lomae* Wilcox, in which the anterior mesonotal hairs are yellowish and are only as long as the second antennal segment. There is some variation in the color of the anterior dorsocentrals and in the number of marginal scutellar bristles, exhibited by the paratypes.

Two additional specimens (one male, one female) of *Stenopogon* from Alajuela, Costa Rica, are similar except the thorax and abdomen are reddish in ground color. It is possible that they represent a second new species, but as they are in poor condition, species determination will have to be deferred until more material is accumulated.

The illustrations were prepared by Susan Kaiser. Thanks to L. Knutson (USNM) for sending specimens in his care, and to C. S. Papp for technical assistance. Special thanks go to John Chemsak who never lets me leave U.C. Berkeley without unidentified asilids.

LITERATURE CITED

Wilcox, J. 1971. The genera *Stenopogon* Loew and *Scleropogon* Loew in America North of Mexico (Diptera:Asilidae). Occasional Papers of the California Academy of Sciences, No. 89, 134 pp., 263 figs.

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Notes on Neotropical Veliidae (Hemiptera) VI. Revision of the Genus *Euvelia* Drake

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The genus *Euvelia* was founded by Drake (1957) with *E. advena* Drake as the only included species. Whereas Drake had but a single female before him, we fortunately have series of *E. advena,* and of three new species described below. A redescription of *E. advena* is provided along with a key to the known species.

We are indebted to the following individuals and institutions for the opportunity to study specimens; abbreviations for the various collections are given in parentheses and used in the text: Dr. R. T. Schuh, American Museum of Natural History, New York (AMNH); Dr. P. H. Arnaud, California Academy of Sciences, San Francisco (CAS); Dr. T. J. Henry, United States National Museum (Natural History), Washington (USNM); Dr. R. C. Froeschner, Curator, Drake Collection, Smithsonian Institution, Washington (CJD); Dr. H. H. Weber, personal collection (HHW) and Max Planck Institut of Limnologie, Plon (Plön); J. T. Polhemus collection (JTP).

Unless otherwise noted, measurements are given in units, 60 units = 1 mm.

Euvelia Drake

Euvelia Drake, 1957. Proc. Biol. Soc. Wash., 70:116.

Type-species *Euvelia advena* Drake, monotypy and original designation.

This genus is characterized by four large blade-like pretarsal structures on each middle tarsus, short fusiform antennal segments, and the middle and posterior acetabula approximate and far removed from the front pair; other characteristics are typical of the Microveliinae. The most closely related genus, *Husseyella* Herring (1955), has four much smaller blade-like pretarsal structures on each middle tarsus and relatively much longer, more slender antennae, but shares the unusual placement of the middle acetabula. The only other American member of the Microveliinae with blade-like pretarsal structures is *Xiphovelia lacunana* (Drake & Plaumann) with three blades on each middle tarsus and the acetabula about equidistant from each other (see Polhemus, 1977).

The differences between *Euvelia* and *Husseyella* are not greater than say the *austrina* group of *Microvelia* and other *Microvelia* species. We believe, however, that a revision of the generic structure of the Microveliinae should result from a cladistic analysis of all taxa of the subfamily, so this matter will be treated in a later publication.

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[1] Contribution from University of Colorado Museum, Boulder, Colorado 80309.

[2] Contribution from Department of Biology, University of Utah, Salt Lake City, Utah 84112.

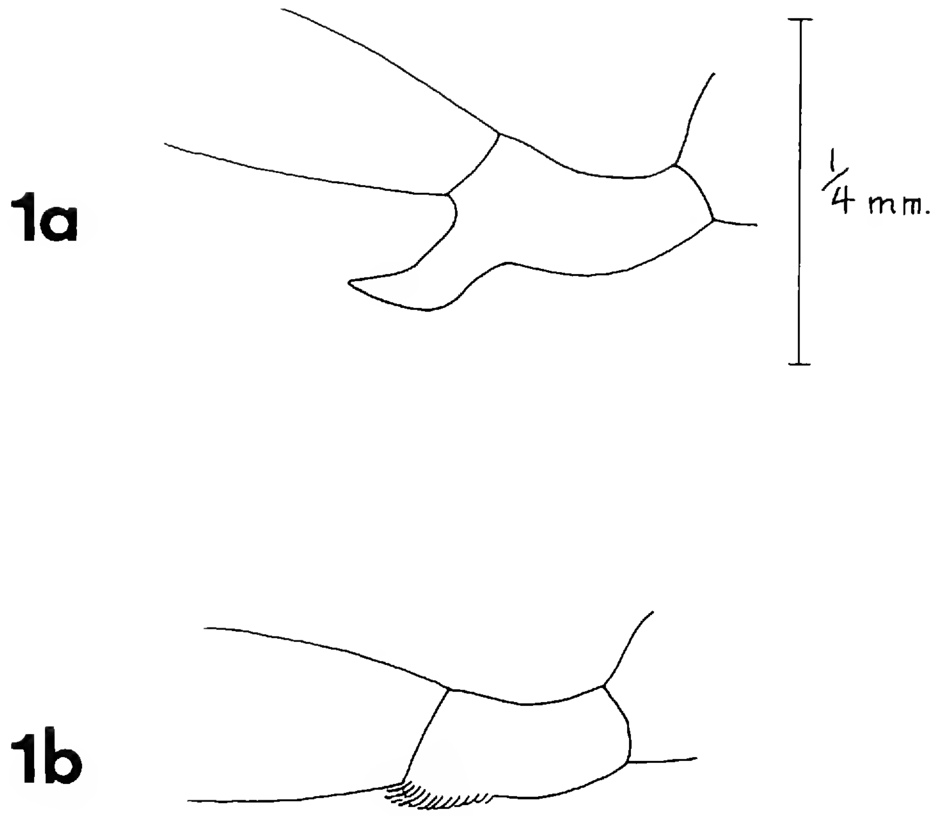

Figure 1. *Euvelia* species, anterior trochanter. A. *E. advena* Drake. B. *E. lata,* n. sp.

KEY TO SPECIES OF *EUVELIA*

1. Body very broad; connexival segments 1 and 4 with silvery hair patches; connexiva without pruinose areas (Fig. 3) . . . . *E. discala,* n. sp.
   Body moderately broad to broad; connexival segments without silvery hair patches; connexival segments 2 and 4–7 (at least) with pruinose areas (Fig. 4) 2
2. Male fore trochanter produced distally into a long distinct spur (Fig. 1a); width of females across humeri about 1.5 times width of head across eyes; females without glabrous area on pleura . . . . *E. advena* Drake
   Male fore trochanter not or only slightly produced; females with a glabrous area on pleura *or* width of humeri almost twice as wide as head across eyes 3
3. Females broad, with short to moderately long stout setae and no glabrous area on pleura; males with a short anteriorly directed spur or tuft of stiff hairs distally on fore trochanter (Fig. 1b) . . . . *E. lata,* n. sp.
   Females narrower, with no stout setae on pleura, but with a depressed glabrous area on pleura (Fig. 2); males without spur or tuft on fore trochanter . . . . *E. concava,* n. sp.

***Euvelia advena* Drake**

Euvelia advena Drake, 1957. Proc. Biol. Soc. Wash., 70:116.

Description.—Apterous male: Elongate, broadest across mesonotal angles; abdomen tapering evenly to apex; tergite seven trapezoidal. Length 1.37 mm, maximum width 0.80 mm.

Ground color black, with scattered pruinose areas. Head black, narrow area along base of vertex and adjoining eyes reddish brown; frons with scattered stout

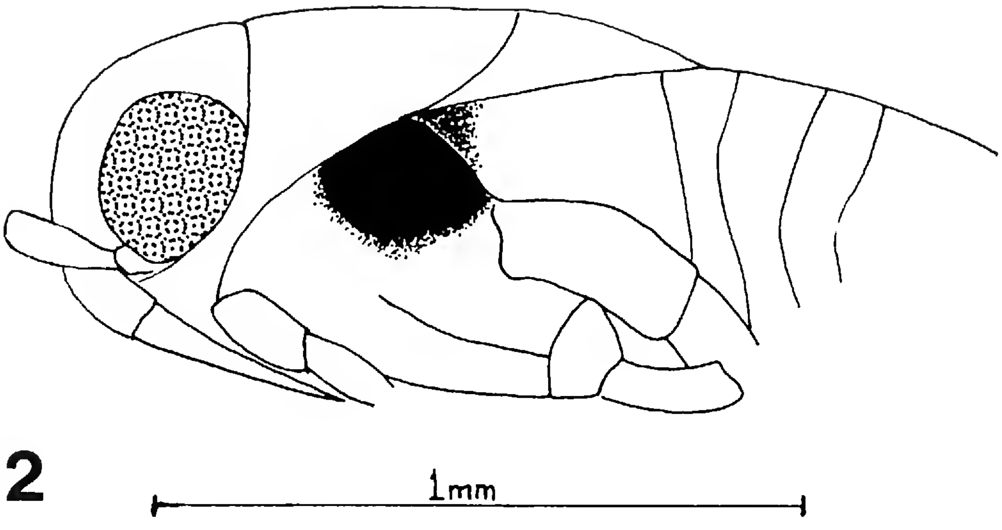

Figure 2. *Euvelia concava,* n. sp., female, lateral view showing depressed glabrous area on pleura.

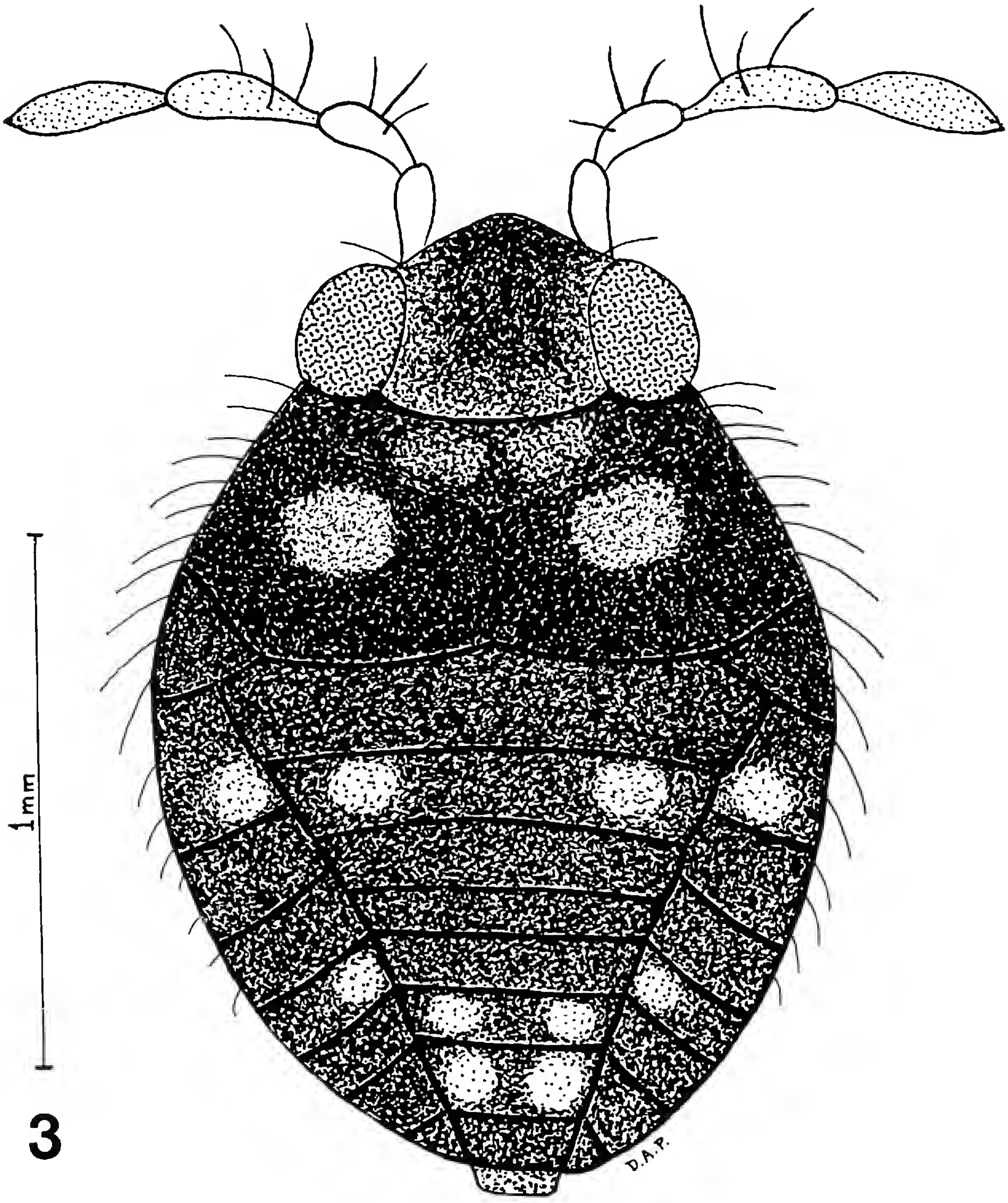

Figure 3. *Euvelia discala,* n. sp., female, dorsal view (legs omitted).

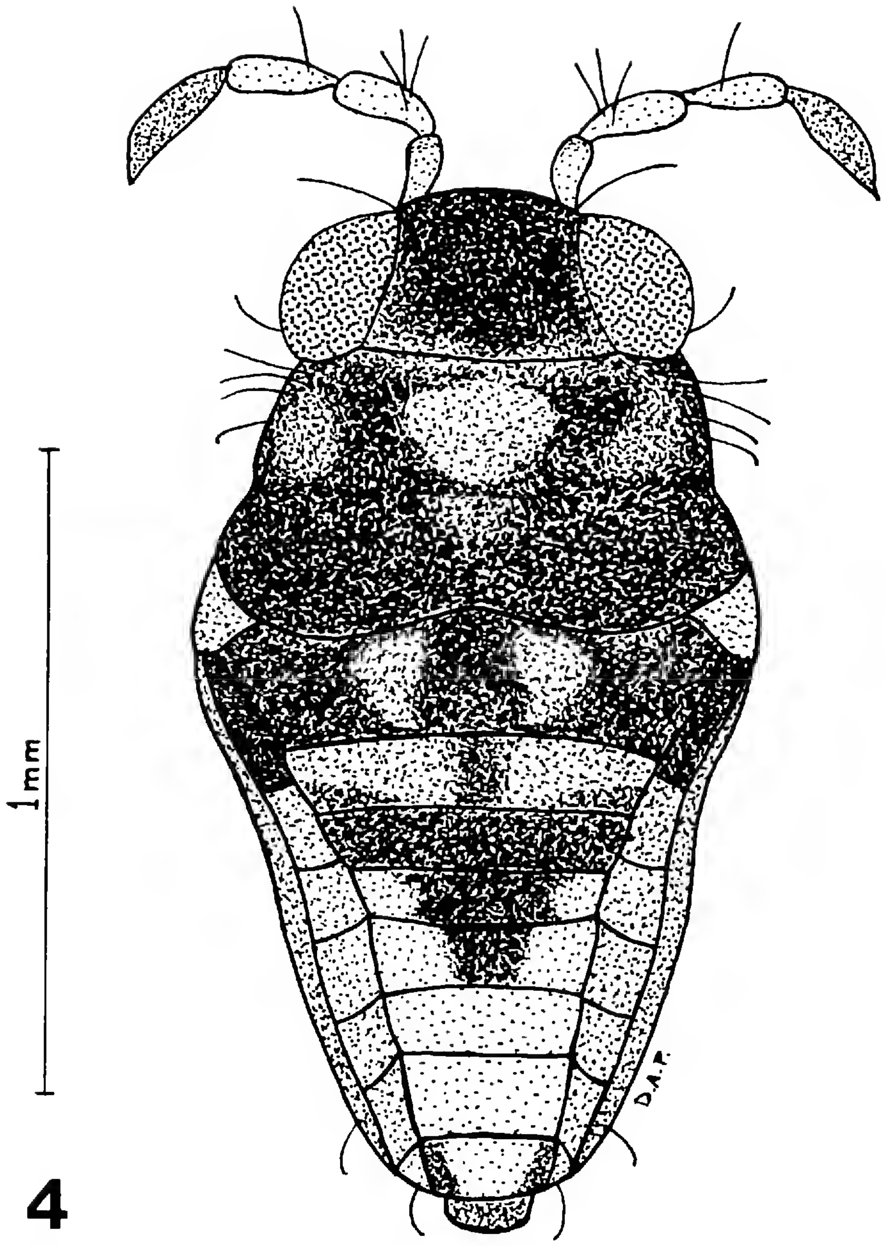

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Figure 4. *Euvelia concava,* n. sp., female, dorsal view (legs omitted).

setae. Antennae chestnut brown, terminal segment black; proportions of segments I–IV: 13; 11; 14; 14.

Pronotum black; anterior lobe with rectangular area medially near anterior margin not reaching inner eye margins pink, surrounded by larger rectangular black area covering medial part of anterior lobe and extending laterally beyond inner eye margins, flanked by lateral pruinose areas; posterior lobe brownish to black medially, black laterally. Posterolateral angles of metanotum pruinose. Pleural region sparsely set with stout setae, without glabrous areas.

Abdomen black; connexiva moderately reflexed; tergites two, five, six, and seven, and connexival segments two, four, five, and six with broad pruinose areas; pruinose areas appearing lavender on more distal segments.

Ventral surface dark grey; rostrum chestnut brown, glabrous; margins of coxal cavity and venter embrowned; narrow glabrous areas present medially on abdominal sternites one through six; usual small tuft of setae arising at end of scent channel above and between hind and middle coxae. Legs pale yellow, infuscated distally along femora and tibiae; male fore trochanter with distinct spur (Fig. 1a); fore tibia sparsely set with stout setae; middle femora with sparse tuft of four setae at base. Legs with following proportions:

	Femur	Tibia	Tarsal I	Tarsal II
Anterior	22	22	9	—
Middle	44	46	11	22
Posterior	28	31	4	15

Genital segments small, inconspicuous; parameres tiny, symmetrical, not diagnostic.

Apterous female: Similar to male but slightly larger, body shape more ovate; tergite 8 broader than in male, nearly rectangular. Length 1.55 mm, maximum width 0.89 mm.

Material examined.—BOLIVIA: 1 ♀ (Holotype), Cuarto Ojo, Piray River, IV-25-1957 (CJD). BRAZIL: 1 ♂, 2 ♀, Rio Madeira, Porto Velho, IX-1937, A. M. Ollala (JTP); 2 ♂, 7 ♀, Goias, Santa Isabel, Ilha de Bananal, Rio Araguaia, B. Malkin (JTP); 10 ♂, 4 ♀, Source region, Rio Xingu, VIII-28 and 29-1965, E. J. Fittkau (JTP, HHW, Plön); 1 ♂, 1 ♀, Rio Negro, 30 km below Barcelos, A333, II-7-1962, E. J. Fittkau (HHW, Plön); 17 ♂, 13 ♀, Rio Cuieiras, Igarape Cachoeira, A428, XI-25-1962, E. J. Fittkau (JTP, HHW, Plön). PERU: 2 ♀, Estiron, Rio Ampiácu, Loreto, rapid forest stream, XI-28 to XII-7-1961, B. Malkin (USNM).

Euvelia lata, New Species

Description.—Apterous male: Ovate, broadest across mesonotal angles, abdomen curving broadly and evenly to apex. Length 1.34 mm, maximum width 0.95 mm.

Ground color black, with scattered pruinose areas; body thickly covered with fine golden pubescence. Head black, narrow area along base of vertex and adjoining inner margins of eyes reddish brown; frons with distinct medial cleft, set with scattered stout setae, especially prominent at base of labrum. Antennae chestnut brown, terminal segment black; proportions of segments I–IV: 11; 11; 16; 16.

Pronotum black; anterior lobe set with scattered stout setae, with ovate area medially near anterior margin but not reaching inner eye margins pink, surrounded by larger rectangular black area covering medial portion of anterior lobe and extending laterally to inner eye margins, flanked by lateral pruinose areas; posterior lobe black, with faint medial furrow. Posterolateral angles of metanotum pruinose. Pleural region sparsely set with stout setae, lacking glabrous areas.

Abdomen black; connexiva weakly reflexed; tergite one with two small triangular pruinose areas flanking medial black area; tergites two, three, five, six, and seven, and connexival segments two, four, five, and six with broad pruinose areas; connexival margins set with stout setae.

Ventral surface dark grey; rostrum chestnut brown, glabrous; coxal cavity black, margins embrowned; small glabrous areas present medially on abdominal sternites four through six; usual small tuft of setae present at end of scent channel. Legs chestnut brown, femora infuscated distally; fore trochanter with small, anteriorly directed tuft of setae (Fig. 1b); middle femora with tuft of four stout setae basally. Legs with following proportions:

	Femur	Tibia	Tarsal I	Tarsal II
Anterior	24	22	11	—
Middle	42	46	11	22
Posterior	28	31	4	15

Apterous female: Similar to male but slightly larger, body shape slightly broader. Length 1.64 mm, maximum width 1.05 mm.

Material examined.—Holotype, male, BRAZIL: Rio Cuieiras, Igarapé de Arara, A410, XI-22-1962, E. J. Fittkau (Plön). Paratypes as follows: BRAZIL: 1 ♂, 1 ♀, same data as holotype (JTP, Plön); 1 ♀, Rio Cururu, Lago da Ziganea, A103, I-24-1961, E. J. Fittkau (HHW); 1 ♀, above Manaus, Cachoeira da Igarapé Gigante, A198, VII-3-1961, E. J. Fittkau (Plön); 1 ♂, above Manaus, St. Antonio, Igarapé da Bajaon, A276, XII-11-1961, E. J. Fittkau (HHW); 3 ♂, 3 ♀, Lago Catuá, IX-12-1961, E. J. Fittkau (JTP).

Discussion.—The key characters will separate this species from all other known *Euvelia*. The body is relatively broad, but not nearly as broad as in *E. discala*, n. sp. The name *lata* refers to the broad body.

Euvelia concava, New Species

Description.—Apterous male: Elongate, broadest across mesonotal angles; abdomen tapering evenly to apex, connexival margins weakly sinuate. Length 1.25 mm, maximum width 0.75 mm.

Ground color black, with scattered pruinose areas. Head black, narrow area along base of vertex adjoining eyes light brown; frons with scattered stout setae along inner margins of eyes, lower portion pruinose. Antennae chestnut brown, segment III infuscated, terminal segment black; proportions of segments I–IV: 11; 9; 11; 13.

Pronotum black; anterior lobe with roughly triangular area medially near anterior margin not reaching inner eye margins pink, surrounded by larger rectangular black area covering medial part of anterior lobe and extending laterally to inner eye margins, flanked by small lateral pruinose areas; posterior lobe black, with distinct medial depression. Posterolateral angles of metanotum pruinose. Pleural region sparsely set with stout setae, without glabrous areas.

Abdomen black; connexiva moderately reflexed; tergite one with two small triangular pruinose areas flanking medial black area, bases adjoining posterior lobe of pronotum; tergites two, three, five, six, and seven, and connexival segments two, four, five, and six with broad pruinose areas; pruinose areas appearing blue on more proximal segments fading to lavender distally.

Ventral surface dark grey; rostrum chestnut brown, glabrous; margins of coxal cavity and venter embrowned; glabrous areas present medially on abdominal sternites three through five; usual small tuft of setae arising at end of scent channel between hind and middle coxae. Legs pale yellow, lightly infuscated distally along femora and tibiae; fore and middle tibiae sparsely set with stout setae. Legs with following proportions:

	Femur	Tibia	Tarsal I	Tarsal II
Anterior	20	16	9	—
Middle	39	35	18	7
Posterior	29	22	4	11

Apterous female: Similar to male but slightly larger; pruinose areas of slightly different shape (Fig. 4). Length 1.49 mm, maximum width 0.80 mm. Anterior lobe of pronotum with stout setae; medial pink pruinose area more rectangular than in male; pleural region with large glabrous area (Fig. 2). Abdomen with connexiva strongly reflexed; pruinose areas more extensive than in male; triangular pruinose patches on abdominal tergite 1 extending to posterior margin of tergite.

Material examined.—Holotype, male BRAZIL: Capitao Vasconselos, on Rio Tuatuari, Upper Xingu Basin, Matto Grosso, VII-31-1957, B. Malkin (CAS). Paratypes, BRAZIL: 21 ♂, 71 ♀, 3 nymphs, same data as holotype (CAS, JTP, USNM).

Discussion.—Euvelia concava, n. sp. most closely resembles *E. advena* Drake, but may be easily separated by the lack of a spur on the male anterior trochanter, and the depressed glabrous area on the pleura of the female. The latter character separates the females from all other known *Euvelia* species, and is apparently the result of a modification to facilitate phoresy. The name *concava* refers to the glabrous concavity on the female.

***Euvelia discala,* NEW SPECIES**

Description.—Apterous male: Ovate, broadest across mesonotal angles, shape as in Figure 3. Length 1.46 mm, maximum width 1.05 mm.

Ground color black, with scattered silvery hair patches, body thickly clothed in fine golden pubescence. Head reddish brown; frons black, with distinct medial furrow, set with stout setae. Antennae chestnut brown, terminal segment lightly infuscated, segments two and three each with three stout spines; proportions of segments I–IV: 11; 11; 18; 16.

Pronotum black; anterior lobe with rectangular area medially near anterior margin reaching inner eye margins reddish brown, sparsely set with stout setae; posterior lobe black, with two round silvery hair patches flanking faint medial furrow, set sparsely with stout setae. Pleural region moderately set with stout setae, lacking glabrous areas.

Abdomen black; connexiva moderately reflexed, set with stout hairs; tergites two, six, and seven, and connexival segments one and four with small round patches of silvery hairs.

Ventral surface dusky brown; rostrum chestnut brown, glabrous; margins of coxal cavity and venter embrowned. Legs chestnut brown; fore and middle tibiae sparsely set with stout setae; distal comb on fore tibia prominent, black. Legs with following proportions:

	Femur	Tibia	Tarsal I	Tarsal II
Anterior	28	26	11	—
Middle	50	48	13	20
Posterior	31	35	4	15

Apterous female: Similar to male, but slightly larger and broader, shape and markings as in Figure 3. Length 1.70 mm, maximum width 1.19 mm. Reddish brown area on anterior lobe of pronotum divided medially by black line; margins of pronotum somewhat more heavily set with stout setae than in male.

Material examined.—Holotype, male BRAZIL: Rio Cuieirias, Igarapé da Arara, A410, XI-22-1962, E. J. Fittkau (Plön). Paratypes as follows: BRAZIL: 4 ♂, 3 ♀, same data as holotype (JTP, HHW, Plön); 1 ♀, Rio Negro, Furo de Paracuuba, Si/Sa 7, IX-17-1959, Sioli & Sattler (Plön); 1 ♂, above Manaus, Reserva Duke, Igarapé Barro Branco, A584, XI-6-1965, E. J. Fittkau (Plön). PERU: 1 ♂, 1 ♀, Estiron, Rio Ampiácu, Loreto, rapid forest stream, XI-28 to XII-7-61, B. Malkin (USNM).

Discussion.—The broad body, long hairs on the dorsum, and silvery spots on the connexiva will separate *E. discala* from other known species of the genus. The name *discala* refers to the shape of the insect.

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A New Species of *Phymatodes* from New Mexico (Coleoptera: Cerambycidae)

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Abstract.—*Phymatodes shareeae,* is described as new from the Nacimiento Mountains, Rio Arriba County, New Mexico. Larval and pupal habits in *Acer glabrum* are also reported.

Members of the relatively large genus, *Phymatodes,* are found throughout the Holarctic Region. The species are mostly small, slender, with maculate elytra, and are found mainly upon broad-leaved trees. In North America however, a considerable number of the described species are immaculate and many utilize coniferous hosts. A new species, closely related to *Phymatodes vulneratus* (LeConte), was collected from northern New Mexico.

Phymatodes shareeae, NEW SPECIES

Male.—Form subcylindrical; color piceous with coxae, bases of femora, tibiae, and antennae rufous or rufotestaceous; elytra with a single pair of oblique white fasciae just behind middle, expanded at the margin. Head with upper frons and vertex coarsely, closely punctate; antennae nearly as long as body, scape sparsely punctate, sparsely ciliate, third segment about as long as fourth. Pronotum a little wider than long, sides broadly rounded, base moderately constricted; disk coarsely, closely punctate, clothed with short, coarse, erect, dark pubescence, interspaces shining. Elytra about twice as long as basal width, sides subparallel, apical half often explanate, apices broadly rounded externally, narrowly rounded internally, surface distinctly punctate at base, more finely and subrugosely punctate behind fasciae; pubescence short, dark, suberect, shining, sparsely clothed with short, erect hairs; posterior tarsi with first segment distinctly longer than following two together. Abdomen with sternites polished, shining, very sparsely punctate and subglabrous; fifth sternite shorter than fourth, apex broadly, feebly emarginate. Length 6–9 mm.

Female.—Antennae surpassing elytral fasciae; femora less strongly clavate; fifth sternite about as long as fourth, apex narrowly rounded. Length 6–10 mm.

Holotype male, allotype (California Academy of Sciences) from 9 miles SW Coyote, Nacimiento Mountains, Rio Arriba County, New Mexico, beaten from *Acer glabrum* Torrey, 21 June 1977 (J. S. Cope). Paratypes as follows: 37 males, 28 females, same locality data, reared from *Acer glabrum,* emerged April 2–19, 1978 (J. S. Cope). Paratypes are deposited in the following collections: University of California at Berkeley, San Jose State University, J. S. Cope, E. Giesbert, F. T. Hovore, J. Huether, R. Penrose, R. Surdick, R. H. Turnbow, Jr., W. H. Tyson, J. E. Wappes.

This species resembles *Phymatodes vulneratus* but the two may be separated by the uniform, dark, short, erect elytral pubescence, expanded elytral fasciae, and rufous antennal coloration of *Phymatodes shareeae.* In contrast *Phymatodes vulneratus* may be characterized by longer, erect, golden elytral pubescence, parallel sided elytral fasciae, and typically dark antennae. Antennal coloration of specimens from southern California often tends to be a light reddish-brown. *Phymatodes vulneratus* is a Pacific Coast species ranging from Southern California to British Columbia while *Phymatodes shareeae* is located 500 miles to the east in northern New Mexico.

Biology.—Both of these closely related species utilize various species of *Acer* as hosts. The entire type series was beaten from or reared from *Acer glabrum.* Larval work is typical of other species in the genus, as summarized by Chemsak and Powell (1964). Larvae work just under the bark of larger branches, lightly scoring the sapwood. The meandering galleries are loosely packed with a light, fine, granular frass mixed with darker bits of bark. Prior to pupation the larva cuts an oblique tunnel into the wood, then turns parallel to the wood grain where a pupal chamber is constructed. The exit hole is plugged with packed granular frass. Adult emergence at the type locality apparently occurs in June.

The following key segment may be inserted into the "Key to North American Species of *Phymatodes*" found in Linsley's (1964) monograph of the Cerambycidae.

3(2). Elytra with 2 pairs of white fasciae or with a single pair just before apex .... (Linsley's 4) 5
Elytra with a single pair of white fasciae just behind middle, pronotum with disk distinctly, closely punctate; elytra distinctly punctate from base to apex 4
4(3). Elytra with single pair of oblique white fasciae, each parallel sided or at most curving slightly forward just before margin; basal ⅔ of elytra usually rufous or rufotestaceous, rarely black or piceous; antennae usually dark, with long flying hairs on segments 2–7. Pacific Coast species .... *vulneratus*
Elytra with single pair of oblique white fasciae, expanded at margin; elytra piceous; antennae rufotestaceous with short suberect hairs on segments 2–7. New Mexico .... *shareeae*

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Scientific Note

Feeding Behavior of *Lacon profusa* (Candèze) (Coleoptera: Elateridae) in Carpenter Ant Attended Colonies of *Cinara* spp. (Homoptera: Aphididae)[1,2]

Very little is known about the food habits of elaterid adults. Most reports suggest that they feed on plant juices and young, tender leaves. Balduf (1935, The bionomics of entomophagous Coleoptera, John Swift Inc. Co., St. Louis), reported *Corymbites virens* Schr. feeding upon *Vanessa* sp. caterpillars (Lepidoptera: Nymphalidae). Bradley and Hinks (1968, Can. Ent., 100:40–50) noted adults of *Lacon brevicornis* (LeConte) at rest in colonies of *Cinara gracilis* Wilson attended by *Dolichoderus taschenbergi* (Mayr) and by *Formica obscuripes* Forel. *Lacon profusus* (Candèze) is treated as a subspecies of *L. brevicornis* by some workers (Arnett, 1952, Supplementary review of the Adelocerina, Wasmann J. Biol., 10:103–126). Day (1971, The southern potato wireworm, U.S.D.A. Tech. Bull. 1443) observed large numbers of adult *Conoderus falli* Lane (Elateridae) associated with honeydew on plants but did not mention whether they were feeding on it. Thomas (1940, Biology and control of wireworms, Bull. Pa. Agric. Exp. Stn., no. 392) reported that baits containing sugar solution or molasses were attractive to some elaterid adults. The literature appears devoid of reference to elaterids or any other Coleoptera attending Homoptera except for Wheeler's (1928, The social insects: Their origin and evolution, Degan, Paul, Trench, Trubner and Co. Ltd., London, 378 pp.) report of silvanid beetles of the neotropical genera *Coccidotrophus* and *Eunausibius* attending pseudococcids.

Adult *L. profusa* were occasionally found associated with *Cinara occidentalis* Davidson on white fir (*Abies concolor* Gord. and Glen.) and *Cinara moketa* Hottes on sugar pine (*Pinus labertiana* Doug.). When disturbed by attending carpenter ants, *Camponotus modoc* Wheeler, the beetle retracted its appendages into pronotal grooves and remained motionless.

During 1977, a total of four females were observed, three at *C. moketa* and one at *C. occidentalis* colonies. The first beetle was observed for 12 hours at the same *C. moketa* colony on July 14, 1977, and it remained on the same tree until it was collected on July 19. On July 15, this aphid colony, previously consisting of 12 apterae and one alate, had disappeared and the beetle had moved to another branch. As this beetle was not marked, it was not certain whether or not it was the same individual on both occasions. The second beetle was observed on July 26 and marked with a spot of red paint on the right elytron. It remained on the same tree until August 3 and at the same *C. moketa* colony for 4 days.

On July 14, 1977, another adult *L. profusus* was observed at one end of an ant-attended *C. moketa* colony. The beetle remained motionless while using its an-

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[2] From a thesis submitted to the University of California, Berkeley, in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Entomology, June 1979.

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tennae and mouthparts to stroke an aphid directly beneath its head. This stroking continued while carpenter ants crawled over the beetle's dorsum. After about 15 minutes of such behavior, the attending ants were carefully removed. The beetle continued its stroking behavior for another 10 minutes with no apparent effect on the aphid. At this point, the beetle slowly picked up the aphid between its mandibles and began consuming it. After 15 minutes, the aphid's head was still protruding from the beetle's mandibles. A newly-arrived ant stroked the protruding head of the aphid and then walked away. After consuming the aphid, the beetle began stroking another aphid which raised its abdomen and exuded a drop of honeydew. Minutes later, the beetle was observed collecting a honeydew droplet from another aphid. It continued stroking the same aphid for another 5 minutes at which time it received more honeydew. This behavior contrasts with that of ants which would move on to a new aphid immediately after collecting honeydew.

On July 17, an adult *L. profusus* was observed eating a *C. moketa* while under attack simultaneously by several ants. One *Camp. modoc* worker grasped the partially consumed aphid and bracing itself against the beetle's head, tore off about half of the aphid's body. Although many ants exhibited alarm behavior (i.e., rapid running about and greatly increased turning rate), the beetle remained absolutely motionless with mouthparts and antennae retracted.

On July 19, 1977, the same beetle (marked earlier) was found at another *C. moketa* colony where it consumed one aphid over a period of 9 minutes. Subsequently, it walked back to the trunk where it elicited no response from a minor worker of *Camp. modoc* and was then attacked by a major worker. The attack lasted about 5 minutes during which time the beetle remained motionless.

By collecting honeydew and consuming aphids, *L. profusa* obtains both carbohydrates and protein. This rich food resource is both immobile and fairly dependable. Thus the beetle may feed for prolonged periods with very little energy expended in search of food, thereby increasing its fecundity and longevity. Although attending ants reduce the beetle's foraging efficiency with their frequent attacks, the ant's presence is probably beneficial to the beetle by reducing competition for aphids from other predators and by reducing aphid dispersal (Tilles and Wood, 1981, Can. Ent., in press). Although *Camp. modoc* competes directly with *L. profusus* for both honeydew and aphids, the ants are much more efficient honeydew collectors and are often successful in pulling aphids from the beetle's grasp. Protective behavior may be stimulated by aphid produced compounds to which the ants respond. *Camp. modoc* becomes very excited when a crushed *C. moketa* is suspended above it.

The armoured exoskeleton of the *L. profusus* appears to be highly resistant to ant attacks. The beetle is apparently undisturbed by attacking ants as it may continue stroking aphids while under attack, or alternatively, can maintain a protective posture for varying periods and thus resume feeding within seconds after cessation of an ant attack.

L. profusus appears to be an inefficient predator because: 1) it spends long periods of time soliciting honeydew from a single aphid, often up to 15 minutes, and 2) it often takes as long as 20 minutes to consume a single aphid.

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Scientific Note

New Records for Two Cerambycids from the Pacific Northwest

Specimens of *Phymatodes oregonensis* Chemsak are uncommon in collections and the larval host has apparently not been recorded. The author reared two female *P. oregonensis* from small branches of an *Alnus* sp. (*A. rubra* Bong. or *A. rhombifolia* Nutt.) collected in Dabney St. Pk., Multnomah County, Oregon, in December 1978. The infested wood was collected from the crown of a fallen tree. The larvae mined beneath the bark and pupated in chambers constructed in the sapwood. Both specimens emerged in February 1979.

A male of *Obrium californicum* Van Dyke was collected by the author on the University of Idaho campus, Latah County, in July 1981 (NEW STATE RECORD). The specimen was taken from the foliage of ocean spray (*Holodiscus discolor* (Pursh) Maxim.) growing in a stand of western white and lodgepole pine. Linsley (Univ. Calif. Publ. Entomol., 21:139) recorded *O. californicum* as occurring from central Oregon and northern California south through the Sierra Nevada to the Tehachapi and Santa Cruz Mountains. It has also been collected in the San Gabriel Mts. of southern California (F. T. Hovore, pers. comm.). This species is known to use western yellow and Jeffrey pines for larval development (ibid.).

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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.
Essig, E. O. 1958. Insects and mites of western North America. Rev. ed. The Macmillan Co., New York, 1050 pp.

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A New Species and Records of *Tanarthrus* (Coleoptera: Anthicidae)[1]

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Interest in the potential rare and endangered insects of public lands has led to the granting of several federal contracts to determine the endemic insect species which are associated with sand dunes. One such contract was given to the California Department of Food and Agriculture Insect Taxonomy Laboratory and has dealt almost exclusively with the major dune formations of the Mojave Desert in California. During the course of this study a number of rarely collected *Tanarthrus* species were found, as well as a new species from the southern San Joaquin Valley. Since many of these species possessed only a few distribution records in my revision (Chandler 1975), new records are entered following the description of the new species.

A portion of the contract report by Andrews et al. (1979) presented data on *Tanarthrus coruscus* Chandler which was obtained from their year-long pitfall trap sets in the Eureka Dunes of Inyo County. They found that this species occurred only along the margin of an adjacent playa. This preference for the margins of alkali lakes and saline soils has been detailed by Chandler (1974, 1979). The majority of the specimens of *coruscus* were collected in May, with small numbers being trapped from June until September. Individuals of *Tanarthrus tartarus* Chandler and *Vacusus confinis* (LeConte) were discovered feeding on a dead *Phodaga alticeps* LeConte (Meloidae), but it is uncertain whether they were attracted to the cantharidin in the beetle, or merely to the presence of a food source.

All measurements are in millimeters in the description of the new species. The specimens from which the new records are taken are in the collections of the California Department of Food and Agriculture and the author. I would like to thank Dr. John F. Burger, University of New Hampshire, for reading the manuscript.

***Tanarthrus* (*Tanarthropsis*) *andrewsi*, NEW SPECIES**

(Figs. 1, 2)

General description.—Length 3.08–3.95. Coloration varying from head, pronotum, and first third of elytra orange and remainder of elytra dark brown, to body all dark brown with orange antennae and legs. Head basally with distinct median impression, punctures on frons shallow and moderately dense, microreticulation distinct between punctures, puncture diameter equal to that of eye facet; eleventh antennomere distinctly constricted, portion before constriction equal in length to tenth antennomere, portion after constriction about twice that of basal portion. Pronotum with antero-lateral angles rounded; punctures dense on disc, similar in

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[1] Scientific Contribution Number 1144 from the New Hampshire Experiment Station.

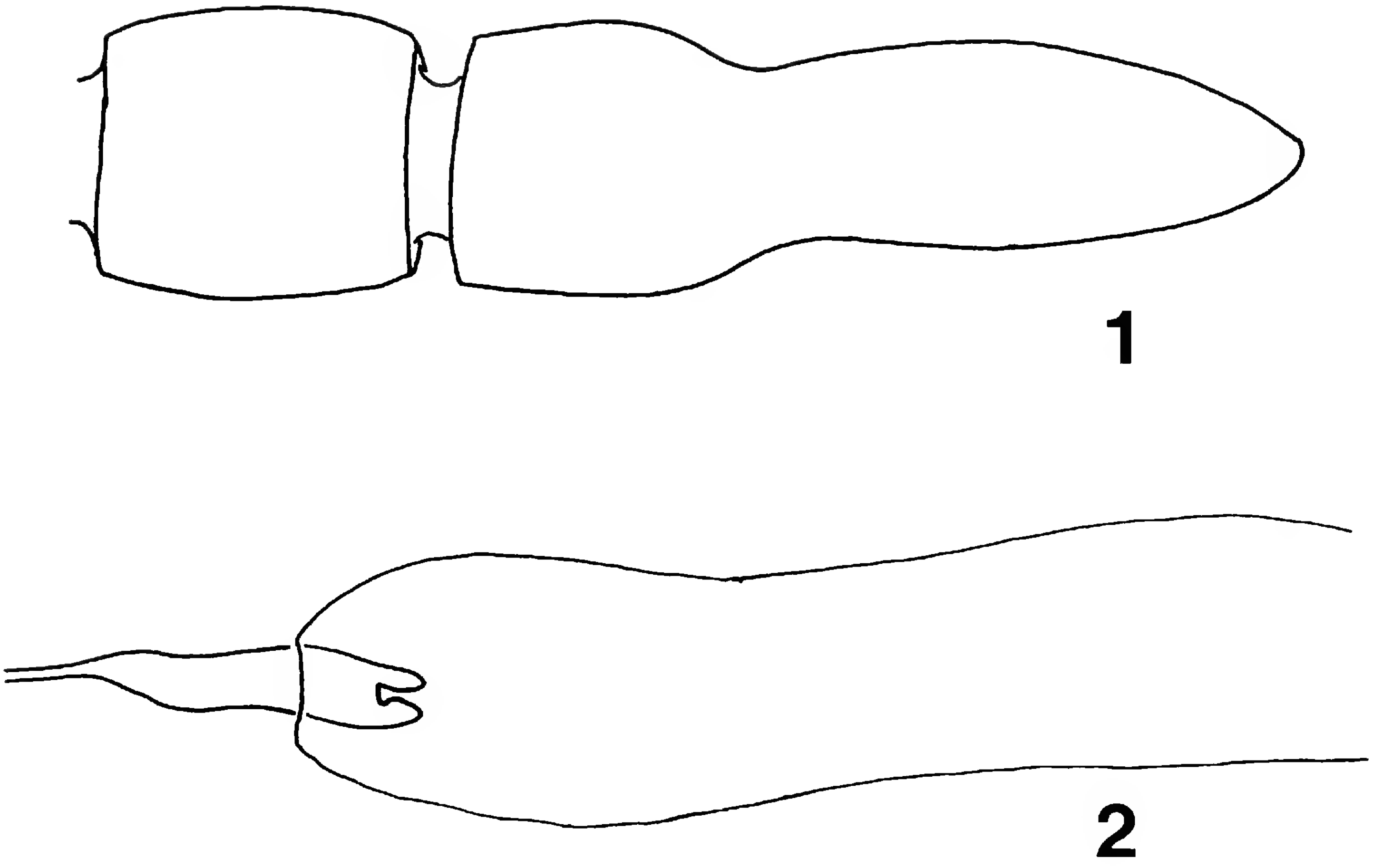

Figure 1,2. 1. Lateral view antennomeres X and XI. 2. Ventral view internal sac of male.

depth and size to those on frons, areas near lateral margins feebly granulate, microreticulation between punctures distinct. Elytra feebly ridged and lacking any obvious microreticulation; pubescence directed posteriorly, all setae appressed.

Male genitalia with tegmen as long as phallobase; internal sac smooth, lacking internal spines; primary gonopore lacking sclerotized spots or ribs.

Female similar to the male in external appearance.

Male holotype.—Soda Lake, San Luis Obispo County, California. Length 3.46. Head 0.78 long, 0.79 wide behind eyes; tenth antennomere 0.08 long, eleventh antennomere with portion before constriction 0.07 long, after constriction 0.15 long. Pronotum 0.71 long, greatest width at point 0.46 from base, collar 0.04 thick, 0.35 wide. Elytra 1.97 long, 0.87 wide across humeri; body dark brown with orange antennae and legs.

Specimens examined.—HOLOTYPE male: *California:* San Luis Obispo Co.: Soda Lake, VI-8-1979, F. G. Andrews and A. J. Gilbert, on salt encrustations at lake edge. PARATYPES: 8 males, 35 females, eutopotypical. The holotype is to be deposited in the California Academy of Sciences. Paratypes will be placed in the collections of the author, the California Department of Food and Agriculture, and the Floyd G. Werner Collection, Tucson, Arizona. The species is named for Fred G. Andrews, who has collected many fine species of Anthicidae.

Distribution.—Only known from an alkali lake at the southern end of the San Joaquin Valley.

Relationships.—Most similar to *vafer* Chandler by the proportions of the last two antennomeres, and by both the male internal sac and primary gonopore lacking spines or sclerotized spots. In *andrewsi* the base of the head is simply depressed medially rather than cleft, and the punctures of the head and pronotum are shallow, not really umbilicate as in *vafer*. *Vafer* may be a somewhat larger species as the single specimen known (the holotype) is 4.23 mm long.

NEW RECORDS OF *TANARTHRUS*

Tanarthrus (*Tanarthrus*) *salinus* LeConte

California: Inyo Co.: SE end Saline Valley, III-30-1976, D. Giuliani, edge of dry lake. Kern Co.: Koehn Lake, VI-14-1964, F. G. Andrews. San Bernardino Co.: Saratoga Springs, VI-13-1964, F. G. Andrews.

Tanarthrus (*Tanarthropsis*) *alutaceus* (LeConte)

California: Imperial Co.: 3 mi NW Glamis, IX-15/16-1972, M. Wasbauer & A. Hardy, blacklight. Inyo Co.: Saline Valley, Artesian Well, 1100 ft, IV-26-1977, D. Giuliani.

Tanarthrus (*Tanarthropsis*) *brevipennis* Casey

New Mexico: Chaves Co.: Bottomless Lakes State Park, VII-25-1975, K. Stephan.

Tanarthrus (*Tanarthropsis*) *coruscus* Chandler

California: Inyo Co.: S end Owens Lake, sand dunes, VII-15-1978, A. R. Hardy & F. G. Andrews, at blacklight; Saline Valley dunes, III-30-1976, D. Giuliani, cereal bowl pit trap; Eureka Valley Dunes, VIII-30-1976, D. Giuliani, blacklight. Riverside Co.: Palen Dunes, IX-20-1977, A. R. Hardy & F. G. Andrews, at blacklight. San Bernardino Co.: 3 mi W Rice, VI-1972, D. Giuliani, sand dunes; Salt Lake, 5 mi N Renoville, IV-17-1974, F. G. Andrews & M. S. Wasbauer; Saratoga Springs, Death Valley, V-6-1965, F. G. Andrews. *Nevada:* Lincoln Co.: Game Range Dunes, VII-14-1975, F. G. Andrews & A. R. Hardy, at blacklight. MEXICO: *Baja California:* Diablo Canyon Dry Lake, VII-16-1979, D. Giuliani, blacklight.

Tanarthrus (*Tanarthropsis*) *inhabilis* Chandler

California: Inyo Co.: Eureka Valley Dunes, VII-13-1975, F. G. Andrews & A. R. Hardy. San Bernardino Co.: Salt Creek, 5 mi N Renoville, IV-17-1974, F. G. Andrews & M. S. Wasbauer.

Tanarthrus (*Tanarthropsis*) *inyo* Wickham

California: Inyo Co.: Deep Springs Valley, Buckhorn Springs, IV-11-1975, D. Giuliani; Big Alkali Lake, VI-14-1979, F. G. Andrews, lake edge. Mono Co.: Mono Lake, Paoha Island, VII-5-1980, D. Giuliani. *Nevada:* Churchill Co.: Sand Mountain, VII-19-1977, D. Giuliani, UV light. Esmerelda Co.: Clayton Valley dunes, IV-17-1974, F. G. Andrews & A. R. Hardy. Pershing Co.: Woolsey, VI-27-1973, T. R. Haig.

Tanarthrus (*Tanarthropsis*) *iselini* Chandler

New Mexico: Roosevelt Co.: Salt Lake near Arch, IX-20-1977, W. A. Iselin.

Tanarthrus (*Tanarthropsis*) *tartarus* Chandler

California: Riverside Co.: Palen dunes, IX-20-1977, A. R. Hardy & F. G. Andrews, at blacklight; 7 mi SE Freda, IV-24/VII-26-1978, F. G. Andrews & A.

R. Hardy, small sand area. San Bernardino Co.: Cadiz Dunes, IX-18-1977, A. R. Hardy & F. G. Andrews, at blacklight.

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PAN-PACIFIC ENTOMOLOGIST
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A New California Species of *Phymatodes* Mulsant (Coleoptera: Cerambycidae)

JOHN A. CHEMSAK AND E. G. LINSLEY

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Specimens of *Phymatodes* are most commonly encountered by rearing. The following new species was reared from branches of *Juniperus californicus* by J. Cope and W. Tyson from the Mt. Hamilton area of California. The larval habits are similar to those of *P. nitidus* and *P. decussatus* as reported by Chemsak and Powell (1964) and Chemsak (1965). *P. tysoni,* n.sp. will key out to *P. nitidus* in Linsley's (1964) key to *Phymatodes* but may be separated by the characters in the diagnosis below.

This study was carried out during a National Science Foundation sponsored study on North American Cerambycidae (Grant DEB-8015523). We wish to thank J. Cope and W. Tyson for making their specimens available for study and Carolyn Tibbetts for preparing the illustration.

Phymatodes tysoni, NEW SPECIES

Male.—Form small, a little depressed; integument shining, pale reddish brown, legs darker, elytra black behind anterior white fasciae except along suture to a little behind apices of posterior white fasciae, metasternum often infuscated, abdomen black. Head finely, sparsely punctate, thinly clothed with long erect hairs; antennae extending to about apical ⅓ of elytra, segments from sixth subopaque, clothed with very short pubescence, basal segments rather sparsely ciliate, second segment less than ½ as long as third, third about as long as fourth. Pronotum as broad as long, sides broadly rounded; disk finely, sparsely punctate, punctures smaller than those at base of elytra, sides coarsely, confluently punctate; erect hairs long, black; prosternum coarsely punctate at sides; meso- and metasternum shallowly punctate, hind coxae clothed with pale, appressed pubescence. Elytra less than 2½ times as long as broad, sides vaguely expanded behind middle; punctures sparse, moderately coarse, becoming finer toward apex; long, dark, erect hairs rather sparse; fasciae ivory-white, subglabrous, anterior pair arcuate, usually oblique on disk, posterior pair oblique, slanting posteriorly from near suture at middle; apices rounded. Legs slender, femora strongly clavate, sparsely punctate, long, erect hairs numerous. Abdomen shining, sparsely punctate and pubescent; last sternite slightly emarginate at apex. Length, 5–7 mm.

Female.—Form similar. Antennae extending to a little beyond middle of elytra. Pronotum with sides rather finely punctate; prosternum finely punctate at sides. Legs with femora more slender. Abdomen with last sternite rounded at apex. Length, 5–8 mm.

Holotype male, allotype (California Academy of Sciences) and 26 paratypes (11 males, 15 females) from Arroyo Mocho Canyon, Alameda Co., California, reared from *Juniperus californicus,* 25, 30 March, 1972 (W. H. Tyson). Additional paratypes: 20 males, 20 females, Arroyo Bayo, Mt. Hamilton, Santa Clara Co., Cal-

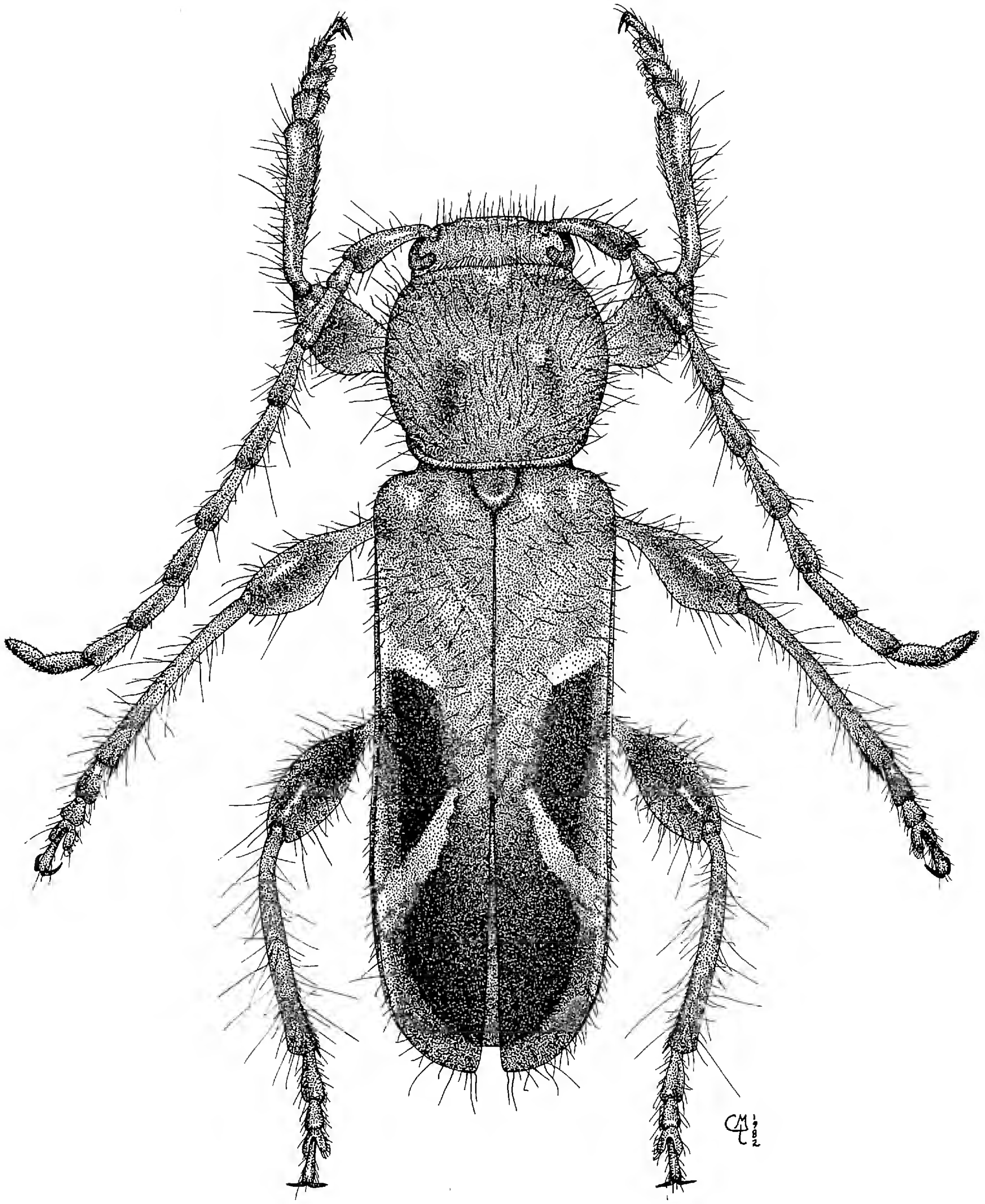

Figure 1. *Phymatodes tysoni* Chemsak and Linsley. ♂.

ifornia, reared from *Juniperus californicus,* 20 March, 1979, 14, 21 March, 1981 (J. Cope); 2 males, 7 mi NW Bitterwater, San Benito Co., California, 10 April, 1967, ex *Juniperus* (J. A. Chemsak); 8 males, 8 females, Isabelle Valley, Santa Clara Co., California, 3 April, 1981 (J. Cope).

The type series is fairly uniform in coloration. Occasionally the pronotum is partially infuscated and the legs are black.

P. tysoni may be separated from *P. nitidus* LeConte by the arcuate, oblique anterior fasciae of the elytra. These are transverse in *P. nitidus.* Additionally the posterior fasciae begin at the middle of the elytra and extend back obliquely in *P. tysoni.* In *P. nitidus* this pair has its apices at the apical ⅓ of the elytra and are less oblique. The punctation of the pronotum in *P. tysoni* is finer than that at the base of the elytra. The punctures in *P. nitidus* are subequal.

We are pleased to dedicate this species to W. H. Tyson for his continuing cooperation on this project.

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A New Species of the Genus *Chinessa* Usinger and Matsuda, 1959, from Papua New Guinea (Hemiptera: Aradidae)

NICHOLAS A. KORMILEV

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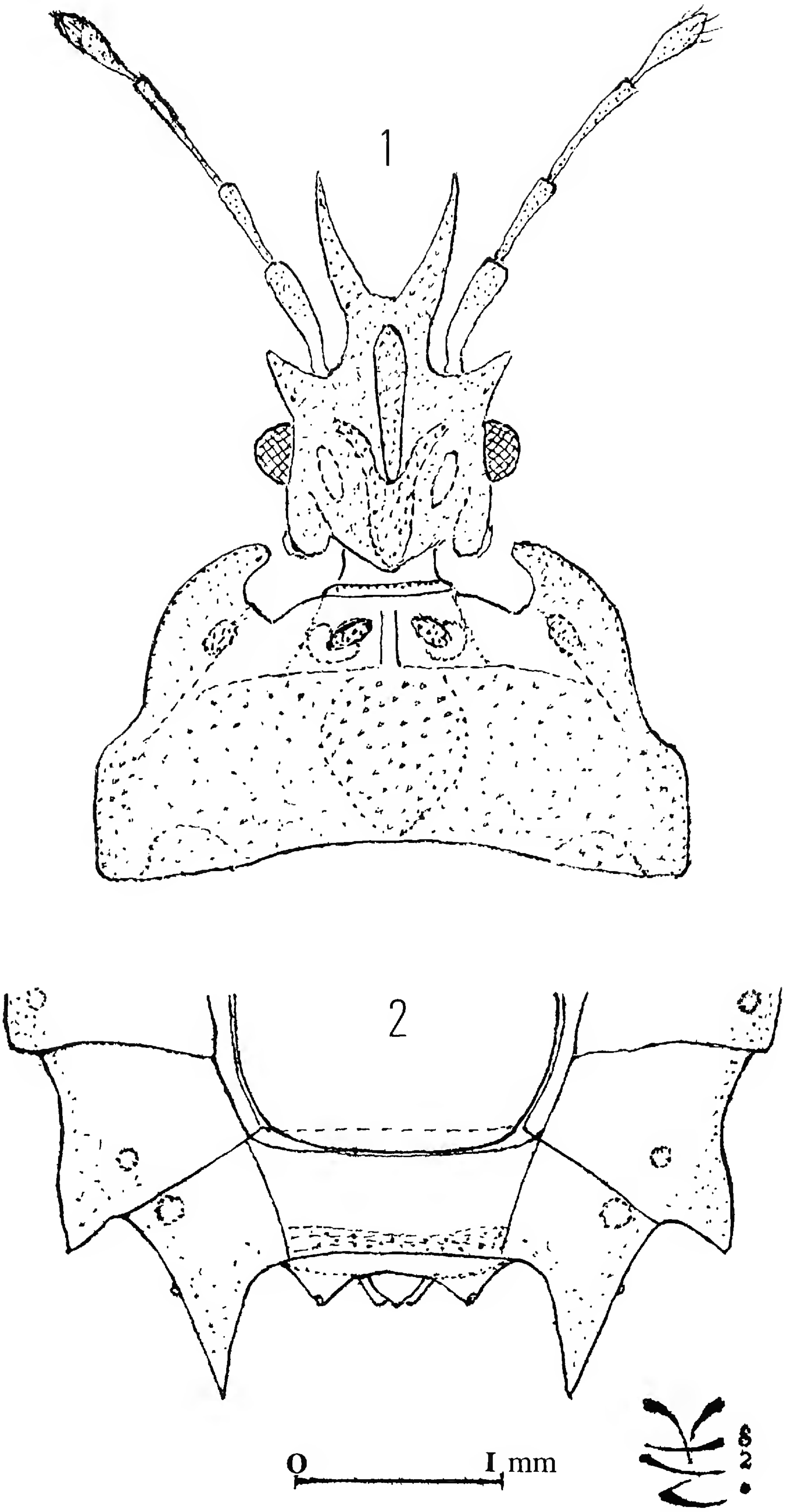
For the privilege of studying a small lot of Aradidae from Papua New Guinea and the Bismark Archipelago, I am sincerely grateful to Paul H. Arnaud, Jr., California Academy of Sciences, San Francisco. The material included a new species of *Chinessa* Usinger and Matsuda, the description of which follows.

The genus *Chinessa* is unusual in that it has a large number of endemic species that are recorded from New Guinea. Of the 22 known species, all but two are from this area, with one each otherwise known from New Britain and Ceram. The genus *Chinessa* more than any other genus of Mezirinae shows specific diversity—particularly in the size and the shape of genae, in the shape of the anterolateral angles of the pronotum, and in the shape of the lobes of the sixth and seventh abdominal segments.

All measurements in this paper were taken with an ocular micrometer, 25 units equal 1 mm. For convenience, the length of the abdomen was taken from the apex of the scutellum to the tip of segment IX and to the tips of the lobes of segment VII.

Chinessa arnaudi Kormilev, New Species
(Figs. 1, 2)

Female.—Elongate, ovate, partially granulate; fore lobe of pronotum laterad of inner tubercles smooth and shiny. *Head* (inclusive of genae) much longer than its width across eyes (48:33); anterior process strongly forked; genae pointed and divergent, much longer than clypeus and reaching ¾ of antennal segment II. Antenniferous tubercles acute and divaricate; postocular consisting of two granules placed one over another and directed backward. Eyes strongly protruding. Vertex raised and granulate. Antennae 1.73 times as long as width of head across eyes; relative lengths 15:13:16:13. Labium not reaching hind border of labial groove, which is closed posteriorly. *Pronotum* less than half as long on median line as its maximum width (32:72). Collar truncate anteriorly; anteriolateral angles produced forward and inwardly, leaving a deep incisure between them and collar. Lateral border rounded on fore lobe, then sinuate and subparallel on hind lobe; hind border sinuate medially. Fore disc with a short median sulcus flanked by 2 (1 + 1) high tubercles; laterad of them smooth and shiny; 2 (1 + 1) smaller tubercles placed sublaterally. Hind disc roughly granulate. *Scutellum* shorter than its basal width (35:40); lateral borders straight and carinate; basal border convex and carinate; median carina thin and high, granulate; disc laterad of it sharply, transversely rugose. *Hemelytra* reaching fore border of tergum VII; corium reaching basal ⅓ of connexivum III; its apical angle acute, apical border straight and only at inner angle sinuate. *Metathoracic scent gland* openings small, moderately gaping. *Legs* unarmed. *Abdomen* ovate, shorter on median line than its maximum width across



Figures 1, 2. *Chinessa arnaudi*, n. sp., ♀. 1. Head and pronotum. 2. Tip of abdomen from above.

segment V (85:95), but longer to the tips of lobes of segment VII (100:95). Connexivum wide, with uneven and punctured upper surface. Tergum VII raised backward and granulate, its hind border truncate; tergum VIII short and wide, but less than width of head across eyes (27:33). Lateral borders slightly convex from II to V; posteroexterior angles III to V progressively protruding; VI forming acute lobes, directed obliquely backward; VII forming long, acute lobes directed backward and produced far beyond segment IX. Paratergites small, conical, as long as the slightly tricuspidate segment IX. Spiracles II to VI ventral, placed far from border; VII placed near the border and slightly visible from above; VIII dorsolateral. *Color* black; hind lobe of pronotum and connexivum sepia brown; labium and tarsi brown.

Total length.—8.08 mm to tip of segment IX; 8.68 mm to tips of lobes of segment VII; width of pronotum 2.88 mm; width of abdomen 3.80 mm.

Holotype.—♀, Papua New Guinea, Morobe District, Forestry Road north of Wau, 9.X.1969 (James E. Tobler). Deposited in the collection of the Department of Entomology, California Academy of Sciences, type no. 14029. It is a pleasure to dedicate this curious species to Dr. Paul H. Arnaud, Jr. He has kindly made available to me the Aradidae under his care for many years.

In my key to *Chinessa* (1971:117) *C. arnaudi,* n. sp. runs to *C. forfex* Kormilev, 1971, but may be separated from it by: smaller size; genae relatively shorter, reaching only to ¾ of antennal segment II (longer than segment II in *forfex*); posteroexterior angles of connexivum VI produced into acute lobes (not produced in *forfex*); antennae relatively shorter, only 1.73 times as long as width of head across eyes (1.8 in *forfex*).

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Biology of the Thatching Ant *Formica haemorrhoidalis* Emery (Hymenoptera: Formicidae)

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The *rufa* group of the genus *Formica* has several species with high population densities and extensive foraging areas, which makes them very important in ecosystems. The six species present in Europe have been extensively studied. The biologies of the more than 20 species that occur in North America are almost unknown. Preliminary investigations have been done by McCook (1884), Cole (1932), Weber (1935), Ayre (1957), and Talbot (1959, 1963, 1972).

Here we present the biology of *Formica haemorrhoidalis* Emery, a species of the *rufa* group which occurs in southern California, USA. *Formica haemorrhoidalis* is a typical member of the *rufa* species group. It is distributed throughout the higher great plains and mountains of western North America (Brown, 1965) including North and South Dakota, Colorado, Utah, Washington, eastern Nevada to the western slopes of the Sierra Nevada Mountains (Creighton, 1950) south to the mountains of southern California (MacKay and MacKay, unpublished).

METHODS AND MATERIALS

The study area was located in the San Bernardino Mountains of southern California, USA, on the north side of Bluff Lake at 2100 meters. The vegetation consists of yellow pine (*Pinus jefferyi* Grev. and Balf.) and fir (*Abies concolor* (Gord. and Glend.) Lindl.). The ants are absent on highly exposed sites and on south facing slopes, but generally occur in clearings within the coniferous forest.

Nest populations were estimated by complete excavation of five nests located outside of the study area. We were also able to determine the population distribution within each nest as well as the nest structure and collect the inquilines. The process of complete excavation of each nest required approximately 100 hours. Each excavation was begun before sunrise to reduce the numbers of foragers not counted. All of the individuals seen were captured and counted, as well as the brood and inquilines. The populations of nests within our study area were visually estimated, based on comparisons of activity, size, etc. with the five nests we excavated.

Nest density was determined by delimiting a six hectare area and labeling all of the nests with numbered aluminum tags. The area was examined weekly to determine the movement of nests and/or formation of new nests, which were also marked.

The movement of winged females and males was observed by individually marking them before the mating flights, with combinations of three different colored dots on the thorax (using Testor's model paint).

Foraging activity was determined by surrounding two nests with sheet metal buried to a depth of about 10 cm, with about 20 cm above ground. Few ants attempted to cross the enclosure so it was not coated with tanglefoot or similar materials. Two plastic tubes (6 cm length, 2 cm diameter) were placed in the sheet metal at ground level for the entrance and exit of the ants. The longer end of each tube was about one centimeter above the ground to prevent the foragers from using the wrong tube to enter or exit the nest. Every hour (day and night) and for one day each week throughout the foraging season of 1978, we collected samples of foragers by placing a glass jar under the entrance tube for one to five minutes, depending on the level of activity. The ants were counted and returned to the nest and the numbers of foragers per hour calculated. All hours are expressed in Pacific Standard Time.

Nest temperatures were measured using thermisters implanted in three different levels of the nests. Air temperatures at the soil surface were also recorded.

Results and Discussion

External nest structure.—The nesting sites consisted of domes made of "thatch" or pine needles, pieces of bark and other such materials, usually constructed adjacent to stumps or logs. This type of nest is characteristic of ants of the *rufa* species group (Ayre, 1957). Examination of 108 nests demonstrated that 59.1% consisted of thatch on logs, 37.3% of thatch on stumps, and 3.6% were constructed on the surface of the ground (MacKay and MacKay, 1982). As most of the nests were associated with logs and stumps of *Pinus jeffreyi,* the distribution of the ants may be limited by the distribution of the pines. The ant is more common in disturbed areas due to the greater availability of nesting sites.

Observations of the 108 nests show that the thatching was more commonly placed on the east side (Fig. 1). Nest construction occurred primarily in the morning on the side which was first exposed to the sun. Scherba (1958) suggested that either the ants sense temperature and build on the warmest side, or the warmer temperatures facilitate nest building over longer periods of time and at a faster rate.

Internal nest structure.—The ant population was distributed in the thatching and in chambers in logs and stumps of *P. jeffreyi,* made by termites, wood boring beetles or ants (*Camponotus* spp.). *Formica haemorrhoidalis* was able to displace the original inhabitants (MacKay and MacKay, 1982). The brood were usually placed inside the chambers and protected with thatching. The larger chambers were packed with thatching. The dryer areas under the bark and upper tunnels contained primarily adult ants and pupae. The eggs, larvae, and queen(s) were found in the lower chambers. No ants were found in the hard interior of the log or stump. Areas under the bark along the roots of stumps often contained large numbers of ants. The ants were rarely found in the soil and then only in the top 5 cm. The internal nest structure is typical of the *rufa* group (Weber, 1935; Talbot, 1971; Kloft et al., 1973).

Nest distribution and density.—The nests of *F. haemorrhoidalis* were located in clearings in the forest (Fig. 2). The only exception was nest #1678 in the lower right hand corner of Figure 2. This nest's population was very small and located in an extremely rotten stump. It may have been a remnant of an area that previously had a higher nest density which had become overgrown with trees. The colony died in the summer of 1979. The clumped nests in the clearings exchanged workers (MacKay and MacKay, in prep.).

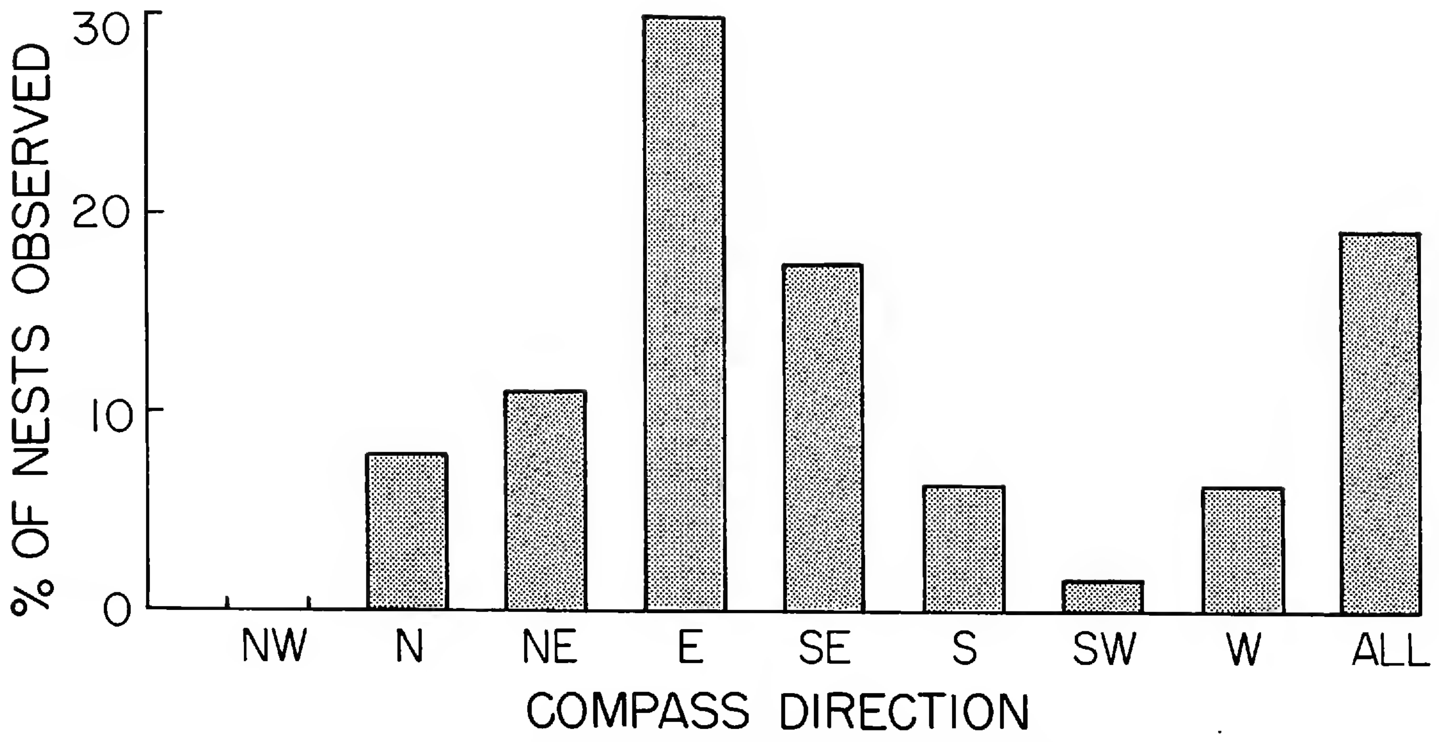

Figure 1. Distribution of thatching on the nest sites of *Formica haemorrhoidalis.*

Many authors conclude that the nests of species of the *rufa* group are spaced "fairly uniformly" or "regular" (*subnitens:* Ayre, 1957, 1959; *opaciventris:* Scherba, 1964). Scherba (1964) concluded that the regular spacing of nests is due to the spacing of suitable or preferred nesting sites or a tendency to locate budded

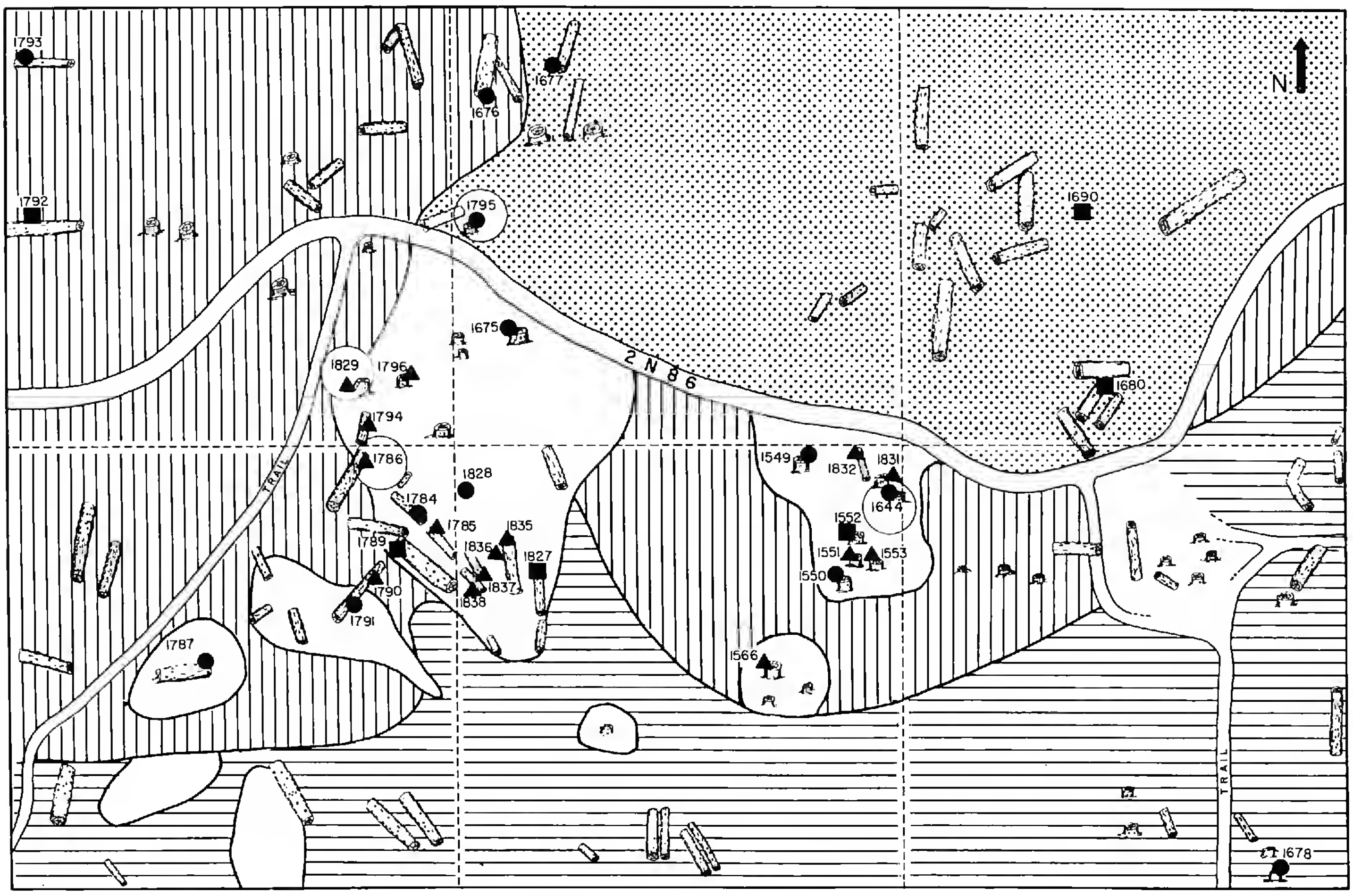

Figure 2. The 6 ha study area. Horizontal lines indicate dense woods; vertical lines, semidense woods. Stippled areas indicate rocky areas with few trees. Clear areas represent clearings. Squares represent nests with populations above 20,000 adult ants; circles, above 10,000 adult ants; triangles, less than 10,000 adult ants. Encircled nests: nests which produced sexuals in 1978. The numbers refer to the individual nests.

Table 1. A comparison of the nest populations of five *Formica haemorrhoidalis* nests.

#	Date	Type of nesting site	Adult ants	Brood
1	July 1977	Stump	27,006	10,570
2	July 1977	Log	16,419	347
3	August 1977	Log	29,681	447
4	September 1977	Log	2024	0
5	April–May 1978	Thatched dome	61,000	*

* Brood not counted.

nests at a distance from the parental nest, an expression of territoriality. Yasuno (1964) found that colonies of *F. japonica* were overdispersed where they occurred in uniform low-density stands and aggregated where they occurred in species-rich areas.

The nest density within the six hectare study area was 5.7 nests/ha. In other areas in the San Bernardino Mountains the nest density ranged from 1 to 15 nests/ha.

Populations and nest phenologies.—The mean adult worker population was 33,529 ± 9595 SE (Table 1). The data for nest #4 were disregarded in the calculation of the mean as it was apparently an incipient nest. Each nest had several queens.

Large numbers of eggs and small larvae were found in a nest excavation begun on 20 April 1978. Apparently, the queen began laying sometime before then. The last snowfall occurred on 17 April and much of the area was still covered with snow at the time excavation was begun. By the first part of July the brood population reached its peak (Table 1). In late summer and fall there were few or no brood in the nest.

Reproduction and nuptial flights.—The nuptial flights of *Formica* spp. are seldom seen (Donisthorpe, 1927). In *F. haemorrhoidalis,* the first winged females were seen and captured at 0900 on June 4, 1978. Others were captured on June 6 between 0800 and 0900 and July 9, 1978 at 1400. During these days the females briefly exited the nest and then reentered it. The nuptial flights began on July 17 and ended on July 23 during both summers. The first sexuals appeared at 0700. Certain conditions of temperature and sunlight act as stimuli to initiate mating flights (Ayre, 1957). On rainy days or after 1000 when the air temperature at the soil surface was above 24°C the sexuals remained inside the nests.

The same individuals made several trips in and out of the nest before the flight, appearing each morning until they finally flew. Workers usually ignored them, but occasionally a worker would attempt to follow a female, capture and wrestle with her, but she always escaped and continued moving away from the nest. The males were more cautious than the females. When they exited from the nest, they either immediately flew or rapidly returned to the nest.

Both sexes climbed plants or other objects before flying. They usually flew upward in a spiral path until they were above the pine trees and then flew north. The females completed more spirals to reach the top of the trees, possibly because they were larger and heavier than the males. The workers encouraged the sexuals to climb vegetation and fly by biting their legs and gaster.

Only a few sexuals left the nests each day. We could not find a swarming area. One pair was observed to copulate in the air: A male on a nest flew directly to a female which was flying nearby and captured her at an altitude of three meters. Both fell to the ground and continued copulation.

After mating, the females landed on objects such as trees and vegetation near established nests (occasionally they landed on the investigators). After a few seconds they flew to the nest surface and entered the nest with no interaction from the workers of the nest.

During the nuptial flight, nest queens also emerged and took up positions on high objects, presumably waiting for males to reinseminate them, as was reported by Marikovsky (1961). We did not observe mating in such females.

Apparently only a small portion of the nests in the six hectare study area produced sexuals. In 1978, sexuals were observed leaving only nests #1644, 1786, 1795, and 1829 (Fig. 2, encircled nests), 12% of the nests in the study area. All of the other nests in the study area were checked each day. Surprisingly it was the smaller and not the larger nests that produced sexuals (Fig. 2). Two of the nests (#1795 and #1829) were less than a year old. Nest #1644 produced sexuals during both 1977 and 1978. Sexuals emerged from each of the nests in the study area at the same time.

Each nest apparently produced only a few reproductives. In 1978, we captured and marked 11 females and 12 males from nest #1644; 46 females and 4 males from nest #1786; 15 females and 11 males from nest #1795, and 71 females and one male from nest #1829. Certainly we did not capture all of the reproductives, especially the males, but our evidence indicates that few are produced in this species. Most ant species produce large numbers of reproductives (MacKay, 1981). As the mated queens of *F. haemorrhoidalis* are allowed to enter established nests, the mortality rate would be much lower than that which occurs in other species where the females must individually found new nests. In 1978, at least 143 females were produced in the 6 ha study area and 11 were seen to enter established nests. There were undoubtedly more females that entered nests which we did not observe, because we could not observe more than two nests at any one time.

Nest formation.—Ant species which practice secondary pleometrosis (mated females enter established nests) usually practice a form of nest formation referred to as "budding." It is simply an emigration of part of a nest to a new nesting site. When workers locate a suitable site, they begin to carry other individuals to the new site. Within a few days there is considerable movement of carried individuals from the "mother" nest to the "daughter" nest. The winged females of *F. haemorrhoidalis* are carried in the same manner as the workers, but are heavier and more difficult for the workers to carry. The males refuse to be carried and have to be dragged to the new nesting site.

We observed the formation of two permanent nests by budding. The first one began on September 10, 1977, and was completed by October 10, 1977, at a distance of 27 meters from the mother nest. The second one occurred around July 17, 1978, at a distance of 23 meters from the mother nest.

The process creates some confusion or conflict as individuals are carried in both directions. During two periods of observation (15 minutes each) on 10 September 1977, 62 and 19 workers, respectively, were carried to the "daughter" nest, while 14 and 12 were carried back to the "mother" nest. During a 15 minute period on 21 September 1977, 26 were carried to the "daughter" nest and 3 were carried back to the "mother" nest.

There is considerable interest in secondary pleometrosis and budding of nests in ants as there may be a conflict among the workers as to which shall stay with the parental queen and which shall go with the new queen (Macevicz, 1979). It would be interesting to use electrophoresis to determine the relationships of the individuals involved. Of the 11 mated females observed entering established nests, apparently only one was reentering the nest she left. The other 10 females were not marked and therefore presumably came from nests which were outside of the 6 ha study area. They were entering established nests other than those they left and thus were not "sisters" of the workers in the nest.

Movement of colonies.—Ants move the entire colony and even the nest material when conditions become unfavorable (Donisthorpe, 1927). We witnessed the movement of one nest to at least three different locations in the 1978 season. Apparently, the first location was too small; the second one was a recently cut stump which did not have chambers produced by other insects. The third location was in a shaded area. The fourth location was not found; the nest may have died. The time between the movements varied between one and two weeks. The process of moving was similar to budding. The worker ants carried all the brood and many of the coworkers. When the nest queens were moving, the ants became alert and assumed an attacking position. The process of moving lasted up to three to four days; during the process the ants did not forage. No other nests were seen to change locations in the study area in the two years of observations.

Interactions between nests.—There was considerable movement of workers between nests, especially in the spring (MacKay and MacKay, in prep.). This species showed no aggressiveness between individuals, even when we mixed workers that were collected from areas several kilometers apart. Three winged females from three different nests were placed together in a large glass jar. There was no aggression between them and one was observed cleaning the antennae and thorax of the other two individuals. They commonly engaged in trophallaxis.

Foraging.—Foraging began early in the spring when there was still snow on the ground and continued until the first heavy snowfall in the winter (May to October). The ants foraged 24 hours a day throughout most of the foraging season, with a small peak in activity about mid-morning and a much larger peak in late afternoon (Fig. 3). The number of foragers was low between 0200 and 0500 and between 1000 and 1600. Foraging did not stop during rain. When there was a full moon the ants increased their nocturnal activity, possibly due to better visibility. The radius of the foraging area extended up to 23 meters from the nest. The prey and food consisted primarily of insects and honeydew from aphids (Vielma et al., in prep.).

Daily foraging activity was apparently influenced by temperature (Fig. 3). During the hottest times of the day, most foragers were inside the nest. Ants outside the nest took refuge beneath pine cones and other objects or waited in the shade of pine trees until the afternoon when the temperature dropped.

Inquilines.—Several species of guests occurred near or inside the nests of *F. haemorrhoidalis.* Many were accidentals, but others could have relationships with the ants or other animals in the mound involving commensalism, mutualism or predation. *Formica haemorrhoidalis* is insectivorous and destroys large numbers of insects (Vielma et al., in prep.), but apparently does not harm the numerous

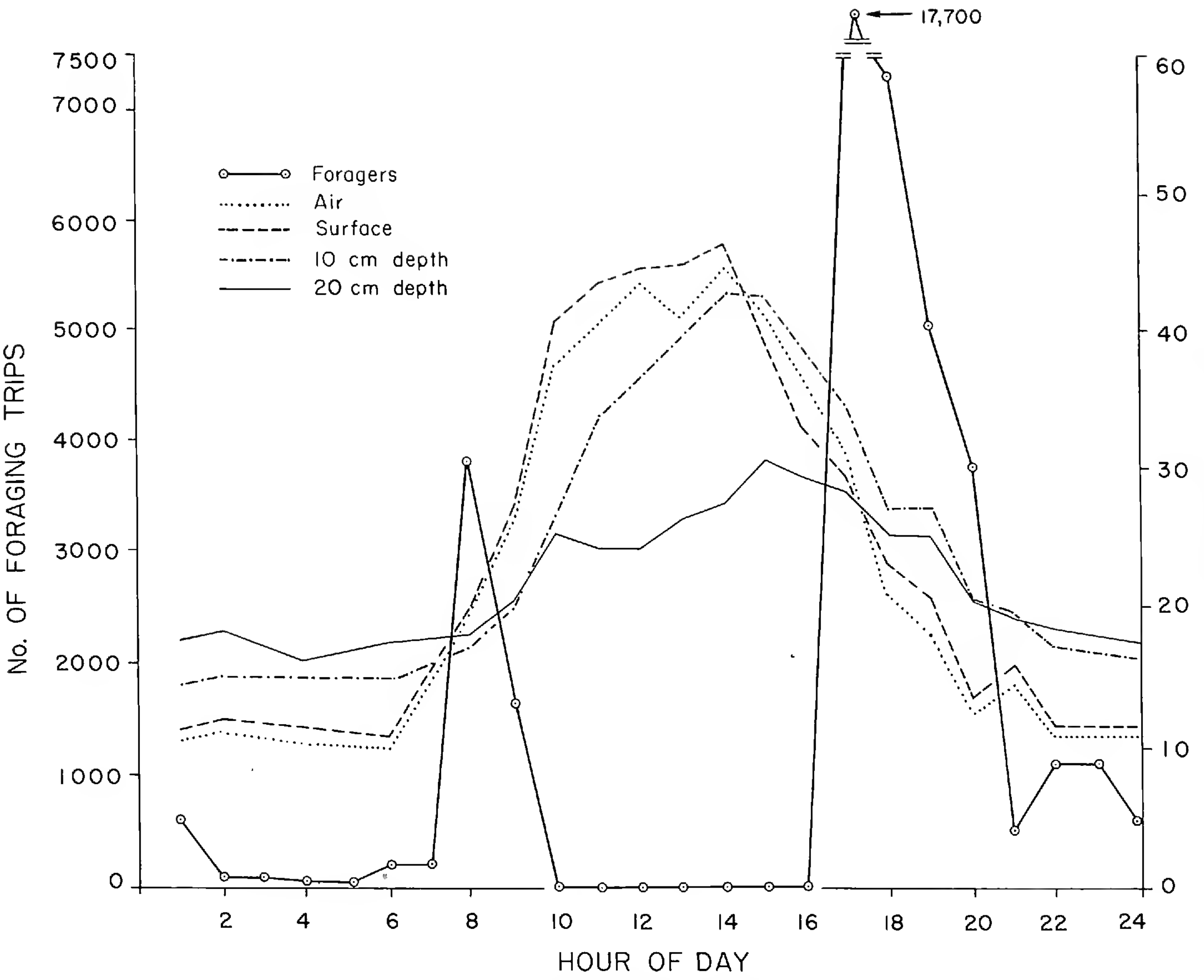

Figure 3. Daily foraging activity of a nest of *Formica haemorrhoidalis* and changes in temperature of the nest on 15 July 1978.

species of inquilines. The most common guests include various species of beetles listed by MacKay (1980). In addition we collected many *Goniusa alperti* Kistner (Coleoptera: Staphylinidae) in the nests, which also occur in the nests of *F. obscuripes* in Washington (Kistner, pers. comm.). *Myrmecophila manni* Schimmer (Orthoptera: Gryllidae) is very common within the nests. Other ant species found nesting in the domes include *Leptothorax hirticornis* Emery, *L. andrei* Emery and *L. muscorum* (Nylander), the latter being very common. A colony of *Manica bradleyi* (Wheeler) was found within one nest. Numerous unidentified spiders were also collected in the nests.

Aggressive behavior.—The workers exhibit aggressive behavior when the nest is directly attacked or disturbed, when they are collecting prey, and when they are moving the queens to a new nesting site. The adult workers lift the anterior part of their body and direct their antennae forward when approached at a distance of 30 cm. Following this, they double the gaster under the thorax and squirt a liquid containing formic acid up to 30 cm. Individuals can squirt consecutively at least twice. Repeated attack causes irritation of the skin ultimately leading to the formation of painful blisters and peeling of the skin.

SUMMARY

Studies of the biology of *Formica haemorrhoidalis* Emery were conducted in the San Bernardino Mountains of southern California, USA. The nesting sites

were stumps or logs covered with pine needles and other plant materials. Colonies contained a mean of 33,529 adult ants. Oviposition began in early April, peak populations of brood occurred in July. Nest density ranged from 1 to 15 nests/ha. Nuptial flights occurred in July; relatively few reproductives were produced. The mated females entered established nests, but usually not the same nest they were raised in. New nests were formed by emigration of part of an established nest. Foraging occurred from May to October. The ants foraged 24 hours a day with a small peak in activity in midmorning and a larger peak in later afternoon. Numerous inquilines were found in the nests, especially beetles, crickets, and other species of ants.

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The United States Forest Service generously granted permission to conduct the investigation on property under their jurisdiction. A. Françoeur verified the identification of *Formica haemorrhoidalis*. D. Kistner, F. Andrews, and K. Cooper identified the beetles. An anonymous reviewer made many valuable suggestions in the manuscript. The research was partially supported by Sigma Xi, the Scientific Research Society of North America.

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Descriptions of the Nearctic Larvae of *Pseudosmittia gracilis*, *Mesocricotopus thienemanni* and *Heleniella* nr. *ornaticollis* (Diptera: Chironomidae: Orthocladiinae)

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The works of European chironomid taxonomists have been used extensively by their North American counterparts (Roback, 1957; Simpson and Bode, 1980; and many others). The review compilations by Pankratova (1970) and Strenzke (1950) have proved to be especially useful for the identification of the larvae of the subfamily Orthocladiinae. Because many species of this subfamily are holarctic in their distribution (Beck, 1980), specific identifications of nearctic larvae can often be made based on European descriptions. This is especially true when the measurements and morphological characters of North American larvae are congruent with those of European specimens, as in *Pseudosmittia gracilis* Goetghebuer. Specific identifications can also be made when the larvae are extremely distinctive and the genus is monotypic as in *Mesocricotopus thienemanni* Brundin.

The specimens for this study were collected in conjunction with U.S. Geological Survey water resource projects. The descriptions that follow are the first that are complete for the larval stages and also the first that are based on nearctic specimens. The diagnoses should be useful in water quality investigations. Unless otherwise noted, the measurements in the descriptions are means expressed in microns. The terminology follows Saether's (1980a) glossary.

Pseudosmittia gracilis Goetghebuer

Diagnosis.—The larvae of the genus *Pseudosmittia* Strenzke can be distinguished from those of all other nearctic Orthocladiinae by the following combination of characters: procerci absent; seta interna of mandible absent; antennae reduced with segment I short and square; SI and SII bifid with equal rami; semiterrestrial habitat. The larva of *P. gracilis* differs from the other known species of the genus in these characters: anal tubules hemispherical; mandible with 4 subequal inner teeth; antennal blade as long as segment I; premandible with 2 inner lobes and 2 sharp teeth (Fig. 1). Examined larvae ($n = 4$) were collected from Bitter Creek near Fort LaClede, Wyoming on November 4, 1976.

4th instar larva.—Head capsule brown with darker mouth parts and occipital margin. Body gray-white. Total length of larva about 3.3 mm.

Head.—Length about 330, width about 265; eyespots large, single. Mentum with 11 teeth in shallow arc; median tooth with center peaked; width: 103. Ventromental plates thin, short and curving to the base of mentum. Mandible with 4 short lateral teeth and a peg-like seta subdentalis; length: 113. Premandible bent at a right angle with 2 blunt inner lobes and 2 long sharp teeth; apical tooth light colored; length: 63. Antenna reduced, 3-segmented with blade about as long as

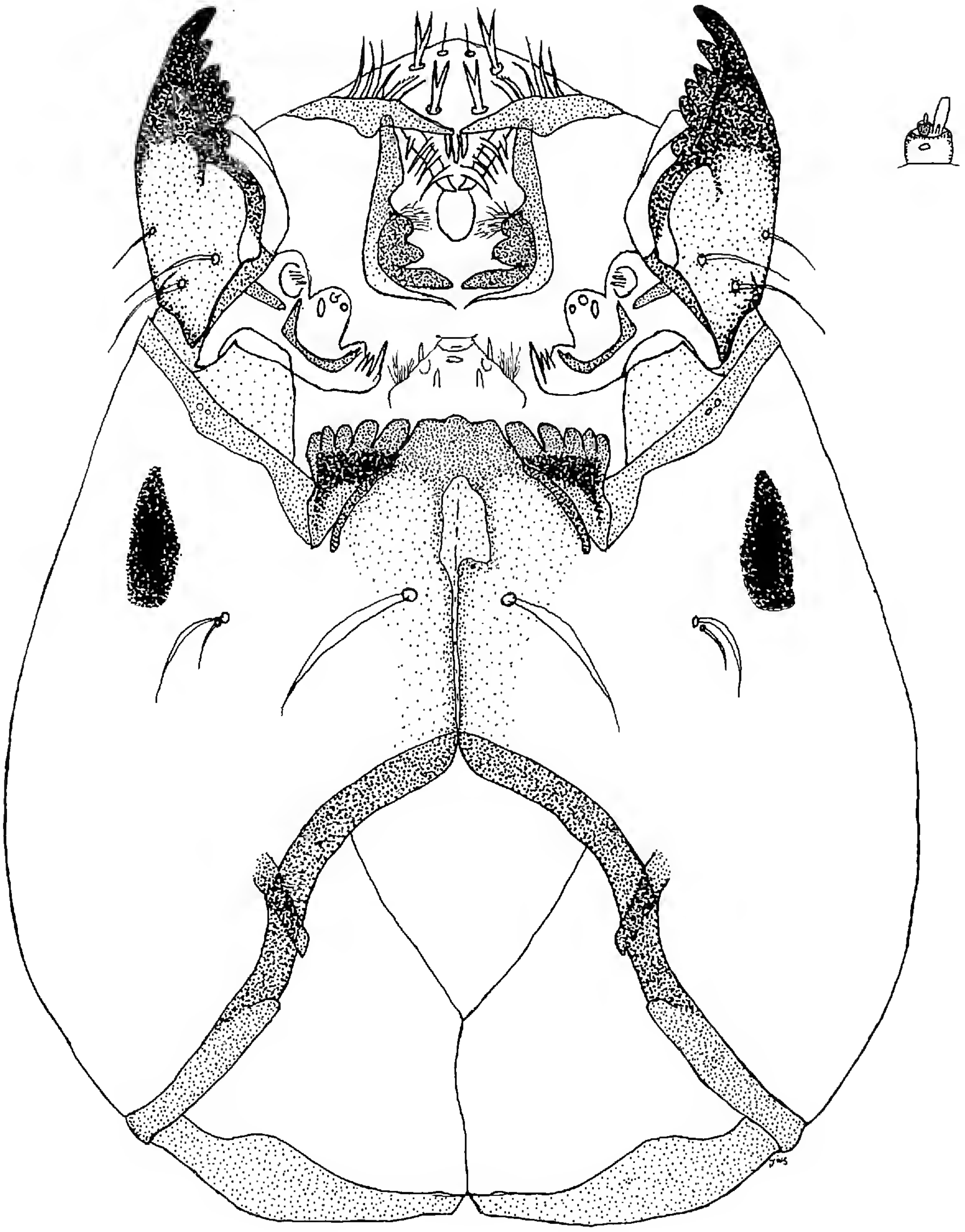

Figure 1. *Pseudosmittia gracilis* fourth-instar larva. Head, ventral aspect. Inset: antenna.

first segment; length of segments: 10:3:1; 1st segment about as wide as long with a large ring organ. Epipharynx with SI and SII bifid with equal rami; pecten epipharyngis consists of 3 small teeth.

Body.—Procerci absent. Posterior parapods reduced, each with 6–8 small yellow claws. Anal tubules hemispherical. Body segments without setae.

The larva of this species has been described and partially illustrated by Thienemann (1944), Strenzke (1950) and Pankratova (1970). It has not previously been reported from North America. Because they are usually terrestrial, the larvae of *Pseudosmittia gracilis* are seldom found in streams except after torrential rains or cave-ins. Although at least nine species of this genus are described in European literature, *P. setavena* (Saether, 1969) is the only described (adult stages) nearctic species. A larva designated as "*Pseudosmittia* group" was keyed and pictured by Oliver et al. (1978).

Mesocricotopus thienemanni Brundin

Diagnosis.—This is a monotypic genus that can be differentiated from other nearctic Orthocladiinae by these characters: Antennae 5-segmented with segment III very short and square; antennal blade exceeds antennal apex; ring organ at about 0.4 of segment I; premandible simple with a clear inner lobe; mandible with 3 small inner teeth and a smooth subdental margin; mentum with 12 dark teeth with median teeth very large and laterally indented (Fig. 2). Examined larva was collected from Sikolik Lake, Alaska on July 7, 1977.

4th instar larva.—Head capsule light brown with dark brown mouthparts. Body light tan. Total length of larva 5.9 mm.

Head.—Length about 335, width about 260. Mentum dark brown with 12 teeth; median teeth very large with lateral indentations; sides of mentum nearly parallel; width: 110. Ventromental plates very thin and curving to basal lateral corners of the mentum. Mandible with 3 small subequal inner teeth and a short clear seta subdentalis; length: 93. Premandible simple and slightly bent; length: 64. Antenna with blade exceeding apex; length of segments: 30:12:2:13:4. Antennal tubercles prominent. Epipharynx with SI bifid and SII simple; pecten epipharyngis consists of 3 narrow sharp teeth.

Body.—Posterior parapods each with 14 variable light yellow claws. Procerci sclerotized each with 7–8 anal setae. Anal tubules pointed and digitate. Abdominal segments with scattered simple setae.

Chernovskii (1949) keyed this larva as "Orthocladiinae gen.? *karelica*" and stated that it was found in "lakes and rivers of Karelia, [USSR] rare." Pankratova (1970) placed this species in the genus *Limnophyes* Eaton. Saether (1980b) stated that the larva corresponds to adults described by Brundin (1956) as *Mesocricotopus.* Later in a personal communication, Dr. Saether stated that the species is *M. thienemanni* and that the larvae are ". . . found in the littoral to the profundal zones of oligo- and mesotrophic lakes." The species is apparently holarctic, but confined to boreal regions.

Heleniella nr. *ornaticollis* Edwards

Diagnosis.—The larvae of *Heleniella* Gowin are distinctive in the following set of characters: antenna 6-segmented with blade exceeding apex and segment II interrupted; premandible bifid with an inner lobe; SI plumose; mentum with 12 teeth with last lateral teeth larger than penultimates; mandible with one sharp and two blunt inner teeth (Fig. 3). The species described below has not been associated with adults and no other larva of this genus has been described from North America. Therefore a specific diagnosis is not possible. Examined larvae ($n = 7$) were collected from an unnamed creek near Huntingdon, Utah on June 7, 1977.

4th instar larvae.—Head capsule yellow with cinnamon brown mouth parts. Body gray-white. Total length of larva about 5.2 mm.

Head.—Length about 340, width about 250. Mentum with 12 unicolorous teeth; median teeth tallest with a distinctive U-shaped notch between them; 4th lateral teeth recessed between 3rd and 5th laterals; width: 90. Ventromental plates with anterior margins overlying the bases of the 2nd and 3rd mental teeth. Mandible with apical tooth and first inner tooth sharply pointed; subdental seta small; length: 80. Premandible bifid with a blunt inner lobe; length: 67. Antenna 6-segmented

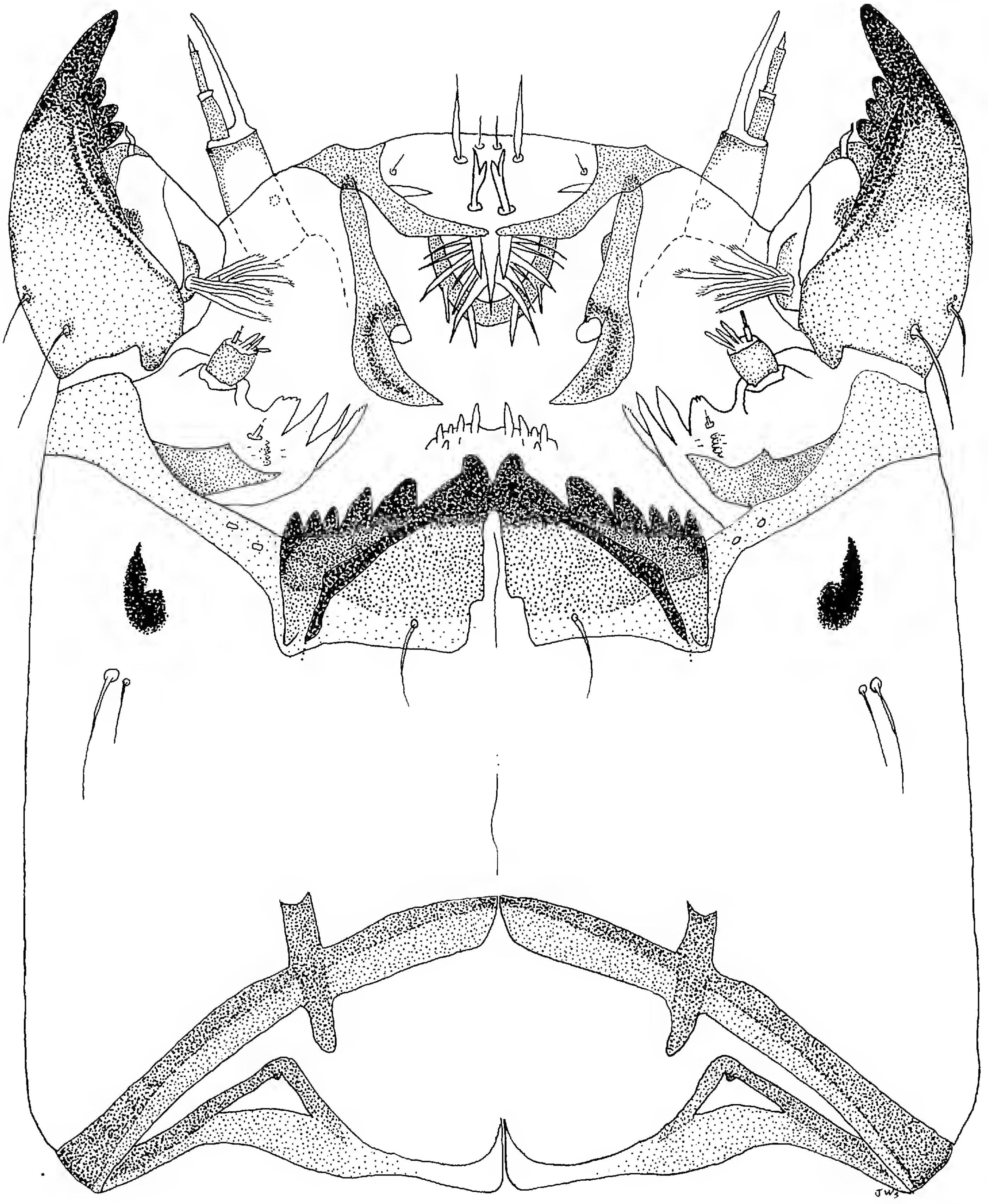

Figure 2. *Mesocricotopus thienemanni* fourth-instar larva. Head, ventral aspect.

with blade exceeding apex; segment II interrupted at about 0.2; segment VI threadlike and difficult to see; length of segments: 48:23:6:5:3:2. Epipharynx with SI plumose with 6–8 short points; SII simple; pecten epipharyngis consisting of 3–5 blunt lobes.

Body.—Procerci short, yellow and sclerotized, each with 8–10 anal setae. Posterior parapods each with 16 clear simple claws. Anterior parapods each with 60–90 mostly pectinate yellow claws.

Epilithic diatoms such as *Synedra* and *Cymbella* were found in the guts which

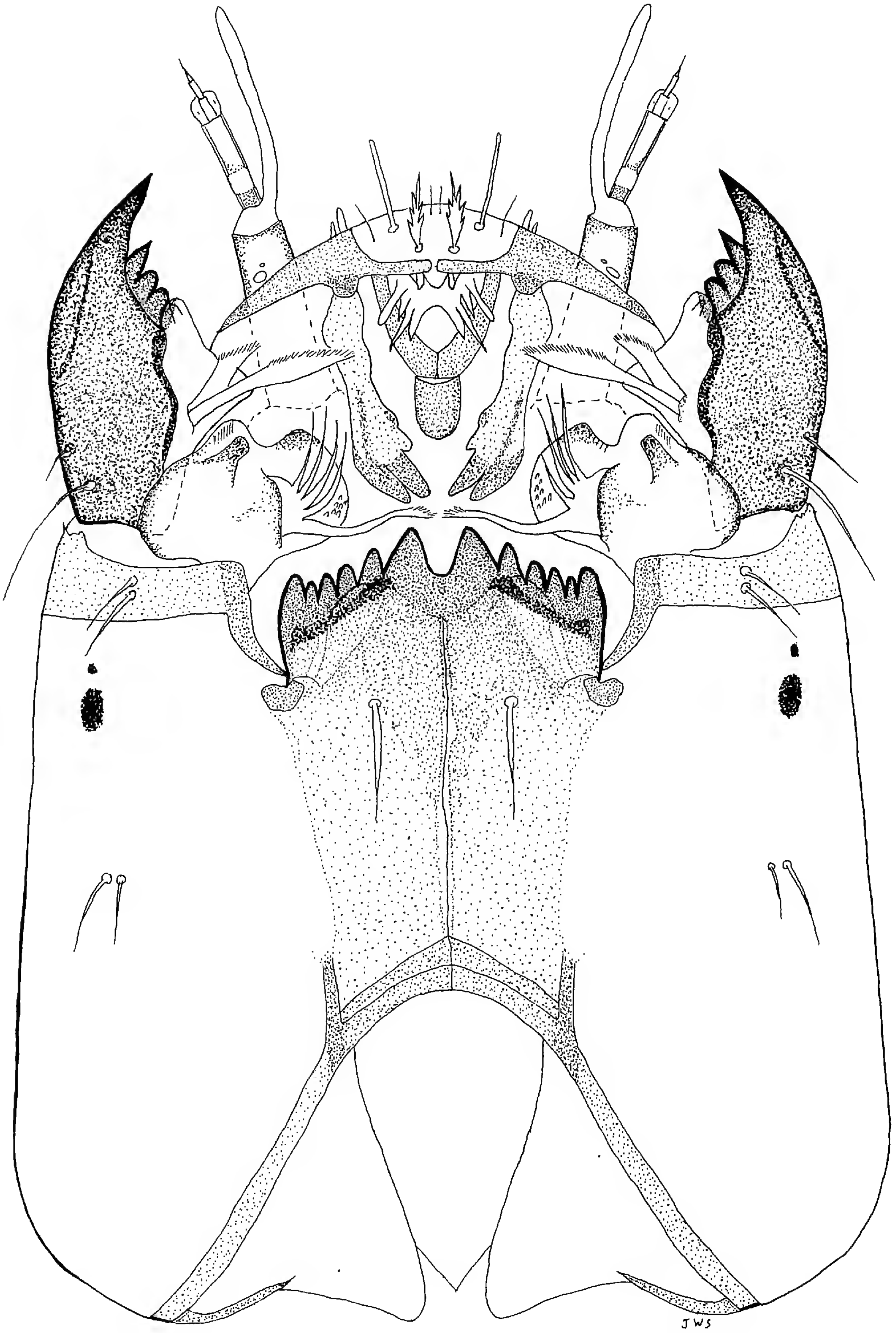

Figure 3. *Heleniella* nr. *ornaticollis* fourth-instar larva. Head, ventral aspect.

explains the worn condition of the mouthparts of most larvae. Saether (1969) described *Heleniella curtistyla* and *H. hirta* from adults and pupae collected in Canada. The larvae described here may correspond to either of these species or to an unknown species. The specimens appear to be very similar to *H. ornaticollis* as keyed and illustrated by Cranston (1979). *Heleniella* larvae are found primarily in boreal or montane streams.

All specimens are deposited in the U.S. Geological Survey National Water Quality Laboratory permanent collection in Doraville, Georgia.

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Meridic Diet for Rearing of the Host Specific Tropical Wood-borer *Plagithmysus bilineatus* (Coleoptera: Cerambycidae)

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Abstract.—A synthetic diet was successfully developed to rear *Plagithmysus bilineatus,* a host specific tropical wood-borer. Host material incorporated into the diet stimulated 1st instar larval feeding immediately after eclosion. The basic diet was also used to rear *Plagithmysus funebris, Plagithmysus varians, Phoracantha semipunctata, Curtomerus flavus, Placosternus crinicornis,* and *Sybra alternans.*

The tropical wood-borer *Plagithmysus bilineatus* Sharp is an endemic pest associated with the decline of ohia-lehua (*Metrosideros polymorpha* Gaudichaud) on the island of Hawaii (Papp et al., 1979). Concern for potential impact on the ohia ecosystem prompted biological studies that necessitated rearing *Plagithmysus* on artificial diet.

Several modifications of Adkisson's et al. (1960) diet for the pink bollworm, *Pectinophora gossypiella* (Saunders), have been used to rear wood-borers. Harley and Willson's (1968) modification was developed for rearing the lantana borer, *Plagiohammus spinipennis* Thomson, and Gardiner (1970) incorporated pulverized plant material into his version to successfully rear temperate species of cerambycid borers. We used both diets in Hawaii to rear adult beetles from larvae collected in the field up to 40 days prior to pupation. However, our efforts to rear the 1st instar larva on these diets were unsuccessful.

This paper reports yet another modification of the diet developed by Adkisson et al. (1960) for the pink bollworm. The modified diet, which is easier to prepare, differs from Adkisson's diet in several ingredients. It has proven useful in laboratory cultures of *Plagithmysus bilineatus* and several other endemic and introduced cerambycids.

PREPARATION

To prepare 1500 ml of the diet (Table 1), first add agar to 900 ml of distilled water in a 1000-ml beaker and bring to a boil. After the agar dissolves, pour the solution into a large Waring Commercial Blender (CB-6) and slowly add peptone, Vanderzant Adkisson Wheat Germ Diet (ICN Pharmaceuticals, Inc.) and 15 g of ohia-lehua sawdust.[1] Blend for 2 minutes at low speed. Then pour the mixture

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[1] Trade names and commercial enterprises or products are mentioned solely for information. No endorsement by the U.S. Department of Agriculture is implied.

Table 1. Composition of the Meridic diet used to rear *Plagithmysus bilineatus* with quantity of ingredients per 1500 ml of media.

Ingredients	Quantity
Water	1260 ml
Agar	70 g
Vanderzant Adkisson Wheat Germ Diet	187.5 g
Sawdust	15 g
Peptone	3 g
Inhibitor:	
Ethyl alcohol (95%)	16.6 ml
Sorbic acid	2 g
Methyl p-hydroxybenzoate	1.4 g
Potassium hydroxide (KOH)	3 g
Vanderzant Modification Vitamin Mixture	75 g

from the blender into three 1000-ml beakers, cover with foil, and autoclave for 15 minutes at 15 psi. While the wheat germ and sawdust mixture is in the autoclave, mix the alcohol, sorbic acid, methyl p-hydroxybenzoate, potassium hydroxide, and Vanderzant Modification Vitamin Mixture (ICN Pharmaceuticals, Inc.) into 360 ml of distilled water until they dissolve. Remove the agar mixture from the autoclave and cool to 50°C, then add the antimicrobial-vitamin solution to the agar and mix in the blender for 2 minutes at low speed. Pour liquified diet into 9 × 50 mm petri dishes with snap-tight lids or 16 × 100 mm disposable petri dishes until three-fourths full. The petri dishes can be stored in the refrigerator until needed.

The *Plagithmysus* diet, compared with that of Adkisson, deletes the antimicrobial butyl p-hydroxybenzoate and adds linseed oil, cholesterol, and ascorbic acid—which are in the wheat germ diet—and peptone, potassium hydroxide, and ohia-lehua sawdust. The incorporated sawdust stimulates feeding and improves larval acceptance of the diet immediately after hatching.

INSECT CULTURE

Eggs were obtained by caging wild-type males and females in the laboratory at 21°C. Small pieces (4 × 10 cm) of ohia-lehua bark placed on the cage floor were examined daily for eggs, which were collected and placed in small petri dishes. Immediately after eclosion, 1st instar larvae were transferred to the diet in petri dishes with snap-tight lids. As the larvae matured they were transferred to the larger petri dishes.

Plagithmysus bilineatus development time from the egg to the adult stage differed significantly between the wild-type and diet-reared specimens ($P < 0.01$). Wild-type specimens developed in an average of 269.6 days (SE 4.71) compared with 171.4 days (SE 2.31) for diet-reared specimens. Size of adults reared on the diet did not differ significantly from that of wild-type specimens ($P < 0.05$). Average dry weight of laboratory-reared adults (28.7 mg, SE 1.01) and wild-type adults (27.0 mg, SE 0.88) was similar.

Of the adults reared from the egg stage, 17% had deformed metatarsal segments. This deformity was nonexistent for those field collected larvae placed on the diet after the 2nd instar and may be indicative of some nutrient deficiency in the first two instars. Larval mortality was 37% and was attributed primarily to injury of 1st instar larva during transfer to the media.

DISCUSSION

Use of this synthetic diet will reduce the development time of *P. bilineatus* and produce laboratory-reared adults equivalent to the wild-type in size. This media has not been evaluated for effects such as fecundity, loss of host preference, or other criteria necessary for continuous laboratory rearing, but may serve as a basis for modified diets of numerous tropical woodborers.

The synthetic diet proved successful for rearing other endemic beetles when sawdust from host trees was substituted for ohia-lehua sawdust. We reared *Plagithmysus funebris* Sharp on diet containing mamane, *Sophora chrysophylla* (Salisbury), sawdust and *Plagithmysus varians* Sharp on diet containing koa, *Acacia koa* Gray, sawdust.

We also reared late instar larvae of the introduced beetles *Phoracantha semipunctata* (Fabricius) and *Curtomerus flavus* (Fabricius) on diet with *Eucalyptus robusta* Smith sawdust, and *Placosternus crinicornis* (Chevrolet) and *Sybra alternans* (Wiedeman) on diet with koa sawdust added. Late instar larvae of *Plagithmysus bilineatus,* which is host specific on ohia-lehua, also developed on the modified diet to which *Eucalyptus robusta* or koa sawdust had been added. The development of *Curtomerus flavus, Placosternus crinicornis, Sybra alternans,* and *Plagithmysus bilineatus* on diet with sawdust of nonhost tree species indicates that acceptance of the diet was not a critical factor after the 2nd instar. This agrees with observations made by Gardiner (1970).

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The Genus *Acanthodoryctes* Turner (Hymenoptera, Braconidae): Redescription and New Generic Synonymy

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The classification of many tropical genera of Braconinae has been in a state of considerable confusion for many years and is not yet fully sorted out. The Australian genus *Acanthodoryctes* Turner which belongs to the subfamily Doryctinae (see Shenefelt and Marsh, 1976) was based on *Iphiaulax morleyi* Froggatt; *Iphiaulax* itself belongs to the subfamily Braconinae. Recently, the author had the opportunity of examining the type of the Indo-Australian genus *Bispinariopsis* Fahringer which is currently placed among the Braconinae (Shenefelt, 1978) and found it to be a doryctine agreeing well with the description of *Acanthodoryctes* and all the specimens under *Iphiaulax morleyi* in the British Museum (Natural History) collections; the type specimen of *Acanthodoryctes* has not been located. Below, features of *Acanthodoryctes* are described and illustrated for the first time, and the type species of *Bispinariopsis* is transferred to this genus.

Genus *Acanthodoryctes* Turner

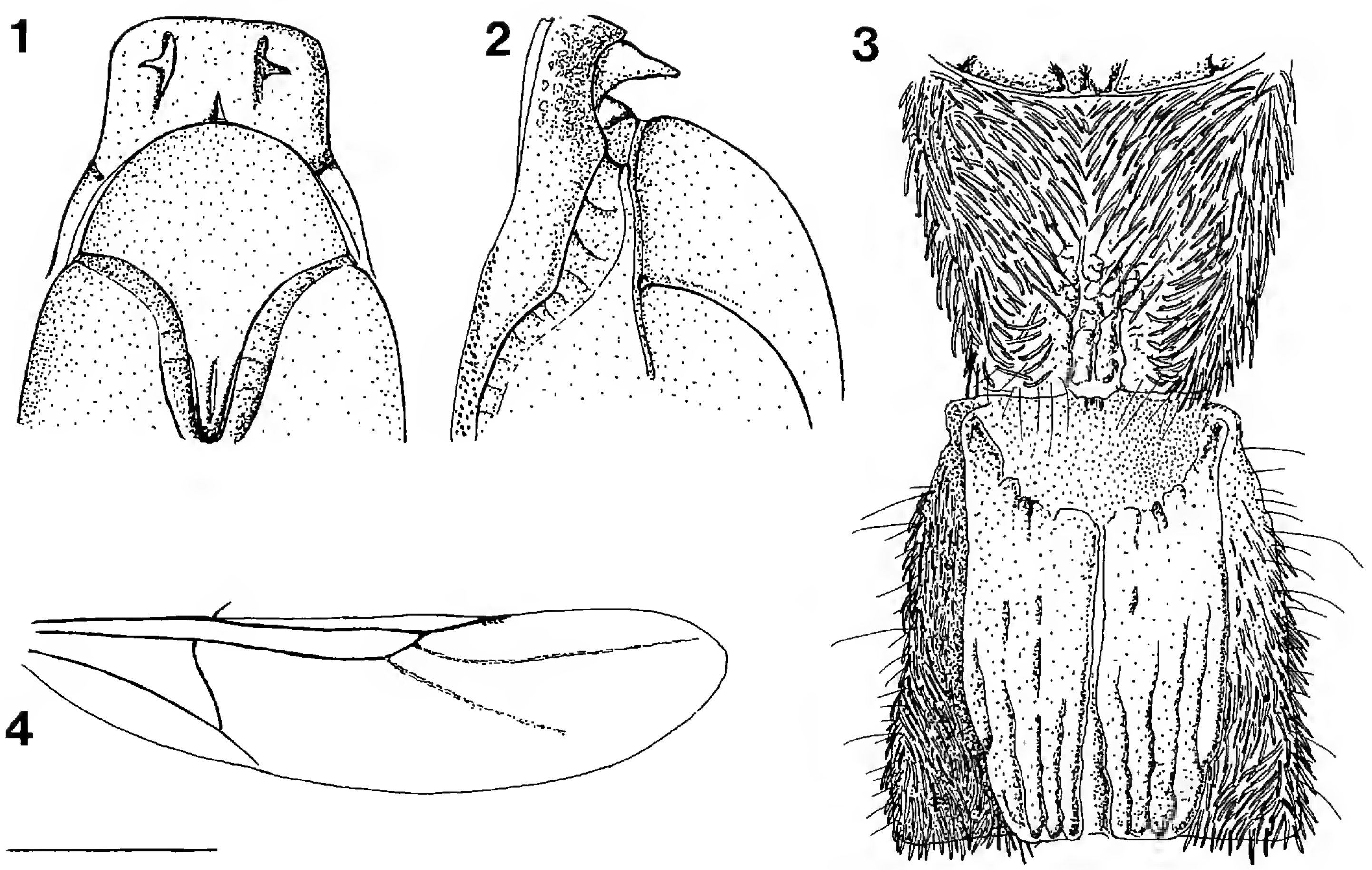
Acanthodoryctes Turner, 1918:55. Type species: *Iphiaulax morleyi* Froggatt, location of type not known. Original designation.

Bispinariopsis Fahringer, 1942:37. Type species: *Atanycolus tomentosus* Szépligeti, in Hungarian Natural History Museum, Budapest. Monobasic and original designation. NEW SYNONYMY.

Generic diagnosis.—Both sexes: Terminal flagellomere formed into a point at the apex; basal flagellomere nearly twice as long as broad; all flagellomeres longitudinally striate and longer than broad. Scapus and pedicellus short and shiny. Maxillary palp six segmented. Hypoclypeal depression deep and dorsally rounded; clypeus rugose; face in the centre smooth and raised, forming a ridge between the antennal sockets, this central area also narrowing ventrally; face irregularly, coarsely punctured laterally. Face and clypeus with long pale hairs. Frontal depression deep. Head cuboid without an occipital margin.

Pronotum produced anteriorly, margined anteriorly and dorsolaterally, within these margins (on the pronope) there are a pair of mid-lateral, longitudinal ridges which are formed into strong dorsal pointing spines, and with a short mid-posterior ridge (Figs. 1 and 2). Middle lobe of the mesonotum smooth and shiny, notauli shallow and wide with a few weak striae; posteriorly the notauli are margined on the medial side, these margins enclosing a sunken area with a median carina. Scutellar sulcus deep with approximately six crenulations. Scutellum smooth but axillae crenulate. Metanotum with three prominent medial, longitudinal carinae.

Propodeum reticulate with a pair of more prominent carinae running anteriorly



Figures 1–4. ♂ *Acanthodoryctes tomentosus* (Szépligeti) comb. n. 1. Pronope and anterior of mesonotum dorsal view. 2. Pronotum and anterior of mesothorax lateral view. 3. Propodeum and first metasomal tergite dorsal view. 4. Right hind wing. Scale bar: Figures 1–3, 1 mm; Figure 4, 2 mm.

from its hind margin. Most of the propodeal sculpture is obscured by dense, long, white, flattened hairs (Fig. 3).

Metasoma: Tergite 1 about 1½× longer than apically broad (Fig. 3), with a raised central area bordered laterally by the dorsal carinae. The lateral areas are obscured by long white hairs, the median area is generally smooth with some longitudinal striations apically. Tergites 2 to 5 with coarse foveate sculpture and with the hind margins densely covered with medially pointing white hairs. Tergite 2 with a very large, slightly raised medial area covering most of the tergum.

Wings: Forewing about ¾ the length of the thorax and abdomen combined; nervus recurrens interstitial, nervulus postfurcal, parastigma large and continuous with the basalis. Radial cell reaching the wing margin ⅔ the way between the apex of the stigma and the wing-tip. Second abscissa of the radius more than 2 × length of the first. Subdiscoideus quite well developed, nearly reaching the wing margin. First brachial cell long; second abscissa of discoideus approximately 0.6 × media. Hindwing (Fig. 4); submediellan cell large, nervellus running distally towards wing margin, basella postfurcal, postnervellus absent.

Legs: Fore femur broad, of equal length to tibia. Fore tibia with a longitudinal row of pegs ("spines" or chaetobothria), tibial spur flattened and densely setose. Middle legs with a row of weaker pegs along the tibiae. Hind femur only 3 × longer than broad; tibia slightly longer than femur; tibial spurs setose and approximately 0.3 × length of basitarsus; hind basitarsus without spines. All claws unidentate, narrow with a poorly developed basal lobe.

Acanthodoryctes tomentosus (Szépligeti), NEW COMBINATION

Acanthodoryctes tomentosus (Szépligeti), comb. nov. (=*Atanycolus tomentosus* Szépligeti; =*Bispinariopsis tomentosus*: Fahringer).

Since *A. tomentosus*, comb. nov. is the type species of *Bispinariopsis,* the latter becomes a junior synonym of *Acanthodoryctes.*

DISCUSSION

The initial placement of both *Iphiaulax morleyi* and *Atanycolus tomentosus* in the Braconinae was probably largely due to the following combination of characters:

i) Occipital carina absent (apomorphous),
ii) Second cubital cell long (plesiomorphous),
iii) Postnervellus absent (apomorphous),
iv) Tergite 1 with a raised central area,
v) Hind coxae with neither teeth nor tubercles (doubtful state)

However, *Acanthodoryctes* shows great affinities to the Doryctinae:

i) Fore and middle tibiae with a row of pegs (apomorphous),
ii) Maxillary palp six segmented (plesiomorphous),
iii) Submediellan cell long (plesiomorphous),
iv) Crenulate axillae (? plesiomorphous),
v) Head cubicoid (plesiomorphous; both cubicoid and transverse heads are found in the Braconinae),
vi) Tergite 1 of metasoma with well developed dorsal carinae (plesiomorphous).

A number of genera of Braconinae possess stout bristles or pegs on the fore tibiae (e.g. *Merinotus* Szépligeti, *Glyptomorpha* Holmgren), however in these the bristles form a large patch rather than a distinct row. The tibial pegs of the tribe Histeromerini also form a patch; this tribe has in the past been regarded as belonging to both the Braconinae and the Doryctinae (Achterberg, 1976). The present author prefers to regard the Histeromerini as doryctines on the basis of venation and the six segmented maxillary palps. The presence of an occipital carina cannot be taken as a diagnostic feature of the Doryctinae (Marsh, 1970) since it is also absent in *Liobracon* Szépligeti, *Liodoryctes* Szépligeti and *Binarea* Brullé; its loss is a widespread apomorphous feature in the Braconidae (Tobias, 1967; Papp, 1974; Achterberg, 1976). The raised medial area on the first tergite of *Acanthodoryctes* is significantly different from the area which partially characterises the Braconinae in that it is bordered by the dorsal carinae and therefore widens towards the base of the segment.

Acanthodoryctes appears close to *Liobracon* with which it shares the following characters:

i) Occipital carina absent,
ii) Head cubicoid,
iii) Pronotum with margins enclosing a deep transverse excavation (apomorphous),
iv) Converging carinae at junction of notauli (? apomorphous),
v) Hind coxae simple,

vi) Hind femora short and broad,
vii) Dense silvery hairs on side of thorax and propodeum (apomorphous).

Acanthobracon may be separated from *Liobracon* by the pronotal teeth, absence of a postnervellus and by the radiellan cell not being divided by a spurious vein.

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Filacus, A New Genus for Four Species of Sawflies Previously Placed in *Macrophya* or *Zaschizonyx* (Hymenoptera: Tenthredinidae)

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Abstract.—Filacus, a new genus, is proposed for four species of sawflies related to *Macrophya* Dahlbom and *Zaschizonyx* Ashmead and is placed in the tribe Sciapterygini of the Tenthredininae. The included species, *doanei* (Rohwer), *provancheri* (Rohwer), *pluricinctellus* (Rohwer), and *pluricinctus* (Norton), all new combinations, were previously considered as one variable species and were placed in either *Macrophya* or *Zaschizonyx.* Representatives of all species occur in California, with two also in Arizona and northern Mexico. Adults have been collected from a great variety of flowers and plants, but the only definite larval feeding records are on *Phacelia* (Hydrophyllaceae), *Amsinckia* (Boraginaceae), and *Ranunculus* (Ranunculaceae). Keys are provided for identification of adults of the genera of Sciapterygini and for adults and larvae of *Filacus.* Larvae of two species, *pluricinctus* and *pluricinctellus,* are described.

For over 30 years, a small group of sawfly species that occur in California, Arizona, and adjacent Mexico have been treated as a single taxon, *pluricincta* Norton, which was assigned either to the genus *Macrophya* Dahlbom or *Zaschizonyx* Ashmead of the subfamily Tenthredininae. Ross (1951) synonymized the 11 species existing at that time, treating them as one variable species, *Macrophya pluricincta* Norton. Benson (1959) was the first to recognize that *pluricincta* was not a typical *Macrophya* (tribe Macrophyini) and placed it in the genus *Zaschizonyx* of the tribe Sciapterygini. Smith (1979) followed Benson's decision for lack of a better placement, and Gibson (1980) also excluded the species from *Macrophya.*

After studying many specimens of "*pluricincta,*" we discovered that it consisted of four species, separable by characters of the lancet, male genitalia, hindtibial spurs, and relatively stable color patterns. Host data and larvae, though not known for all species, help to support our conclusion that four species exist. We also believe that these species cannot be assigned to any described genus, and therefore, we propose a new genus for them.

Adults of the four species separated below are rather commonly collected in California, mostly from flowers in early spring. Plants from which adults have been collected may not represent their true host plant, but larvae have been found feeding on plants of the genera *Phacelia, Amsinckia,* and *Ranunculus.* Because adults commonly visit flowers, they may play a role in pollination. Many specimens examined have parts of the body covered with pollen.

Filacus Smith and Gibson, New Genus

Type-species.—*Macrophya pluricincta* Norton.

Description.—Head evenly convex, without deep frontal or antennal furrows and without antennal tubercles. Clypeus flat, anterior margin shallowly, broadly, circularly emarginate, without acute or rounded lateral lobes (Fig. 1); labrum rectangular with front margin truncate to slightly emarginated and depressed (Fig. 1); width of malar space slightly less than ½ diameter of front ocellus; occipital carina present laterally, obsolete on upper lateral and dorsal margins of head; eyes converging below, distance between eyes below slightly less than maximum eye length; each mandible bidentate (Fig. 1). Antenna stout, length less than 1½× head width; 3rd segment nearly as long as segments 4 + 5; 1st and 2nd segments each longer than broad. Metepimeral appendage rounded, smooth; epicnemium present. Basal plates contiguous on meson, not separated nor with broad membranous area. Hindtibia longer than hindfemur; hindcoxa slightly enlarged but smaller than mesepisternum in lateral view, therefore apex of hindfemur reaches nearly to apex of abdomen; foretibial spurs slightly to distinctly curved, not straight; hindtibial spurs less than or slightly more than apical width of hindtibia (Figs. 2, 3); tarsal claw of female with inner tooth as long as and broader than outer tooth, teeth not appressed to each other, that of male with inner tooth slightly longer and broader than outer tooth and teeth appressed. Forewing with vein 2A + 3A joined to 1A basad to center of anal cell, sometimes with very short anal crossvein.

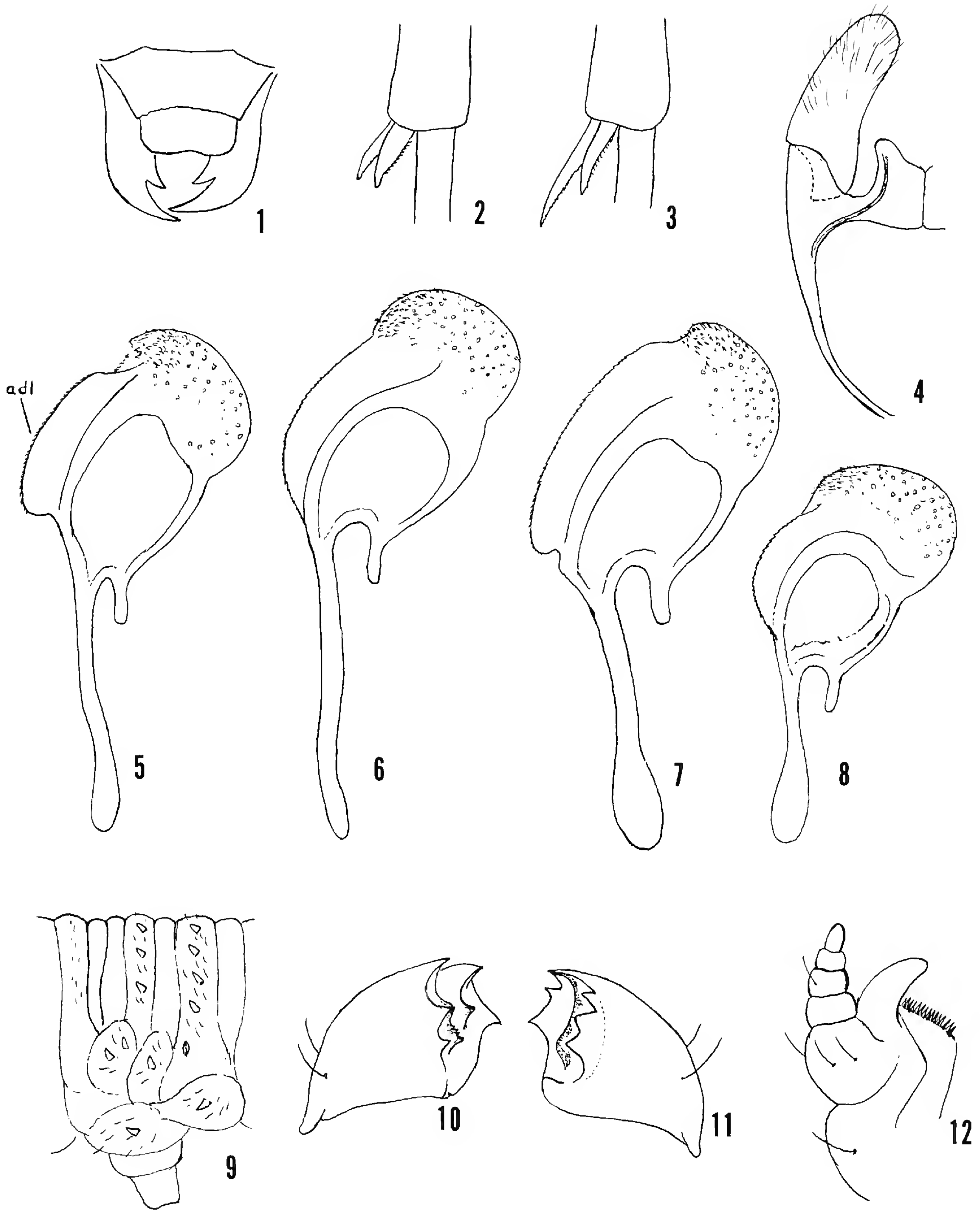
Adults of all species are rather stout sawflies, 6–8 mm long, black with various yellow markings, commonly with yellow transverse stripes on the abdomen, and with fine, uniform punctation on the head and thorax, the texture, however, subshining and not with dull surface sculpture.

Matsuda (1957) described the head morphology of "*Macrophya pluricincta,*" but we cannot determine the species of *Filacus* to which this description refers.

Larva.—Antenna conical, 5-segmented. Clypeus with 4 setae; labrum with 6 setae; mandible with 2 setae on outer surface. Maxillary palpus 4-segmented; 2nd segment with 1 seta; palpifer with 3 setae; stipes with 1 seta; lacinia with 12–13 short spines (Fig. 12). Labial palpus 3-segmented; prementum with 4 setae. Right mandible with 3 ventral teeth, 3 medial teeth, and 1 broad dorsal tooth (Fig. 10); left mandible with 3 ventral teeth, 3 dorsal teeth, and medial ridge extending basally from outer dorsal tooth (Fig. 11). Clypeus with median depression. Each thoracic leg with femur longer than trochanter. Abdominal segments 1–8 each 7-annulate (Fig. 9); tubercles and setae on annulets 2 and 4 and on each postspiracular lobe, subspiracular lobe, and surpedal lobe; 7th annulet with only short setae; prolegs without setae. Hairs present on head and setae present on thoracic legs, 10th tergum, and subanal area.

The larvae are typically caterpillar-like and feed externally.

Remarks.—Although species of *Filacus* show some affinities with members of the tribe Macrophyini, most characters support its placement in the Sciapterygini, where it was placed by Benson (1959). The evenly convex head, lack of furrows on the head, lack of antennal tubercles, presence of a metepimeral appendage,



Figures 1–12. *Filacus* spp. 1. Clypeus, labrum, mandibles of *F. pluricinctus.* 2. Hindtibial spurs of *F. pluricinctellus.* 3. Hindtibial spurs of *F. pluricinctus.* 4. Male genital capsule, ventral, of *F. pluricinctus.* 5. Male valve of *F. doanei.* 6. Male valve of *F. pluricinctus.* 7. Male valve of *F. pluricinctellus.* 8. Male valve of *F. provancheri.* 9–12. Larva of *F. pluricinctellus.* 9. 3rd abdominal segment, anterior to right. 10. Right mandible, ventral. 11. Left mandible, ventral. 12. Maxilla. adl = anterodorsal lobe.

and slightly enlarged hindcoxa are characters shared with the Macrophyini, but the following place *Filacus* in the Sciapterygini: Hindtibia longer than hindfemur, hindtibial spurs shorter than or not much longer than apical width of hindtibia, anterior margin of labrum truncate or emarginate and depressed, and occipital carina present only laterally. Four genera are currently recognized in the Sciapterygini, and *Filacus* can be separated from them by the key presented here.

Filacus is separated from *Zaschizonyx,* the only other Nearctic genus of Sciapterygini, by the following: Distance between eyes below less than eye length (subequal to or greater in *Zaschizonyx*); basal plates contiguous on meson (separated and with broad membranous area in *Zaschizonyx*); malar space less than ½ diameter of front ocellus (slightly less than diameter of front ocellus in *Zaschizonyx*); each mandible bidentate and with single cutting margin (each mandible with 5 or more teeth and with dorsal and ventral cutting edges in *Zaschizonyx*); epicnemium present (absent in *Zaschizonyx*); metepimeral appendage broad and apically rounded (narrow and acutely pointed apically in *Zaschizonyx*); and head and thorax finely punctate (impunctate in *Zaschizonyx*). *Deda* Gibson (1980), a genus in the Macrophyini, is superficially like *Filacus* and is also distributed primarily in California; however, *Deda* has quadridentate mandibles, a setiferous metepimeral appendage, an emarginate clypeus with rounded lateral lobes, a convex labrum, and small eyes, with the distance between the eyes below greater than the maximum eye length.

Larvae are known for two species of *Filacus,* but they cannot be separated from other genera because generic characters for most North American larval Tenthredininae have not been determined. They are separated from larvae of *Aglaostigma* Kirby by the presence of two setae on each mandible (one in *Aglaostigma*), and from *Sciapteryx* Stephens and *Rhogogaster* Konow by the lack of setae on the prolegs (present in those two genera). Larvae of *Macrophya* and *Tenthredo* Linnaeus may also be separated from the above three genera by the same characters, but larvae of *Macrophya* and *Tenthredo* are inadequately known, and the larva of the single species of *Zaschizonyx* is unknown. Use of characters in the above description and known host plant information may help to identify larvae of *Filacus.*

The genus name is based on the abbreviation of California spelled backwards; the gender is masculine.

Adults of the four species of *Filacus* may be identified by comparing the lancet and male valves with figures, by certain color patterns, and with the help of the key to species.

KEY TO GENERA OF THE TRIBE SCIAPTERYGINI

Adults

1. Antenna with furrow on outer side of segments 4–9 (antennal tubercles high; malar space greater than diameter of front ocellus; clypeus with central emargination and rounded lateral lobes; eyes parallel, not converging below; inner tooth of tarsal claw longer and stouter than outer tooth) (China) . . . . *Tyloceridius* Malaise

   Antenna without furrow 2

2. Eyes, scarcely converging below, far apart, lower interocular distance greater than eye length; malar space usually 2× or more diameter of front ocellus; head and thorax densely punctate and dull (antennal tubercles low) (Palearctic) . . . . *Sciapteryx* Stephens

   Eyes converging below, lower interocular distance equal to or less than eye length; malar space at most equal to diameter of front ocellus; head and thorax finely punctate and subshining or impunctate 3

3. Basal plates widely separated on meson, leaving large membranous area (distance between eyes below, subequal to eye length; malar space slightly less than diameter of front ocellus) (Nearctic) .... *Zaschizonyx* Ashmead

Basal plate contiguous on meson, without membranous area 4

4. Clypeus emarginate for ⅓ or more of medial length, with narrow rounded lateral lobes; anterior margin of labrum not emarginate or depressed (Palearctic) .... *Elinora* Benson

Clypeus shallowly, circularly emarginated for less than ⅙ its medial length, without lateral lobes (Fig. 1); anterior margin of labrum emarginate and depressed (Fig. 1) (Nearctic) .... *Filacus,* new genus

KEY TO SPECIES OF *FILACUS*

Adults

1. Female 2

Male 5

2. Abdominal terga with apical edges yellow dorsally and laterally; hindtibial spurs longer than apical width of hindtibia; hindcoxa with apical ⅓–½ yellow 3

Abdomen black (if some terga have yellow apical edges, then only dorsally and hindtibial spurs stout and about ⅔ of apical width of hindtibia); hindtibial spurs shorter or longer than apical width of hindtibia; hindcoxa black or with about apical ⅓ yellow 4

3. Serrulae of lancet each with anteriorly projecting subbasal teeth well separated from ventrally projecting lobe (Fig. 16); each abdominal tergum broadly black along entire basal margin dorsally and laterally, thus the abdomen appearing transversely striped; mesepisternum always entirely black .... *pluricinctus* (Norton)

Serrulae of lancet each without anteriorly projecting subbasal teeth, ventral margin flat (Fig. 14); each abdominal tergum generally broadly black only dorsally, with lateral downturned margins yellow, thus the abdomen with a broad, longitudinal yellow stripe on each side; mesepisternum sometimes with small central yellow spot .... *doanei* (Rohwer)

4. Hindcoxa entirely black and/or abdomen with dorsum of some terga yellow apically; hindtibial spurs stout, about ⅔ apical width of hindtibia; serrulae of lancet each flattened ventrally, intersegmental setae continuous from dorsal to ventral margin of lancet (Fig. 18) .... *pluricinctellus* (Rohwer)

Hindcoxa with apical edge yellow and/or abdomen black with yellow confined to basal plates and 9th tergum; hindtibial spurs slender, slightly longer than apical width of hindtibia; serrulae of lancet each rounded apically, with 1 or 2 indistinct anterior subbasal teeth, intersegmental setae of lancet indistinct (Fig. 20) .... *provancheri* (Rohwer)

5. Abdomen beyond basal plates entirely black 6

Abdominal terga with apical edges yellow usually dorsally and laterally .. 7

6. Hindtibial spurs stout, about ⅔ apical width of hindtibia; hindcoxa black

or only extreme apical edge indistinctly yellow; valve elongate, with anterodorsal lobe (Fig. 7) .... *pluricinctellus* (Rohwer)

Hindtibial spurs slender, longer than apical width of hindtibia; apical edge of hindcoxa broadly yellow; valve ovate, without anterodorsal lobe (Fig. 8) .... *provancheri* (Rohwer)

7. Lateral downturned margins of terga usually entirely yellow, thus the abdomen with a broad longitudinal yellow stripe on each side; outer surface of hindfemur commonly entirely yellow; valve with anterodorsal lobe (Fig. 5) .... *doanei* (Rohwer)

Each abdominal tergum black basally and yellow apically both dorsally and laterally, thus the abdomen with a transversely striped appearance; outer surface of hindfemur usually with black stripe for entire length; valve without anterodorsal lobe (Fig. 6) .... *pluricinctus* (Norton)

Known Larvae

1. Body with lateral dark spots resulting in broken supraspiracular and subspiracular longitudinal lines; usually with black stripe extending from ocellus to hindmargin of head; on *Phacelia* .... *pluricinctus* (Norton)

Head and body unicolorous; on *Amsinckia* .... *pluricinctellus* (Rohwer)

***Filacus doanei* (Rohwer), NEW COMBINATION**

(Figs. 5, 13, 14)

Labidia doanei Rohwer, 1909a:91.
Macrophya truncata Rohwer, 1909b:331.

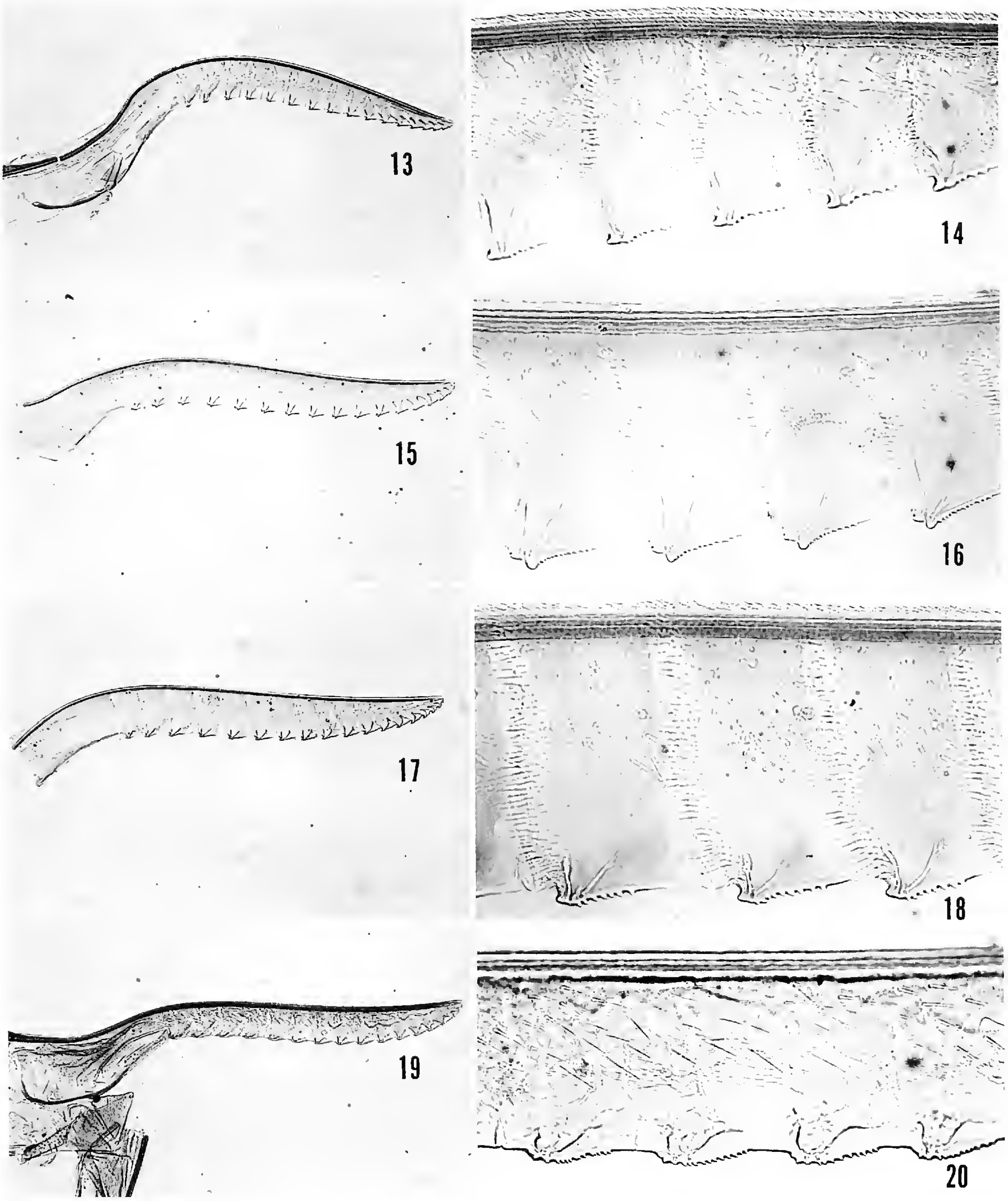
Female.—Antenna and head black; clypeus and labrum sometimes yellowish anteriorly and laterally and palpus sometimes yellowish except for apical segment. Thorax black with following yellow: Broad posterior margin of pronotum, tegula, mesoscutellum, and sometimes small central spot on mesepisternum. Abdomen with basal plates yellow, posterior margin black; remaining terga mostly black basally and yellow apically on dorsum, usually solidly yellow laterally; apical yellow margins broader toward apex of abdomen; basal 3 or 4 sterna usually black, remaining sterna yellow; sheath black. Legs yellow with following black: Coxae except for extreme apical margin of fore- and midcoxae and apical ⅓ or more of hindcoxa; 1st segment of fore- and midtrochanters and inner surface of 1st segment of hindtrochanter; basal ⅓ to ½ of fore- and midfemora, mid- and hindfemora sometimes with inner surfaces completely black; apex of each tibia, usually only on inner surface of fore- and midtibiae; inner surface of each tarsus black, hindtarsus more extensively so, sometimes apical segments of each tarsus entirely black. Wings hyaline; veins dark brown; stigma pale brown.

Hindtibial spurs 1⅓× as long or longer than apical width of hindtibia; hindbasitarsus equal in length to following 3½ segments combined. Each serrula of lancet with apical margin flat, with 6 or 7 coarse posterior subbasal teeth, without anterior subbasal teeth (Fig. 14).

Male.—Coloration similar to female, except without yellow spot on mesepisternum, mesoscutellum sometimes black, and femora sometimes with less yellow. Valve as in Figure 5, with anterodorsal lobe.

Larva.—Unknown.

Types.—Rohwer described the female of *doanei* and stated "Specimens from



Figures 13–20. Female lancets of *Filacus* spp. 13–14. *F. doanei.* 15–16. *F. pluricinctus.* 17–18. *F. pluricinctellus.* 19–20. *F. provancheri.* Entire lancet on left, central portion of lancet on right. Photographs by GAPG.

Stanford University, March 9, 1905; Palo Alto, March 31, 1893, and April 27, 1895." We located one specimen from the type-series in the USNM labeled "9 Mar. 1905, Stn. U., Cal.," "Macrophya doanei Roh., type ♀," "♀ type No. 14270 U.S.N.M." We designate this specimen the lectotype of *doanei.*

Macrophya truncata was described from 5 ♂ and 8 ♀. We found 5 ♂ and 3 ♀ in the USNM labeled by Rohwer as cotypes, and all are labeled "Claremont Cal., Baker." We designate a female lectotype with the additional labels "♀ cotype No. 14269 U.S.N.M.," "Macrophya truncata Roh., cotype ♀," and we have labeled it so; the other 5 ♂ and 2 ♀ are paralectotypes.

Distribution.—California: Lake Co. and Bay region southward, most records from coastal counties but occurring inland in the south; Lake Co., San Francisco Co., San Mateo Co., Stanislaus Co., San Benito Co., Monterey Co., Tulare Co., San Luis Obispo Co., Santa Barbara Co., Ventura Co., Los Angeles Co., San Bernardino Co., Riverside Co., San Diego Co. Arizona: Yuma, 7.IV.1979. Mexico: Baja California, Norte, 10 mi N San Vincente, 25.III.1973. Two specimens are labeled "Victoria, B.C., Mch. 10, '05." We consider these specimens mislabeled since this locality is considerably disjunct from the most northern record of this species in California.

Collection data.—Adults have been collected from February 17 (Riverside, California) to May 15 (Wildwood Canyon, San Bernardino County, California), with most records in March and April. We do not have data for reared material, but the following collection data were found on adult specimens: *Cryptantha muricata, Cryptantha intermedia, Gilia achillaefolia, Sisyrinchium* sp., *Nemophila,* on *Nemophila menziesii, Phacelia,* Umbelliferae, and ex Boraginaceae.

Remarks.—Of the four species in *Filacus,* adults of *doanei* have the most extensive abdominal yellow. The sides of the abdomen are almost entirely yellow, thus it appears partly black above and below with lateral, longitudinal yellow stripes. This is also the only species in which a yellow spot may be present on the female mesepisternum. Other distinguishing characteristics are the female lancet and male valve (see Figs. 5–8, 13–20).

***Filacus pluricinctus* (Norton), NEW COMBINATION**

(Figs. 1, 3, 4, 6, 15, 16)

Macrophya pluricinctus Norton, 1862:118.
Macrophya multicincta Rohwer, 1909b:333.
Macrophya napensis Rohwer, 1911:410.

Female.—Antennae and head black; anterior margin of clypeus and anterior margin of labrum sometimes yellow. Thorax black with broad posterior margin of pronotum, tegula, and usually small or large spot on mesoscutellum yellow. Abdomen with basal plates mostly yellow with basal margin black, rest of abdomen with banded appearance, terga dorsally and laterally black on basal portion, yellow apically, the yellow margins increasing in width toward apex of abdomen; sterna also banded. Legs yellow with following black: Coxae except apical margins of fore- and midcoxae and about apical ⅓ of hindcoxa; trochanters except most of 2nd segment of fore- and midtrochanters and usually all of hindtrochanters; inner surface of femora and usually basal ⅓ to ½ of outer surface; inner surface of tibiae, or sometimes all surfaces at base and apex with black on hindtibia broadest, sometimes hindtibia all yellow except for extreme base and apex; inner surface of tarsi sometimes all blackish with part of basitarsi or all of hindbasitarsus yellowish. Wings subhyaline; veins dark brown; stigma pale brown, especially on ventral ½.

Hindtibial spurs 1¼× as long or longer than apical width of hindtibia; hindbasitarsus subequal in length to following 3 segments combined. Each serrula of lancet with 2 anteriorly projecting subbasal teeth, well separated from ventrally projecting lobe, and 10–11 posterior subbasal teeth (Fig. 16).

Male.—Coloration similar to female, except clypeus and mesoscutellum usually black, basal plates black with posterior margin yellow, femora and tibiae usually mostly yellow on outer surfaces, but hindfemur commonly with longitudinal black stripe on outer surface, and hindtarsus mostly black. Genitalia as in Figures 4, 6; valve without anterodorsal lobe.

Larva.—Characters as for genus. Head amber with black stripe from each ocellus to hindmargin of head. Body with broken subspiracular and supraspiracular longitudinal blackish stripes. (Larvae from Salinas, Monterey Co., Calif., May 11, 1978, on *Phacelia* sp.; in the Illinois Natural History Survey.)

Types.—The syntypes of *pluricinctus* Norton, a male and a female labeled "San Mat.," "pluricincta," "type 13991" are in the Museum of Comparative Zoology, Harvard University. The female is hereby designated lectotype, the male is a paralectotype. Rohwer described *multicincta* from 3 ♀ from Claremont, California; 2 ♀ were found in the USNM, and one is hereby designated lectotype. The lectotype is labeled "Claremont, Cal., Baker," "♀ cotype No. 14264, U.S.N.M.," "Macrophya multicincta Roh., cotype ♀." The second specimen is a paralectotype. Rohwer described *napensis* from one female; the holotype is in the USNM, and is labeled "Napa Co., Cal.," "Hym. slide 205," "antenna mounted," "♀ type No. 14616 U.S.N.M.," "Macrophya napensis Roh., type ♀."

Distribution.—California: Yolo and Napa counties southwards; Napa Co., Yolo Co., Marin Co., Contra Costa Co., San Francisco Co., San Mateo Co., Stanislaus Co., Mariposa Co., Monterey Co., Fresno Co., Tulare Co., Inyo Co., San Luis Obispo Co., Santa Barbara Co., Kern Co., Los Angeles Co., San Bernardino Co., Riverside Co., San Diego Co., Imperial Co. Arizona: Globe, 14.IV.33; Catalina Mts., 19.IV.1957; "A" Mtn., Tucson, 19.III.1962; Ragged Top, Silverbell Mts., Pima Co., 24.III.78, ex *Phacelia* sp.; N. side Tortolita Mts., 5.IV.1966, on *Phacelia* (?); Baboquivari Camp, Babq. Cn., 17.IV.1966, on *Hydrophyllum occidentale*; Pima Co., Silverbell Bajada; N. ent. Tucson Mts., 16.III.63, on flower; Pima Co., Catalina Mts., 3000′, Sabino Canyon Sta., 15.IV.65. Mexico: nr. La Zapopita Valle de Trinidad, Baja Calif., 17.IV.62; Baja Calif. Norte, 7 mi SE Maneadero, 100′ el., 25.III.1973.

Collection data.—Specimens have been collected from February 24 (Agua Caliente Ind. Res., Palm Canyon, Riverside Co., and Bakersfield, Kern Co., California) to May 28 (San Francisco, California), with most records in March and April. The species has been reared from larvae feeding on *Phacelia distans* (San Mateo Co., Pescadero, San Gregorio site, 6.V.71, A. R. Moldenke) and possibly *Phacelia* sp. (Corona, Calif., 12.III.62, Brawner), of the family Hydrophyllaceae. Data from labels on adult specimens are as follows: *Phacelia, Phacelia distans, Phacelia* flower, coll. on *Phacelia, Phacelia crenulata,* on flower, *Nemophila, Amsinckia,* on *Hydrophyllum occidentale,* ex lupine, ex *Encilia farinosa,* and on *Phacelia tanasetifolia.* Most of the collection records are from *Phacelia* in California and Arizona.

Remarks.—The black and yellow transversely banded appearance of the abdomen of adult specimens is similar to those of *doanei* and *pluricinctellus,* but in *doanei* the lateral downturned margins of the terga are yellow, while in *pluricinctellus* they are black laterally. Also, adults of *pluricinctellus* have short apical spurs on the hindtibia, shorter than the apical width of the tibia, whereas those of *pluricinctus* are longer than the apical width of the hindtibia. The lancet of females of *pluricinctus* has two distinct anterior subbasal teeth on each serrulae, well separated from the ventrally projecting basal lobe; the lancets of females of other species do not have such anterior subbasal teeth.

Filacus pluricinctellus **(Rohwer), NEW COMBINATION**

(Figs. 2, 7, 17, 18)

Macrophya pluricinctellus Rohwer, 1909b:332.
Macrophya occidentalis Rohwer, 1909b:330.
Macrophya bakeri Rohwer, 1909b:331.
Macrophya melanostoma Rohwer, 1909b:333.

Female.—Antenna and head black; anterior margin of clypeus and most of labrum sometimes yellow. Thorax black with posterior margin of pronotum, tegula, and spot on center of mesoscutellum yellow. Abdomen black with following yellow: Basal plates and usually apical margins of remaining terga dorsally, basal terga may be entirely black, and amount of yellow on apical margins of terga increases posteriorly. Legs yellow with following black: Coxae except sometimes apical margins; trochanters; femora except basal ½ to ⅔ of outer surface; line on inner surface of fore- and midtibiae; apices of mid- and hindtibiae; line on inner surface of each tarsus with apical tarsal segment mostly black. Wings hyaline; veins dark brown; outer surface of costa and subcosta and sometimes basal ¼ of these yellowish; stigma entirely or with ventral ½ yellowish.

Hindtibial spurs short and broad, nearly triangular, their length equal to about ⅔ of apical width of hindtibia (Fig. 2). Hindbasitarsus subequal in length to following 3 tarsal segments combined. Each serrula of lancet truncate apically, without anterior subbasal teeth and with about 8 coarse posterior subbasal teeth (Fig. 18).

Male.—Coloration similar to that of female, but abdomen black, inner surface of all femora with complete black stripe, mesoscutellum black, tegula partly black, hindtarsus sometimes all black, and extreme apical margin of 1st tergum sometimes yellowish. Valve as in Figure 7, with anterodorsal lobe.

Larva.—Characters as given for genus description. Head and body unicolorous greenish, without black markings; only eyespot black. (Larvae from Cuyama, California, April 12, 1956, on *Amsinckia,* H. T. Osborn; LaGrange, California, April 15, 1953, *Amsinckia* sp., R. P. Allen; Lindcove, Tulare Co., California, April 4, 1956, ex *Amsinckia,* R. P. Allen; in the Illinois Natural History Survey and USNM.)

Types.—Rohwer described *Macrophya pluricinctella* from an unspecified number of females from "Palo Alto, California; Stanford University, California; Claremont, California." We found 3 females in the USNM labeled as cotypes, 2 from Claremont and 1 from Palo Alto. A specimen from Claremont, labeled "Claremont, Cal., Baker," "♀ cotype No. 14267, U.S.N.M.," "Macrophya pluricinctella Roh., cotype ♀" is hereby designated lectotype; the other two specimens are paralectotypes.

Macrophya bakeri was described from one male; the holotype is labeled "Claremont, Cal., Baker," "♂ type No. 14262 U.S.N.M.," "Macrophya bakeri Roh., type ♂." *Macrophya melanostoma* was described from one female; the holotype is labeled "Claremont, Cal., Baker," "♀ type No. 14263 U.S.N.M.," "Macrophya melanostoma Roh., type ♀." *Macrophya occidentalis* was described from one male; the holotype is labeled "Claremont, Cal., Baker," "♂ type No. 14266 U.S.N.M.," "Macrophya occidentalis Roh., type ♂."

Distribution.—California: Napa, Yolo, and Yuba counties southward in coastal and central areas to San Diego Co.; Sonoma Co., Napa Co., Yolo Co., Yuba Co., Marin Co., Solano Co., Sacramento Co., El Dorado Co., Contra Costa Co., Alameda Co., San Francisco Co., San Mateo Co., Santa Clara Co., Stanislaus Co., Santa Cruz Co., Monterey Co., San Benito Co., Fresno Co., Kings Co., Tulare Co., San Luis Obispo Co., Santa Barbara Co., Kern Co., Los Angeles Co., San Bernardino Co., Riverside Co., San Diego Co. Arizona: Boyce-Thompson Arboretum, 2500′, 3½ mi W Superior, Pinal Co., Feb. 24, 1973, on flowers.

Collection data.—Representatives of this species have been collected from February 4 (Stanford University, California) to May 19 (Alviso, California), with most records in March and April. Adults have been reared from larvae feeding on *Amsinckia tessellata* (Riverside Co., Riverside, California, March 23, 1971) and *Amsinckia* sp. (Santa Barbara Co., Ventucopa, California, March 28, 1960) of the plant family Boraginaceae. Collection records from adult label data are as follows: on barley, *Nemophila,* at flowers *Brassica, Brassica, Amsinckia, Amsinckia douglasiana,* on *Sambucus, Phacelia, Ranunculus californicus,* on California poppy, *Ranunculus,* on flowers, *Mimulus,* on elderberry, ex sweeping grasses, ex wheat fiddleneck, ex wheat, on *Amsinckia* (yellow fiddleneck), *Phacelia transectifolia,* and ex Boraginaceae. Most records are from *Amsinckia* including a series of over 200 specimens from Mojave, California that were swept from *Amsinckia* sp.

Remarks.—The combination of the black abdomen, at least black laterally in the female, the short hindtibial spurs which are shorter than the apical width of the hindtibia, and the lack of anterior subbasal teeth on the serrulae of the lancet will distinguish adults of this species. In some female specimens the dorsal transverse yellow bands on the abdomen are more extensive, even slightly extending laterally, and these may be confused with those of *pluricinctus.* However, females of the latter species possess long hindtibial spurs, longer than the apical width of the hindtibia, and well separated anterior subbasal teeth on the serrulae of the lancet. The hindtibial spurs and genitalia should be examined for accurate identification of *pluricinctus* adults.

***Filacus provancheri* (Rohwer), New Combination**

(Figs. 8, 19, 20)

Macrophya albipes Provancher, 1895:95 (preoccupied in *Macrophya* by *Macrophya albipes* (Dahlbom), 1835).
Macrophya provancheri Rohwer, 1909b:328 (new name for *albipes* Provancher).
Macrophya nigricornis Rohwer, 1909b:329–330.

Female.—Antenna and head black; apical margin of labrum and subapical palpal segments may be yellowish. Thorax black with posterior margin of pronotum, tegula, and small or large spot on mesoscutellum yellow. Abdomen black, basal plates with 2 broad yellow spots, last tergum yellow. Legs yellow with following black: Coxae except for apical margins; 1st trochanteral segment of fore- and midlegs and inner surface of 1st trochanteral segment of hindleg; femora except apical ½ to ⅓ of outer surface; line on inner surface of fore- and midtibiae; base and apex of inner surface of hindtibia entirely; line on inner surface of each tarsus and most of apical tarsal segment of each tarsus. Wings subhyaline; veins dark brown, stigma pale brown.

Hindtibial spurs subequal to or slightly longer than apical width of hindtibia. Hindbasitarsus subequal in length to following 3½ tarsal segments combined. Serrulae of lancet low, rounded, with 1 or 2 indistinct anterior subbasal teeth and 9–10 coarse posterior subbasal teeth; segmental hairs indistinct, not confined to distinct vertical rows and not extending from dorsal to ventral edges of lancet (Fig. 20).

Male.—Coloration similar to female but apical tergum black, mesoscutellum black, hindtibia black with yellow streak on outer surface, and hindtarsus sometimes entirely black. Genitalia as in Fig. 8; valve without anterodorsal lobe.

Larva.—Unknown.

Types.—The lectotype of *Macrophya albipes* Provancher is in the Provancher Collection, Université Laval, Sainte-Foy, Québec (Smith, 1975); it is from Los Angeles. *Macrophya nigricornis* Rohwer was described from both sexes from "Mountains near Claremont, California." The lectotype, by present designation, is a female in the USNM labeled "Mts. near Claremont, Cal., Baker," "Macrophya nigricornis Rohwer, cotype ♀." The male, a paralectotype, has the same data except for the sex and an additional label "♂ cotype No. 14265 U.S.N.M."

Distribution.—California: Mendicino, Napa, Yolo, and El Dorado counties south in coastal and central areas to San Diego Co.; Mendocino Co., Sonoma Co., Napa Co., Yolo Co., El Dorado Co., Solano Co., Marin Co., San Francisco Co., Contra Costa Co., San Mateo Co., Santa Cruz Co., Santa Clara Co., Alameda Co., Stanislaus Co., Tuolumne Co., Merced Co., San Benito Co., Fresno Co., San Luis Obispo Co., Santa Barbara Co. (including Santa Cruz Is.), Ventura Co., Los Angeles Co., San Bernardino Co., San Diego Co.

Collection data.—Collection records are from January 18 (Redwood City, San Mateo Co., California) to May 20 (Davis, California), with most collected in March and April. One rearing record is from larvae feeding on *Ranunculus nystriculus* (Tuolumne Co., Buck Meadows, Mather Site, reared, 16-III-71, A. R. Moldenke) of the family Ranunculaceae. Larvae were not found from this rearing. Collection data from adult specimens are as follows: on *Sambucus,* dandelion, swept from *Ranunculus ceanothus, Ranunculus californicus, Ranunculus, Montia, Montia perfoliata,* ca. *Montia* under *Q. lobata,* coll. on *Rubus,* coll. on *Ceanothus,* visiting miner's lettuce, *Nemophila menziesii, Rhus trilobata,* ex. misc. grass. One long series was collected on *Montia perfoliata* (Portulacaceae) at Strawberry Canyon, California, and another series from Almaden, Quicksilver Park, a mixed-oak woodland south of San Jose. Pertaining to the latter series, L. Bezark (pers. comm.) stated that they were abundant very low to the ground in association with miner's lettuce, *Montia perfoliata,* "Upon closer inspection the critters were apparently stuck to the very tiny flowers by their mandibles. Leaves were torn off to place specimens in a killing jar."

Remarks.—Adults of *provancheri* are the darkest colored of the species of *Filacus,* the abdomen being black with yellow markings only on the basal plates and the ninth tergum of the female. The male of *pluricinctellus* also has a black abdomen, but the hindcoxae are all black and the hindtibial spurs are stout. The lancet of females of *provancheri* is very different from those of other species, lacking well defined rows of segmental hairs and having rounded serrulae with both anterior and posterior subbasal teeth.

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Description of a New Purpuricenine Genus, *Linsleyella* (Coleoptera: Cerambycidae)

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The genus *Deltaspis* was proposed by Audinet-Serville (1834) for the species *auromarginata* described at the same time. Since then, the genus has been a dumping ground for species of uncertain affinities. One of these, *D. virens* Bates (1885) is clearly unrelated to *auromarginata* and is being placed into a new genus described below. Included are two apparently undescribed species.

This study was conducted in conjunction with a National Science Foundation sponsored study on North American Cerambycidae (Grant DEB-8015523). Most of the material utilized, in the Essig Museum of Entomology, Berkeley, was collected with financial support from the National Science Foundation, the University Research Expeditions Program, University of California, Berkeley, and A. & M. Michelbacher. Additional specimens were loaned by Cornell University, Field Museum of Natural History, Chicago, Los Angeles Natural History Museum, University of Kansas and Texas A&M University. Marlin Rice made his Texas material available. Carolyn Tibbetts prepared the illustration.

***Linsleyella,* NEW GENUS**

Form moderate sized, somewhat depressed; integument metallic. Head small, front short; palpi unequal, truncate at apices; mandibles short, angulate at apical one-third; eyes large, deeply emarginate, finely faceted, not embracing antennal insertions; antennae slender in males, outer segments enlarging in females, 11-segmented, longer than body in males, shorter than body in females. Pronotum flattened, sides broadly rounded; disk abruptly delimited at sides, not callused dorsally; prosternum shallowly impressed, intercoxal process not extending beyond margins of coxae, apex not expanded, coxal cavities wide open behind, rounded externally; mesosternum with intercoxal process gradually arcuate, lying below margins of coxae; metepisternum moderately broad, sides subparallel, slightly tapering posteriorly. Elytra subparallel, slightly tapering posteriorly. Elytra subparallel; apices rounded to subtruncate. Scutellum triangular, as broad as long, apex acute. Legs slender; hind femora arcuate, not extending to apices of elytra; tarsi slender, third segment cleft almost to base.

Type species.—Deltaspis virens Bates.

This genus is distinctive by the metallic coloration of the integument, apically expanding antennae of the females, and by the rounded flattened, pronotum.

It is a pleasure to dedicate this genus to my friend and colleague, E. G. Linsley.

Three species are presently known.

KEY TO THE SPECIES OF *LINSLEYELLA*

1. Elytra with punctures coarse to moderately coarse, pubescence moderately dense, erect, long and short 2

Elytra with punctures fine, very dense, pubescence very dense, subdepressed. Length, 11–15 mm. Texas .... *ricei*

2\. Elytra with punctures very coarse, contiguous. Hind tibiae with suberect black setae. Antennae of females with tenth segment as long as broad. Length, 8–12 mm. Mexico .... *virens*

Elytra with punctures moderately coarse, subconfluent. Hind tibiae lacking black setae. Antennae of females with tenth segment distinctly longer than broad. Length, 10–12 mm. Mexico .... *michelbacheri*

***Linsleyella ricei*, New Species**

(Fig. 1)

Male.—Form moderate sized; integument dark metallic greenish, appendages black; pubescence whitish, dense, subdepressed and erect. Head with front confluently punctate, moderately densely clothed with long erect hairs; vertex confluently punctate, long, erect hairs numerous; antennae extending beyond elytra by one or two segments, basal segments rather densely clothed with short, depressed, black setae, outer segments opaque, very finely, densely pubescent, first segment shorter than third, fourth slightly longer than first, shorter than third, eleventh segment appendiculate. Pronotum broader than long, disk convex, moderately coarsely, subconfluently punctate, with a vague median callus behind middle; pubescence long, erect; prosternum coarsely punctate on posterior one-half, pubescence long, dense; meso- and metasternum finely, densely punctate, densely clothed with long, subdepressed pubescence. Elytra about 2½ times as long as broad; punctures fine, very dense, finer toward apex; pubescence dense, subdepressed, longer and erect over basal one half; apices subtruncate. Legs with femora densely pubescent; tibiae with numerous short, black setae along inner margins. Abdomen finely, densely punctate, densely pubescent; last sternite subtruncate at apex. Length, 11–15 mm.

Female.—Form similar. Antennae shorter than body, outer segments slightly enlarged, longer than broad. Abdomen with last sternite broadly truncate at apex. Length, 13 mm.

Holotype male (California Academy of Sciences) from White River Lake, Crosby Co., Texas, 19 September 1980, on *Heterotheca* (M. E. Rice). Sixteen paratypes (10 males, 6 females), same locality, 17 September 1980 (M. Dicetto), 6 October 1980 (Rice), 12 October 1980 (Rice), 2–3 October 1982 (Rice, E. G. Riley, R. Turnbow). One male paratype from 4 mi E Loco Hills, Otero Co., New Mexico, 4 October 1970 (O'Brien, Richardson).

The fine, very dense punctation and dense pubescence of the elytra will readily separate this species.

This species is named in honor of Marlin E. Rice for his aid and cooperation in the studies on Cerambycidae.

***Linsleyella virens* (Bates), New Combination**

Deltaspis (?) *virens* Bates, 1885, Biol. Centrali-Americana, Coleop., 5:323.

Male.—Form moderate sized; integument bright metallic greenish, blueish, or bronze, appendages metallic; pubescence rather sparse, mostly pale, erect, short and long. Head confluently punctate, sparsely clothed with long, erect hairs; an-

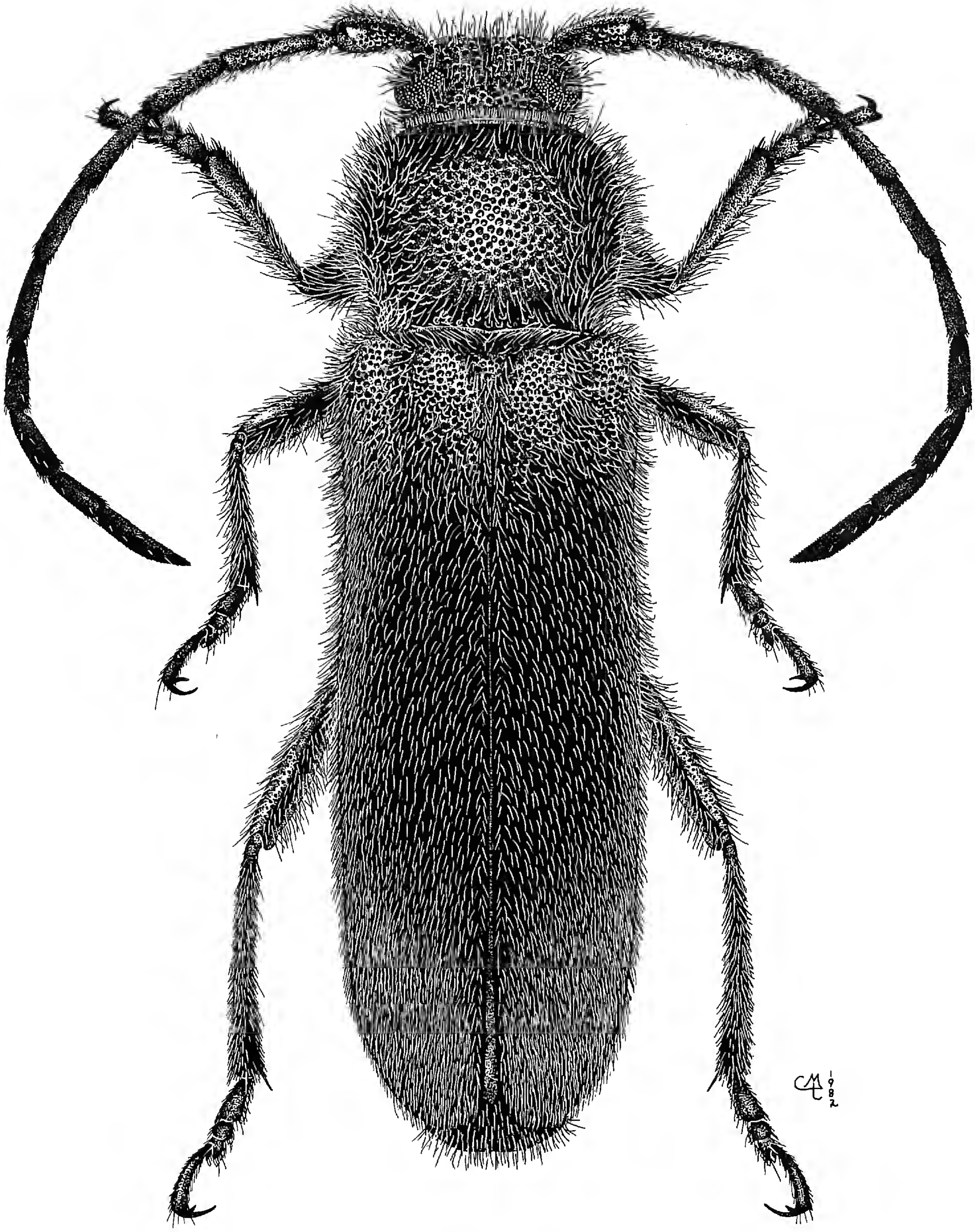

Figure 1. *Linsleyella ricei* Chemsak, female.

tennae slightly longer than body, basal segments shining, with numerous, short, black, subdepressed setae, outer segments minutely pubescent, first segment shorter than third, fourth subequal to first, eleventh appendiculate. Pronotum broader than long, somewhat depressed; disk vaguely impressed at sides, coarsely, closely punctate; pubescence sparse, long, erect; prosternum deeply punctate over posterior two-thirds, moderately densely pubescent; meso- and metasternum densely punctate at sides, sparsely at middle, sides densely pubescent. Elytra less than 2½ times as long as broad; punctures very coarse, contiguous, becoming slightly finer toward apex; pubescence moderately sparse, erect, long and short, longer toward base; apices rounded. Legs with femora moderately sparsely clothed with long, flying hairs; tibiae with short, dark setae. Abdomen sparsely, indistinctly punctate, moderately densely pubescent; last sternite shallowly emarginate-truncate. Length, 8–11 mm.

Female.—Form similar. Antennae shorter than body, outer segments expanded, about as broad as long. Abdomen with last sternite broadly truncate at apex. Length, 9–12 mm.

Type locality.—Mexico.

Range.—Vera Cruz, Puebla, Oaxaca.

Flight period.—June to September.

Adults are commonly encountered on flowers of *Selloa glutinosa.*

The very coarse punctures, strongly shining integument and rather sparse pubescence will separate this species.

Material examined.—Mexico: 79 males, 26 females, 7 km SE Morelos Canada, Puebla, 4–10 July 1974, 4 October 1975, 20 September 1977, on flowers of *Selloa glutinosa* (J. Chemsak, J. Powell, E. G. Linsley, A. & M. Michelbacher); 1 male, 1 female, Tehuacan, Puebla, 6 July 1941 (H. Dybas), 2 July 1955 (R. & J. Selander); 1 male, 1 female, 6 mi SW Techuacan, 9 August 1980, 8 July 1981 (Schaffner et al.); 2 males, Tecamachalco, Puebla, 24 June 1951 (H. Evans), 2 July 1953 (U. Kansas Mex. Exped.); 2 females, 2 mi E Tecamachalco, 27 June 1964 (C. Johnson); 1 male, 19 mi NW Calcaloapan, Puebla, 30 July 1963 (J. Doyen); 1 male, 10 mi N Miltepec, Oaxaca, 4 August 1976 (Peigler et al.); 1 male, Jalapa Rd., K 341, 14 October 1945.

Linsleyella michelbacheri, NEW SPECIES

Male.—Form moderate sized; integument metallic dark blueish; pubescence pale, moderately dense, erect, long and short. Head confluently punctate, moderately densely clothed with long, erect pubescence; antennae extending about two segments beyond elytra, basal segments with a few black setae, outer segments opaque, minutely pubescent, first segment shorter than third, third slightly longer than fourth, eleventh appendiculate. Pronotum broader than long; punctures coarse, subconfluent; pubescence rather sparse, long, erect; prosternum with a delimited area of deep punctures extending to sides but not across middle, pubescence moderately dense, erect; meso- and metasternum finely, densely punctate at sides, sparsely at middle, sides densely pubescent. Elytra about 2½ times as long as broad; punctures moderately coarse, subconfluent, becoming finer toward apex; pubescence rather sparse, short and suberect and long and erect, erect hairs more numerous toward base; apices rounded. Legs with femora rather sparsely clothed with long flying hairs; tibiae clothed with pale pubescence. Abdomen rather sparsely punctate, pubescence long, suberect; last sternite emarginate at apex. Length, 11–12 mm.

Female.—Form similar. Antennae shorter than body, outer segments slightly enlarged, longer than broad. Abdomen with last sternite broadly truncate. Length, 10–12 mm.

Holotype male, allotype (California Academy of Sciences) and 3 paratypes (2 males, 1 female) from 16 miles SE Saltillo, 6500 ft, Coahuila, Mexico, 25 September 1976 (J. Chemsak, J. Powell, A. & M. Michelbacher). Additional paratypes as follows: 4 females, 17 males SE Saltillo, 14 September 1977 (J. Chemsak, A. & M. Michelbacher); 1 female, 1 mi N El Tunal, Coahuila, Mexico, 11 August 1977 (E. I. Schlinger); 2 males, 87 mi N. Zacatecas, Zacatecas, Mexico, 7 August 1968 (J. Bigelow, M. Cazier). An additional female from Fraile, Coahuila, Mexico, 10–18 July 1941 (K. L. Retherford) is assignable to this species.

This species differs from *L. virens* by the less coarsely punctate elytra, absence of dark setae on the tibiae and by the more slender distal segments of the female antennae.

I am pleased to name this species for A. E. Michelbacher for his friendship and assistance over the years.

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Synonymy in California Channel Island Epeolini Bees (Hymenoptera: Anthophoridae)

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A recent review of the endemic insect fauna of the California Channel Islands (Miller, 1984) indicated 16 taxa of bees (Apoidea). Earlier revisions of bee taxa containing California Channel Island endemics have shown that the island endemics are synonyms of mainland taxa: *Anthidium* Grigarick and Stange, 1968; *Dioxys* Hurd, 1958; *Melissodes* LaBerge, 1961; *Andrena* LeBerge and Ribble, 1975, Ribble, 1968; *Bombus* Milliron, 1971; *Coelioxys* Mitchell, 1973; *Agapostemon* Roberts, 1972; *Osmia, Halictus* Sandhouse, 1927, 1941; *Hylaeus* Snelling, 1970; and *Colletes, Bombus* Stephen, 1954, 1957. Thus, the number of both endemic species and subspecies has been greatly reduced. Some island endemics are recognized as good taxa, such as *Perdita layiae layiae* Cockerell (Timberlake, 1956).

Here I present two additional synonyms of California Channel Island Epeolini bees in the genera *Epeolus* and *Triepeolus.*

Epeolus minimus (Robertson, 1902)

Epeolus eastwoodae Cockerell was described from San Miguel Island, Cuyler's Cove, near the shore, July 27, 1927 [*sic* 37] (Cockerell) (Cockerell 1937). Examination of the holotype (California Academy of Sciences #4651) and comparison with the holotype of *Epeolus minimus* (Robertson) (Illinois Natural History Survey #22953) indicates the two are conspecific. An additional 11 male and 7 female specimens from San Miguel Island were also compared to both types. There was some difference in the overall size of the specimens, but no major differences. *E. minimus* is a widespread species from the midwestern United States: Illinois and Wisconsin, westward to California (Hurd, 1979). In Cockerell's original description of *E. eastwoodae* he mentions that the specimen was taken at flower of *Malacothrix implicata* Eastwood; however there is no plant label on the specimen, nor is there the information that the bee was taken at Cuyler's Cove and the date is July 27, 1937 not 1927 as indicated in the publication.

E. minimus females are recognized by the broad pygidium bordered apically with a carina, mid-apical edge being truncate; pygidium is covered with red-brown hairs; pseudopygidium is a semi-circular patch of short, silver hairs offset posteriorly by white pubescence. Male pygidium is one-and-one-half times as wide as long and the carina is broadly U-shaped and covered with silver-white pubescence. Apical white hair bands of tergites 2–5 have narrow medium black stripes, band of the sixth is complete.

Epeolus minimus is found on five of the California Channel Islands (San Miguel, Santa Rosa, Santa Cruz, Anacapa and Santa Catalina) and is represented by over 100 specimens.

Triepeolus heterurus (Cockerell & Sandhouse, 1924)

Epeolus piscatoris Cockerell was described from Santa Catalina Island, Fisherman's Cove, at flower of *Sinapis,* June 9, 1933, W. P. Cockerell (Cockerell, 1939). Examination of the holotype (CAS #6652) and comparison with the holotype of *Triepeolus heterurus* (Cockerell & Sandhouse) (CAS #1611) showed the two to be conspecific. An additional 4 females from Santa Catalina Island were also similar to *T. heterurus* and an additional 11 specimens of *T. heterurus* from other California Channel Islands are also similar.

Triepeolus heterurus is a very distinctive species. Female pygidium is covered with red-brown hairs parted along the dorsoventral mid-line giving the appearance of two distinct patches. White apical hair bands on tergites 2–5 are complete. Male pygidium is twice as long as wide, carina is acutely rounded apically and the segment is covered with black pubescence. White apical hair bands of tergites 2–5 are uninterrupted, sixth has a narrow median black stripe.

Trieleolus heterurus is also known from Santa Cruz Island and Anacapa Island.

ACKNOWLEDGMENTS

Drs. W. E. LaBerge and W. J. Pulawski made type specimens available for study and the late Dr. P. D. Hurd supplied information on type specimen location. Dr. G. E. Bohart helped with the original identification of *T. heterurus* and R. L. Brumley aided with *E. minimus* identification.

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Review of the Japanese Species of the Genus *Gabrius* Stephens (Coleoptera, Staphylinidae) (121st Contribution to the Knowledge of Staphylinidae)

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Abstract.—The Japanese species of the genus *Gabrius* Stephens are reviewed. Fourteen species are recognized, nine of them are described as new. All species are described and illustrated, and a key is presented to aid in the identification of the species. All available records and biological data for the species are provided.

Lectotypes are designated for *G. egens* (Sharp), *G. kuanshanensis* (Bernhauer) and *G. conicus* (Bernhauer).

Gabrius conicus (Bernhauer) is placed in synonymy with *G. sharpianus* (Cameron).

Only a few species of the genus *Gabrius* Stephens are at present known from Japan. Sharp (1874, 1889) described three species of *Philonthus* Stephens which were later assigned to *Gabrius* (Scheerpeltz, 1933), however, two of these, *G. prolatus* (Sharp) and *G. spadiceus* (Sharp), in fact belong to *Philonthus.* Cameron (1930) described *G. septempunctatus* and erected the name *G. sharpianus* for the specimens originally mentioned by Sharp (1889:40) as *Philonthus nigritulus* (Gravenhorst) and Tottenham (1940) redescribed the latter species under the name *G. demarcatus.* Bernhauer (1939a, 1939b) added three more species (*G. subdepressus, G. conicus* and *G. unzenensis*). No additional species of *Gabrius* have since been described from Japan. The list of species of *Gabrius* previously recorded from Japan includes therefore only the following names, chronologically arranged:

Gabrius egens (Sharp, 1874)
Gabrius sharpianus (Cameron, 1930)
Gabrius septempunctatus (Cameron, 1930)
Gabrius conicus (Bernhauer, 1939)
Gabrius subdepressus (Bernhauer, 1939)
Gabrius unzenensis (Bernhauer, 1939)
Gabrius demarcatus Tottenham, 1940

The names *G. conicus* and *G. demarcatus* are synonyms of *G. sharpianus.* The original material of *G. septempunctatus* was not found in the Cameron collection in the British Museum (Natural History), London (G. Kibby, pers. comm.), and the species cannot therefore be interpreted at this moment. It could be conspecific with any of the species with 7 punctures in the dorsal rows on the pronotum treated in this paper.

For many years I have known that the above list is inadequate since the genus

Gabrius is, in fact, very rich in species in Japan. Several species described as new in this paper have been in my collection for years and were supposed to be described in a joint paper with Mr. Y. Watanabe, Tokyo. For several reasons, however, the paper was never published although a preliminary study of the type material of the involved species was carried out by myself.

In 1980 I had the opportunity to collect in Japan for almost five weeks, together with my friend Ivan Löbl from the Museum d'Histoire Naturelle in Genève (Switzerland) and my wife Zdena. During this time a large collection of the genus *Gabrius,* containing several hundred specimens and many new species, was made and the availability of this material prompted me to return to my previously abandoned project.

In the following paper all new species are described and a review of the species of *Gabrius* known to occur in Japan at present is given. A key to species is included. There is no doubt that the species included in this paper represent only a portion of the existing fauna; it is hoped that the paper will stimulate the interest in this genus in Japan and bring our knowledge to a level comparable to that of the west Palaearctic fauna.

The material studied is deposited in the Canadian National Collection, Ottawa, Canada, and in the Muséum d'Histoire Naturelle in Genève, Switzerland (MHNG).

KEY TO SPECIES

1(12). Dorsal rows of punctures on pronotum each with seven punctures. (Occasionally one puncture missing or one additional puncture present unilaterally.)

2(3). Paramere of aedoeagus with short, obtusely triangular median projection (Figs. 7, 8). Length 6.1–7.3 mm ..... 3. *G. kobayashii,* n. sp.

3(2). Paramere of aedoeagus at least slightly emarginate in middle of apical margin, frequently divided into two variably long branches apically (Figs. 5, 14, 17, 20, 23).

4(5). Median lobe of aedoeagus in front of paramere abruptly, angulately narrowed into obtusely lanceolate apical portion (Fig. 13). Length 5.8–7.0 mm .... 5. *G. yamanei,* n. sp.

5(4). Median lobe of aedoeagus in front of paramere evenly and gradually narrowed into more or less conical apical portion (Figs. 4, 16, 19, 22).

6(9). Paramere of aedoeagus apically divided into two very long branches; branches longer than basal portion of paramere (basal apodemes not included) (Figs. 5, 20).

7(8). Branches of paramere of aedoeagus each with inner margin obliquely truncate apically, truncate portion with numerous sensory tubercles; branches separated by rather wide arc mediobasally (Fig. 5). Length 6.0–7.5 mm .... 2. *G. subdepressus* (Berhnauer)

8(7). Branches of paramere of aedoeagus each with inner margin simple, not obliquely truncate apically, with only a few sensory tubercles near apex; branches separated by rather acute angle mediobasally (Fig. 20). Length 5.0–5. 5 mm .... 7. *G. damon,* n. sp.

9(6). Paramere of aedoeagus apically divided into two short branches; branches shorter than basal portion of paramere (basal apodemes not included) (Figs. 17, 23).

10(11). Branches of paramere of aedoeagus separated mediobasally by deep, V-shaped emargination (Fig. 17). Length 5.9 mm ..... *G. io*, n. sp.

11(10). Branches of paramere of aedoeagus separated mediobasally by less deep, U-shaped emargination (Fig. 23). Length 5.0–5.7 mm, ... 8. *G. abas*, n. sp.

12(1). Dorsal rows of punctures on pronotum each with six punctures. (Rarely one additional puncture present unilaterally.)[1]

13(14). Apical portion of median lobe of aedoeagus strongly asymmetrical, with apex hook-like curved (Fig. 41). Length 4.0–4.8 mm .... 14. *G. nepos*, n. sp.

14(13). Apical portion of median lobe of aedoeagus symmetrical, apex never hook-like curved (Figs. 1, 10, 25, 28, 31, 34, 38).

15(16). Paramere of aedoeagus very wide, not constricted in middle, sensory tubercles situated partially away from apical margin, forming characteristic pattern (Fig. 11). Length 6.0–6.5 mm ... 4. *G. egens* (Sharp)

16(15). Paramere of aedoeagus more or less narrow, distinctly constricted in middle, sensory tubercles situated strictly on apical margin (Figs. 2, 26, 29, 32, 36, 39).

17(18). Apical margin of paramere of aedoeagus with small median emargination and one deeper and much wider emargination on each side (Fig. 39). Length 4.2–4.9 mm .... 13. *G. ophion*, n. sp.

19(20). Dorsal face of apical portion of median lobe distinctly swollen (lateral view) (Fig. 35). Length 5.2–6.2 mm .. 12. *G. sharpianus* (Cameron)

20(19). Dorsal face of apical portion of median lobe not swollen (lateral view).

21(22). Antenna long, 3rd segment longer than 2nd, 4th segment distinctly, 5th segment slightly longer than wide. Aedoeagus and paramere as in Figures 1, 2. Length 5.5–6.2 mm ... 1. *G. unzenensis* (Bernhauer)

22(21). Antenna moderately long, 3rd segment as long as 2nd, 4th segment at most slightly longer than wide, 5th segment about as long as wide. Aedoeagi and parameres different (Figs. 25, 26, 28, 29, 31, 32).

23(24). Median lobe of aedoeagus strongly, almost conically narrowed apically, with subacute apex (Fig. 25). Length 4.0–4.5 mm .... 9. *G. demades*, n. sp.

24(23). Median lobe of aedoeagus less strongly and not conically narrowed apically, with rounded apex (Figs. 28, 31).

25(26). Sternite of male pygidium shallowly emarginate apically (Fig. 30). Notch in middle of apical margin of paramere shallower and less wide; sensory tubercles on apical margin of paramere larger and more crowded together; median lobe shorter and stouter (Figs. 28, 29). Length 4.8–5.2 mm .... 10. *G. philo*, n. sp.

26(25). Sternite of male pygidium deeply emarginate apically (Fig. 33). Notch in middle of apical margin of paramere deeper and wider, sensory tubercles on apical margin of paramere smaller and not crowded together; median lobe longer and narrower (Figs. 31, 32). Length 4.7–5.1 mm .... 11. *G. kuanshanensis* (Bernhauer)

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[1] Rare specimens with an atypical number of punctures in the dorsal rows of pronotum should be run through both halves of couplet 1(12).

1. *Gabrius unzenensis* (Bernhauer, 1939)
(Figs. 1–3)

Philonthus unzenensis Bernhauer, 1939b:153.
Gabrius unzenensis; Smetana, 1973:129.

Material studied.—Japan: Honshu: Mie Pref., 20.VI.61, Y. Watanabe (2).

For the description and other information about this species see Smetana 1973: 129–130.

See Figures 1–3 for details of the sternite of the male pygidium and the aedoeagus. Note especially the arrangement of sensory tubercles on the paramere of the aedoeagus.

Distribution.—*Gabrius unzenensis* is at present known only from Japan (Kyushu and Honshu).

Discussion.—In my previous paper (Smetana, 1973:129) the year 1938 is given as the publication date of this species. The date "December 1938" is printed at the bottom of the page with the description of *G. unzenensis*; however, the wrapper of the "III/IV Heft" of the Entomologisches Nachrichtenblatt (pages 113–176) gives May 1939 ("Ausgegeben im Mai 1939") as the publication date. The correct year for this species is therefore 1939 and not 1938.

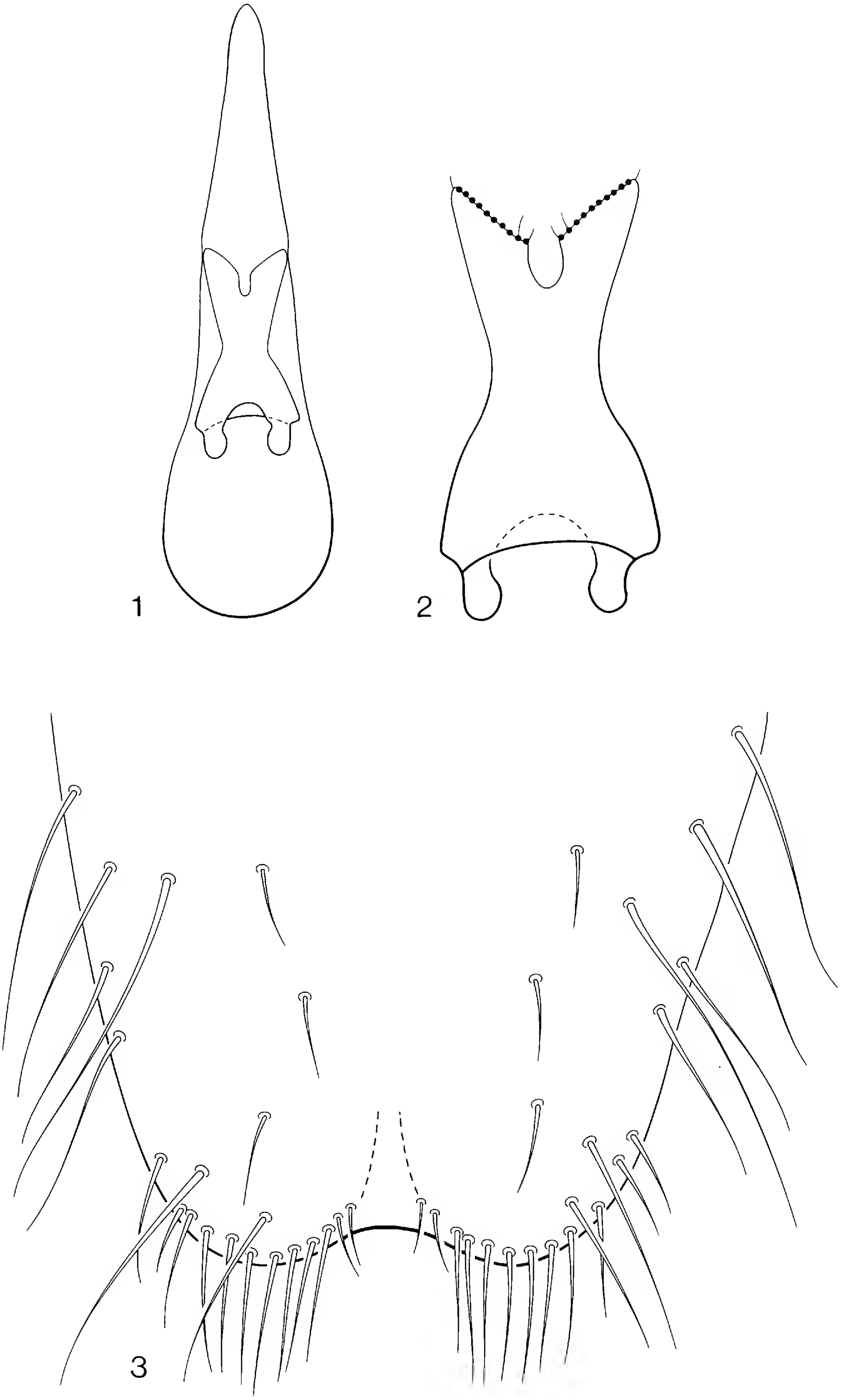
2. *Gabrius subdepressus* (Bernhauer, 1939)
(Figs. 4–6)

Philonthus subdepressus Bernhauer, 1939a:97.
Gabrius subdepressus; Smetana, 1973:130.

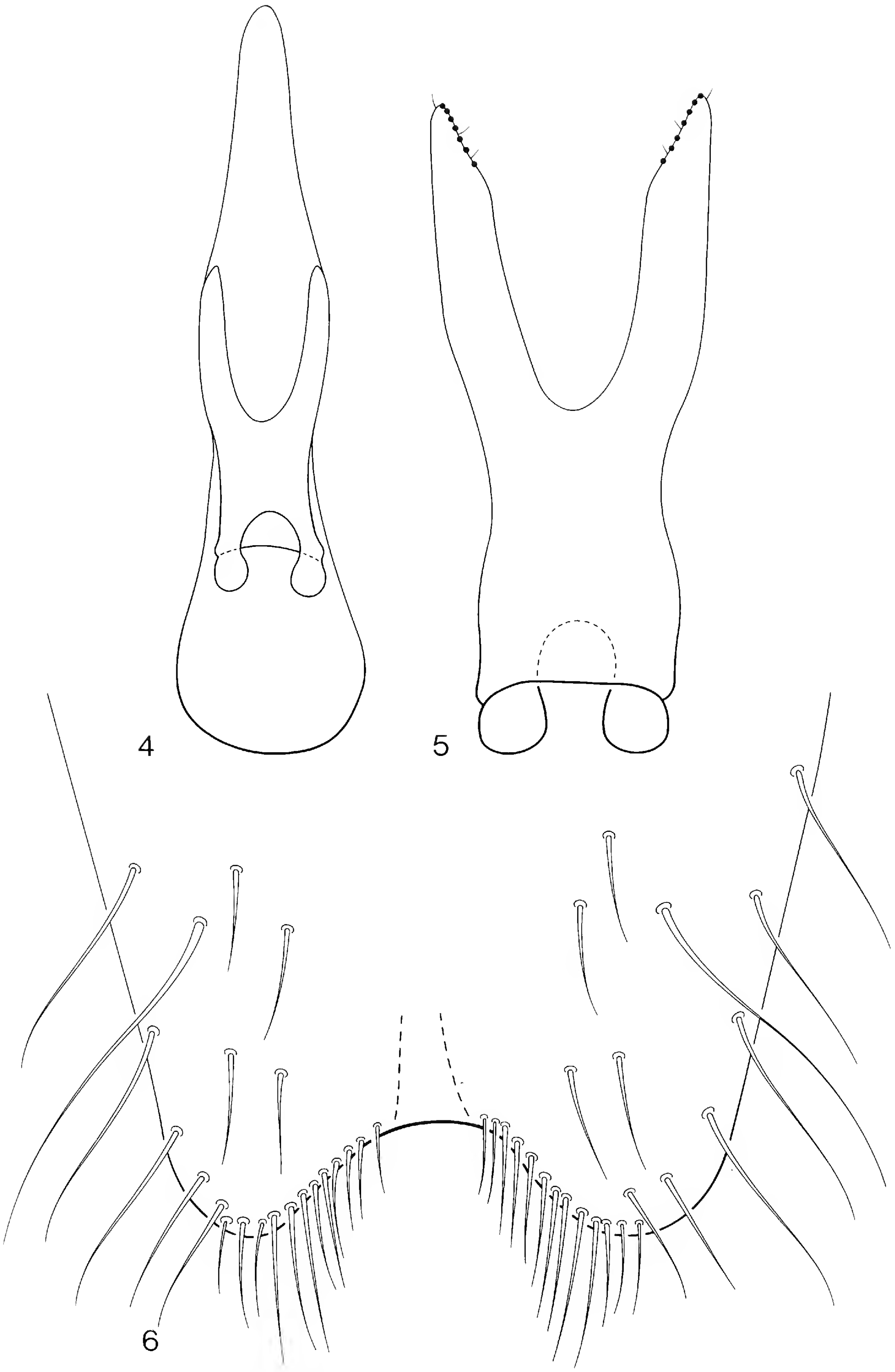
Material studied. Japan: Honshu: Asama Plateau, Nidoage, 22.VIII.60, Y. Watanabe (4); Nikko Nat. Park, Ryuzu, 1400 m, 16.VII.80, A. & Z. Smetana (4); Nikko Nat. Park, below Konsei Pass (W side), 1500–1600 m, 15.VII.80, A. & Z. Smetana (4).—Additional localities can be found in Smetana 1973:130.

Piceous black to black, elytra usually somewhat paler; palpi and legs brownish yellow, inner portions of middle and hind tibiae darkened. Head feebly longer than wide (index 24:22), indistinctly widened posteriorly, temporal angles rather rounded. Eyes rather small and flat, tempora more than twice as long as length of eyes in dorsal view (index 21:9). Antenna in general similar to that of *G. astutus* Er., outer segments hardly to slightly transverse. Pronotum rather narrow, longer than wide (index 29:22), usually slightly narrowed posteriorly, dorsal rows of punctures often somewhat irregular, each with seven (exceptionally eight) punctures. Elytra flat and moderately long, at sides slightly longer than pronotum (index 32:29), with fine and dense punctation. Punctation of abdomen finer than that of elytra, seventh (fifth visible) tergite with whitish apical seam.

Male.—Sternite of pygidium deeply and widely emarginate, small triangular median area before emargination flattened and smooth; lateroapical margins of emargination bearing rather strong and long setae becoming gradually shorter both medially and laterally (Fig. 6). Aedoeagus rather large and elongate, apical portion of median lobe long, strongly and evenly narrowed apically (Fig. 4). Branches of paramere each with inner margin obliquely truncate apically, truncate portion with numerous sensory tubercles; branches separated by rather wide arc mediobasally (Fig. 5).



Figures 1–3. *Gabrius unzenensis*. 1. Aedoeagus. 2. Underside of paramere. 3. Apical portion of sternite of male pygidium.



Figures 4–6. *Gabrius subdepressus*. 4. Aedoeagus. 5. Underside of paramere. 6. Apical portion of sternite of male pygidium.

Length 6.0–7.5 mm.

Distribution.—*Gabrius subdepressus* is at present known from Manchuria in northeastern China and from Japan (Honshu and Kyushu).

Discussion.—*Gabrius subdepressus* is similar to *G. astutus,* however, it differs, in addition to the differences on the aedoeagus, by the smaller eyes, the different number of punctures in the dorsal rows on the pronotum (there are only six punctures in each row in *G. astutus*) and by the different male secondary sexual characters.

In my previous paper (Smetana, 1973:130) the year 1938 is given as the publication date of this species. The date"September 1938" is printed at the bottom of the page with the description of *G. subdepressus*; however, the wrapper of the "II.Heft" of the Entomologisches Nachrichtenblatt (pages 65–112) gives February 1939 ("Ausgegeben im Feber 1939") as the publication date. The correct year for this species is therefore 1939 and not 1938.

See Smetana (1973:130) for the information on the type series of this species.

3. ***Gabrius kobayashii,*** NEW SPECIES

(Figs. 7–9)

Holotype (male) and allotype (female).—"Japan Gumma Pr. 7 km E Usui Pass 850 m 24.VII.80 A. & Z. Smetana." In the Canadian National Collection, Ottawa (CNC No. 16178).

Paratypes.—Same data as holotype (9); Gumma Pref., 6 km E Usui Pass, 750 m, 20.VII.80, A. & Z. Smetana (8); Gumma Pr., 5 km E Usui Pass, 900 m, 25.VII.80, A. & Z. Smetana (3); Gumma Pr., Usui Bypass, 700 m, 20.VII.80 A. & Z. Smetana (1); Mie Pr. Hirakura, 21.VI.61, Y. Watanabe (5).

Externally very similar to *G. subdepressus,* but differing as follows: eyes slightly larger, index length of eyes to length of temples in dorsal view 11:19 (same index in *G. subdepressus* 9:21), punctures on temporal portion of head in general less numerous, microsculpture on head and pronotum finer, with less appreciable tendency to form irregular meshes on frontal portion of head and on middle anterior portion of pronotum.

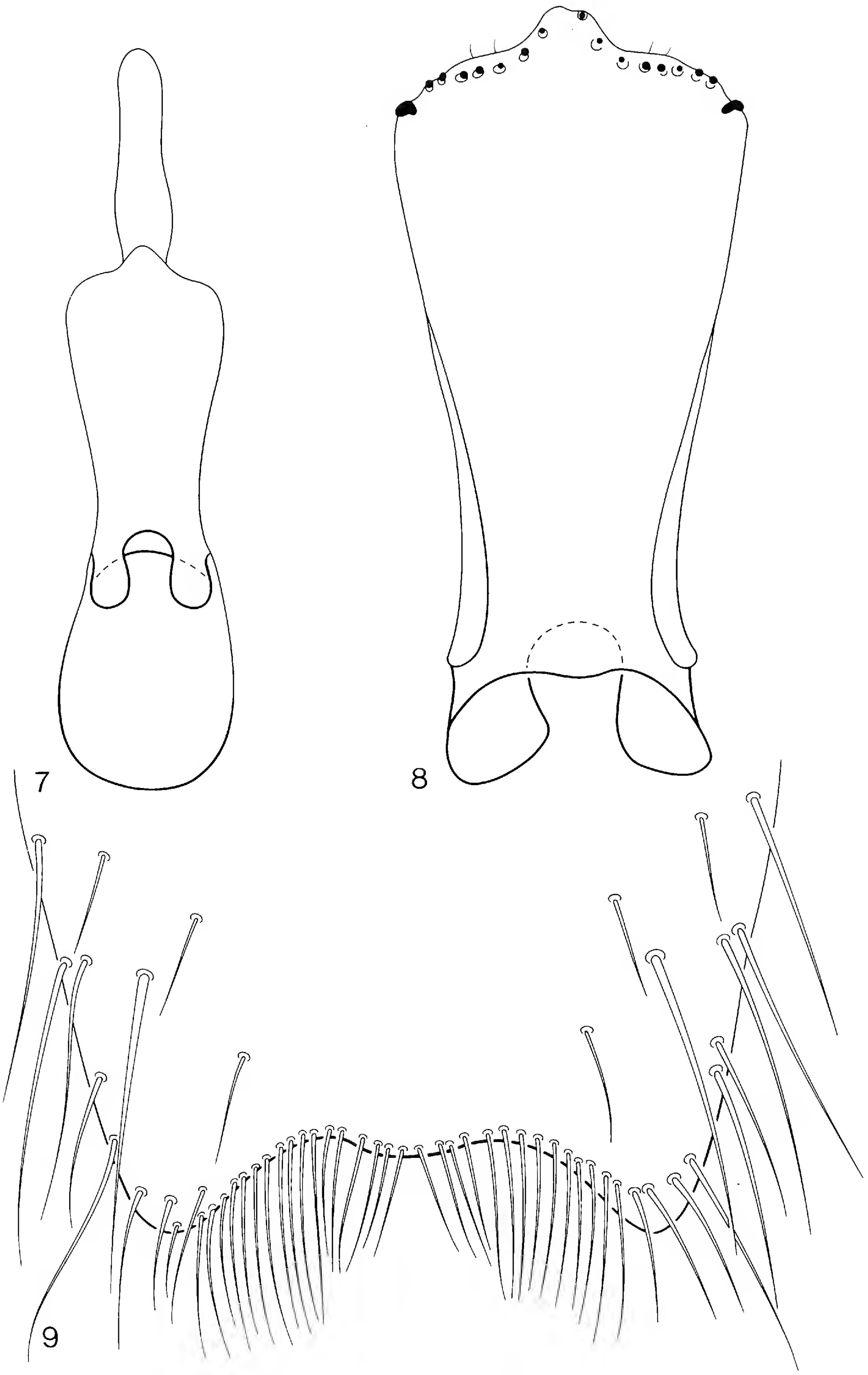
Male.—Sternite of pygidium broadly emarginate, emargination slightly bisinuate, its apical margin bearing numerous long and rather strong setae becoming gradually shorter towards midline (Fig. 9). Aedoeagus rather large, with bulbus and basal portion of median lobe wide, median lobe anteriorly suddenly narrowed into long and narrow, basally attenuate and apically rounded apical portion. Paramere wide, entirely covering middle portion of median lobe, its apical margin broadly arcuate with small, obtusely triangular median projection. Sensory tubercles on underside of paramere arranged along apical margin, including median projection, and becoming distinctly less dense toward middle (Figs. 7, 8).

Length 6.1–7.3 mm.

Distribution.—*Gabrius kobayashii* is at present known only from one locality each in Mie and Gumma Prefectures in Central Honshu.

Bionomics.—The specimens from near Usui Pass were collected by sifting fallen leaves and other debris along creeks.

Discussion.—The external characters, distinguishing this species from *G. subdepressus* are inconspicuous, however, the differences in the size of the eyes and in the development of the microsculpture on the head and pronotum seem to be



Figures 7–9. *Gabrius kobayashii*. 7. Aedoeagus. 8. Underside of paramere. 9. Apical portion of sternite of male pygidium.

constant. *Gabrius kobayashii* is also very similar in all external characters to *G. yamanei,* but differs from the latter by the same set of characters as from *G. subdepressus.*

Etymology.—Patronymic, named in honour of Dr. F. Kobayashi, Forestry and Forest Products Research Institute, Ushiku, Ibaraki, in appreciation of his enormous assistance during our field work in Japan in the summer of 1980.

4. *Gabrius egens* (Sharp, 1874)

(Figs. 10–12)

Philonthus egens Sharp, 1874:44.
Gabrius egens; Smetana, 1960:303.

Material studied.—Japan: Honshu: Kyoto Pref., Kyoto, 7.–8.VIII.80, Cl. Besuchet (MHNG)2.

For description and other information about this species see Smetana (1960: 303–304).

See Figures 10–12 for details of the sternite of the male pygidium and the aedoeagus. Note especially the arrangement of sensory tubercles on the paramere of the aedoeagus.

Type material.—I was able to study three out of four specimens of the original series (see Sharp, 1874:45) deposited in the British Museum (Natural History), London. The specimens are labelled: Spec. No. 1: "Japan. G. Lewis."/"Sharp Coll. 1905-313."/"Philonthus egens Type D.S." Spec. No. 2: "Japan. G. Lewis 1910-230"/"Philonthus egens mihi D.S." Spec. No. 3: "Japan. G. Lewis."/"Japan" (oval yellow label)/"Sharp Coll. 1905-313." The specimen No. 1 bearing the label "Philonthus egens Type D.S." was dissected and the aedoeagus and the pygidium were mounted in Canada balsam. It is hereby designated as the lectotype of *G. egens*; the label "Lectotype Philonthus egens Sharp A. Smetana des. 1981" has been attached to this specimen.

Bionomics.—No details are known about the habitat requirements of this species.

Distribution.—*Gabrius egens* is at present known only from Hyogo (Sharp, 1874: 45) and Kyoto Prefectures (Honshu).

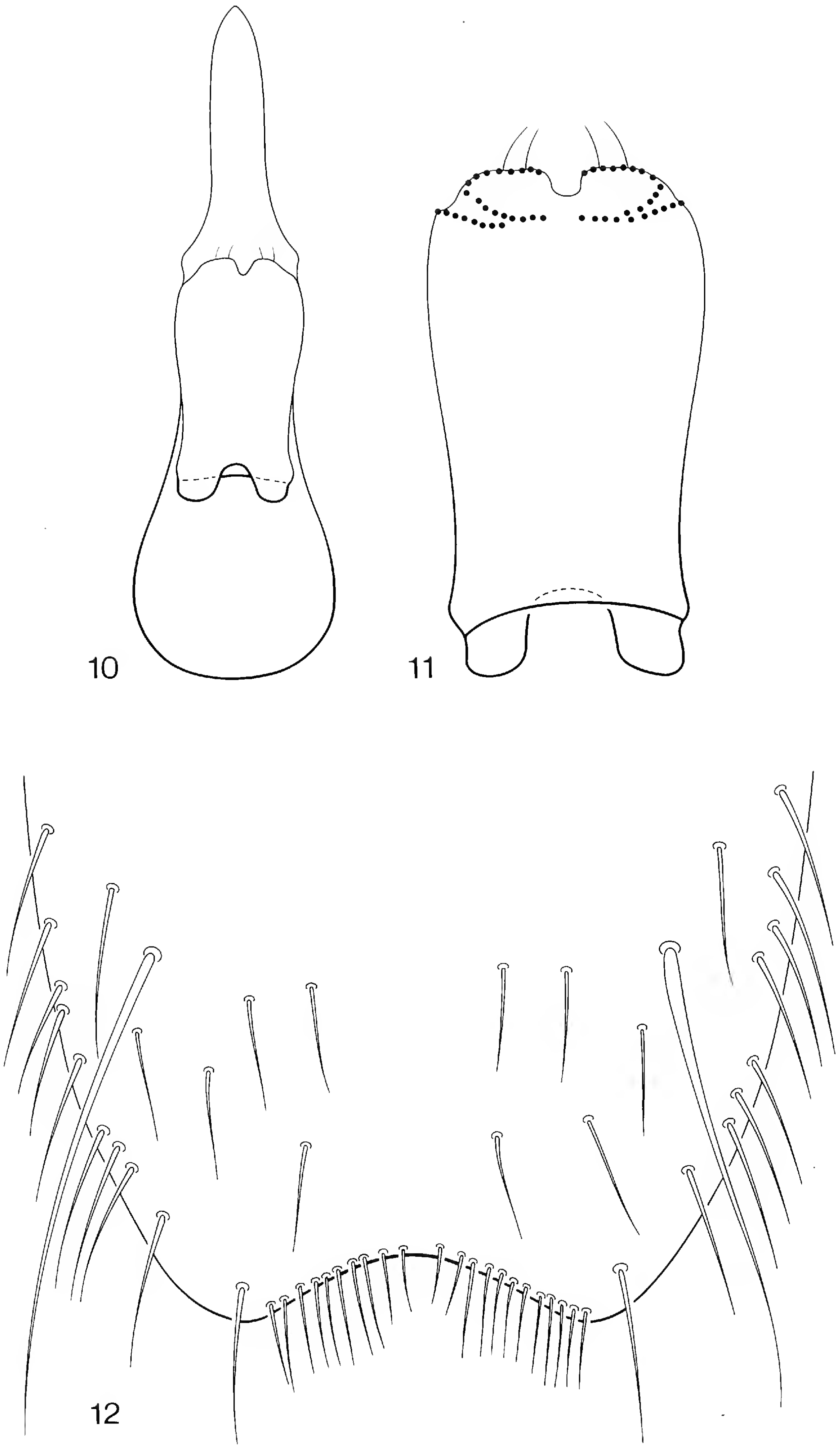
Discussion.—The aedoeagus of *G. egens* is in general appearance similar to that of *G. yamanei,* however, it is distinctive mainly by the differently shaped apical portion of the paramere with the differently arranged sensory tubercles (Figs. 11, 14).

The specimen subsequently designated as lectotype was received in damaged condition with almost no antennae (only six outer segments of right antenna present), with extensive damage to the legs and with the apical portion of the aedoeagus missing. The quite characteristic paramere, however, is present. The apical portion of the aedoeagus on Figure 10 was reconstructed from my previous illustration (Smetana, 1960:304).

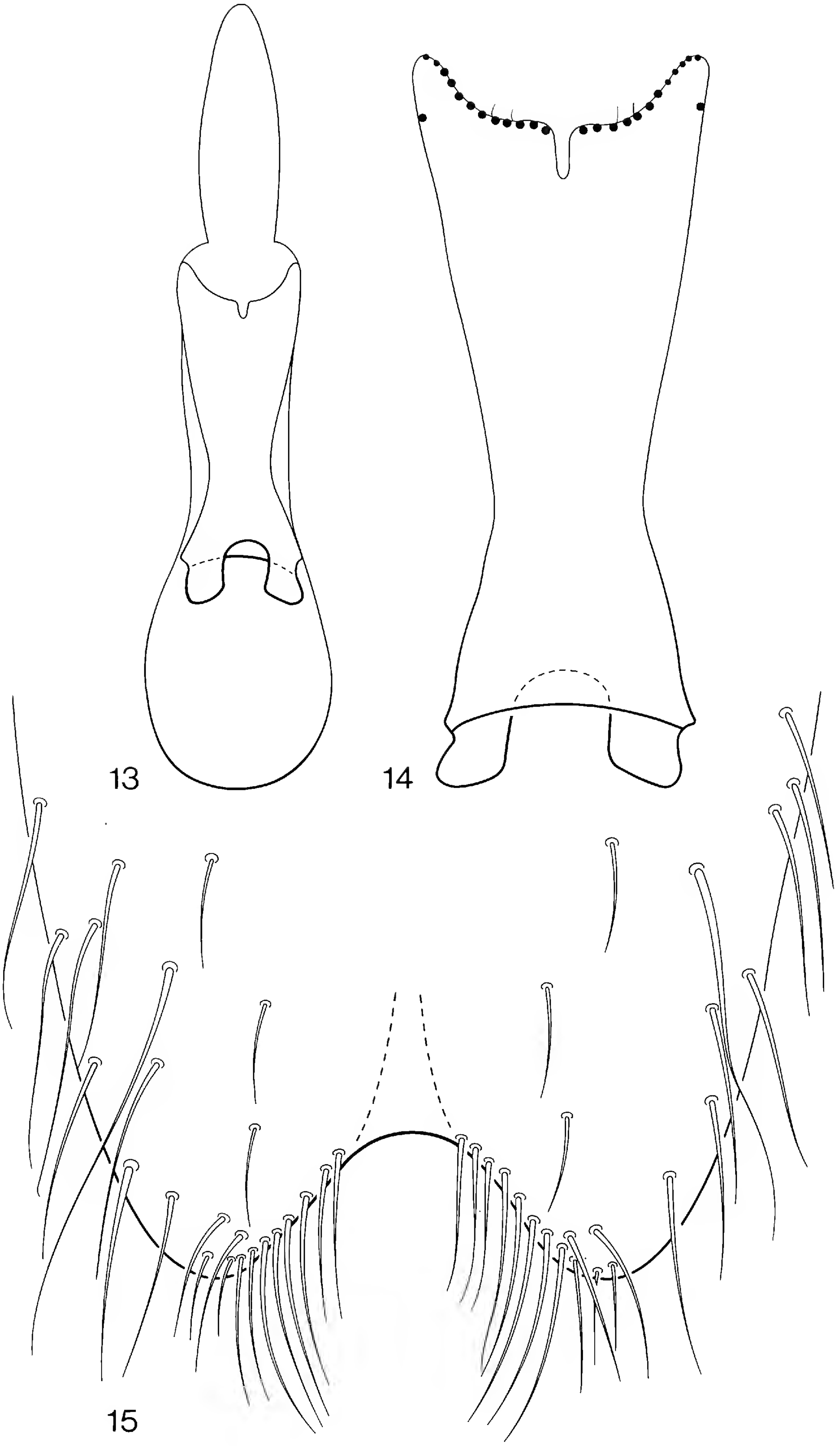
5. *Gabrius yamanei,* New Species

(Figs. 13–15)

Holotype (male) and allotype (female).—"Japan Gumma Pr. 5 km E Usui Pass 900 m 25.VII.80 A. & Z. Smetana." In the Canadian National Collection, Ottawa (CNC No. 17180).



Figures 10–12. *Gabrius egens.* 10. Aedoeagus. 11. Underside of paramere. 12. Apical portion of sternite of male pygidium.



Figures 13–15. *Gabrius yamanei.* 13. Aedoeagus. 14. Underside of paramere. 15. Apical portion of sternite of male pygidium.

Paratypes.—Same data as holotype (41); Gumma Pref., sous Usui Pass, 400 m, 25.VII.80, I. Löbl (MHNG) 1; Gumma Pref., 6 km E Usui Pass, 750 m, 20.VII.80, A. & Z. Smetana (47); Gumma Pref., sous Usui Pass, 850 m, 24.VII.80, I. Löbl (MHNG) 25; Gumma Pref., 7 km E Usui Pass, 850 m, 24.VII.80, A. & Z. Smetana (29); Gumma Pref., sous Usui Pass, 850 m, 24.VII.80, I. Löbl (MHNG) 5; Okutama near Tokyo, 29.IV.61, K. Mizusawa (2).

Externally extremely similar to *G subdepressus* and differing only in characters on aedoeagus and in having slightly different male secondary sexual characters.

Male.—Sternite of pygidium deeply, triangularly emarginate, small triangular median area before emargination flattened and smooth; lateroapical margins of emargination bearing rather strong and long setae becoming gradually shorter both medially and laterally (Fig. 15). Aedoeagus rather large and in general similar to that of *G. kobayashii,* however, with median portion of median lobe narrower, with apical portion somewhat wider and with differently shaped paramere. Paramere anteriorly very broadly, arcuately emarginate, with small and narrow median notch in middle of apical margin. Sensory tubercles on underside of paramere arranged densely along apical margin, one isolated tubercle on each lateral margin situated distinctly below apical row of tubercles (Figs. 13, 14).

Length 5.8–7.0 mm.

Distribution.—*Gabrius yamanei* is at present known from around Usui Pass near Karuizawa in Gumma Prefecture and from near Tokyo (Central Honshu).

Bionomics.—All specimens from near Usui Pass were collected by sifting wet fallen leaves and other debris along creeks, sometimes together with specimens of *G. kobayashii.*

Discussion.—Except for the smaller average size, *G. yamanei* does not appreciably differ externally from *G. subdepressus.* Also the emargination of the sternite of male pygidium is almost identical in both species, however, the strong setae in the emargination are longer and denser in *G. yamanei.* For a comparison with *G. kobayashii* and *G. egens* see the discussion under the respective species.

Etymology.—Patronymic, named in honour of Dr. A. Yamane, Forestry and Forest Products Research Institute, Ushiku, Ibaraki, in appreciation of his great help during our field work in Japan in the summer of 1980.

6. *Gabrius io,* New Species

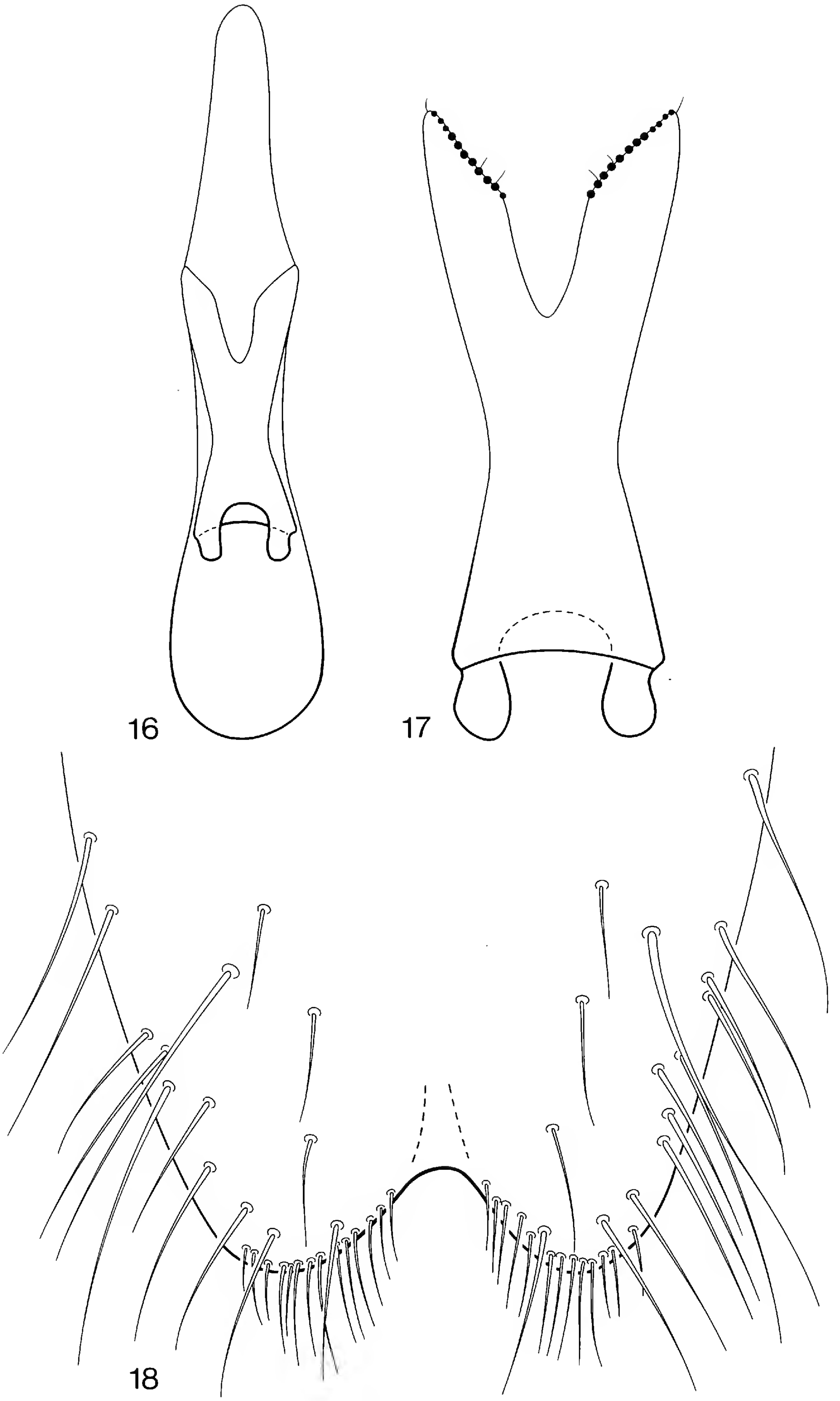
(Figs. 16–18)

Holotype (male).—"Japan Kyoto Pr. Seryo-toge, 500–700 m, 6.VIII. 80 A. & Z. Smetana." Deposited in the Canadian National Collection, Ottawa (CNC No. 17181).

Paratypes.—Kyoto Pref., Seryo-Toge, 13 km N Kyoto, 500–600 m, 6.VIII. 80, I. Löbl (MHNG) 2.

Externally extremely similar to *G. subdepressus* and differing only in characters on the aedoeagus and in having slightly different male secondary sexual characters.

Male.—Sternite of pygidium deeply, triangularly emarginate, small triangular median area before emargination flattened and smooth; lateroapical margins of emargination bearing rather strong and long setae becoming gradually shorter both medially and laterally (Fig. 18). Aedoeagus very similar in general shape to that of *G. subdepressus,* however, differing in shape of paramere. Paramere with branches shorter and wider, shorter than basal portion of paramere and separated



Figures 16–18. *Gabrius io*. 16. Aedoeagus. 17. Underside of paramere. 18. Apical portion of sternite of male pygidium.

mediobasally by deep V-shaped emargination, with sensory tubercles more numerous (Figs. 16, 17).

Length 5.9 mm.

Distribution.—*Gabrius io* is at present known only from the type locality in the Kyoto Prefecture (Honshu).

Bionomics.—The holotype was taken by sifting a small pile of rotting grass.

Discussion.—The holotype of this species is slightly smaller than most specimens of *G. subdepressus*, however, this is probably insignificant; the range of size in *G. io* can be expected to be comparable to that of *G. subdepressus.*

The male secondary sexual characters on the pygidium of *G. io* are very similar to those of *G. subdepressus*, however, the emargination is narrower and the setae on lateroapical margins of the emargination are shorter and less strong in *G. io.*

Etymology.—The specific name is the Latin interjection expressing joy.

7. ***Gabrius damon***, NEW SPECIES
(Figs. 19–21)

Holotype (male) and allotype (female).—"Tachiyzawa - Vill. (Yamagata Pref.) Japan 30.VII.60 Coll. Y. Watanabe." In the Canadian National Collection, Ottawa (CNC No. 17182).

Paratypes.—Same data as holotype (1); same data as holotype but date 2.VIII.60 (1).

Externally very similar to *G. subdepressus* and differing only by its smaller size, by the characters on the aedoeagus and in having slightly different male secondary sexual characters.

Male.—Sternite of pygidium rather deeply triangularly emarginate, small triangular median area before emargination flattened and smooth; lateroapical margins of emargination bearing rather strong and long setae becoming gradually shorter both medially and laterally (Fig. 21). Aedoeagus very similar in general shape to that of *G. subdepressus*, however, in general smaller and less robust. Paramere narrower and more elongate, branches separated by rather acute angle mediobasally, each with inner margin simple, not obliquely truncate apically and with only a few sensory tubercles near apex (Figs. 19, 20).

Length 5.0–5.5 mm.

Distribution.—*Gabrius damon* is at present known only from the type locality in the Yamagata Prefecture (northern Honshu).

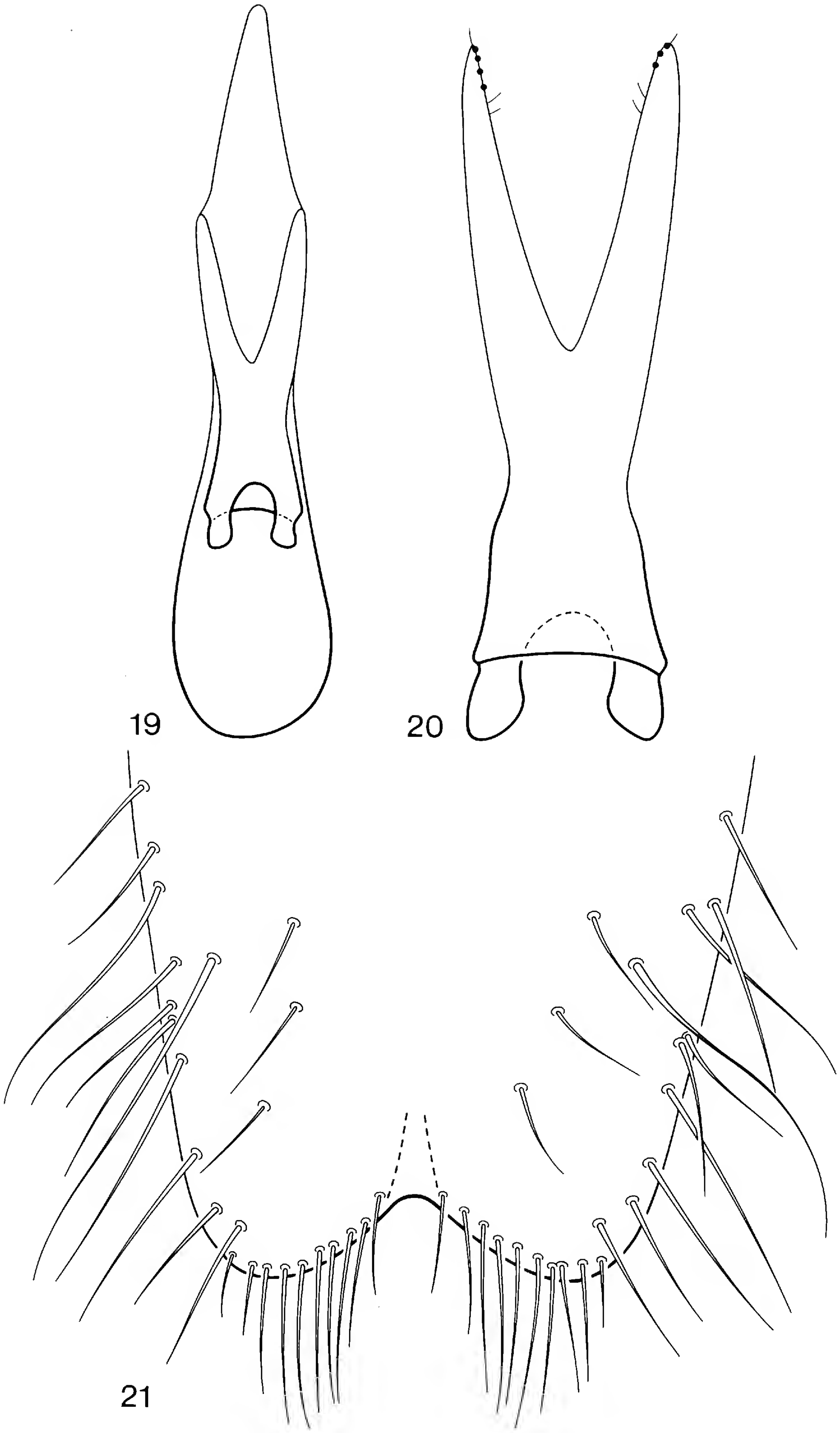
Bionomics.—No details are known about the habitat requirements of this species.

Discussion.—The male secondary sexual characters on the pygidium of *G. damon* are very similar to those of *G. subdepressus*, however, the emargination is narrower and less deep in *G. damon.* It resembles that of *G. io*, however, in the latter the setae on lateroapical margins of the emargination are more numerous.

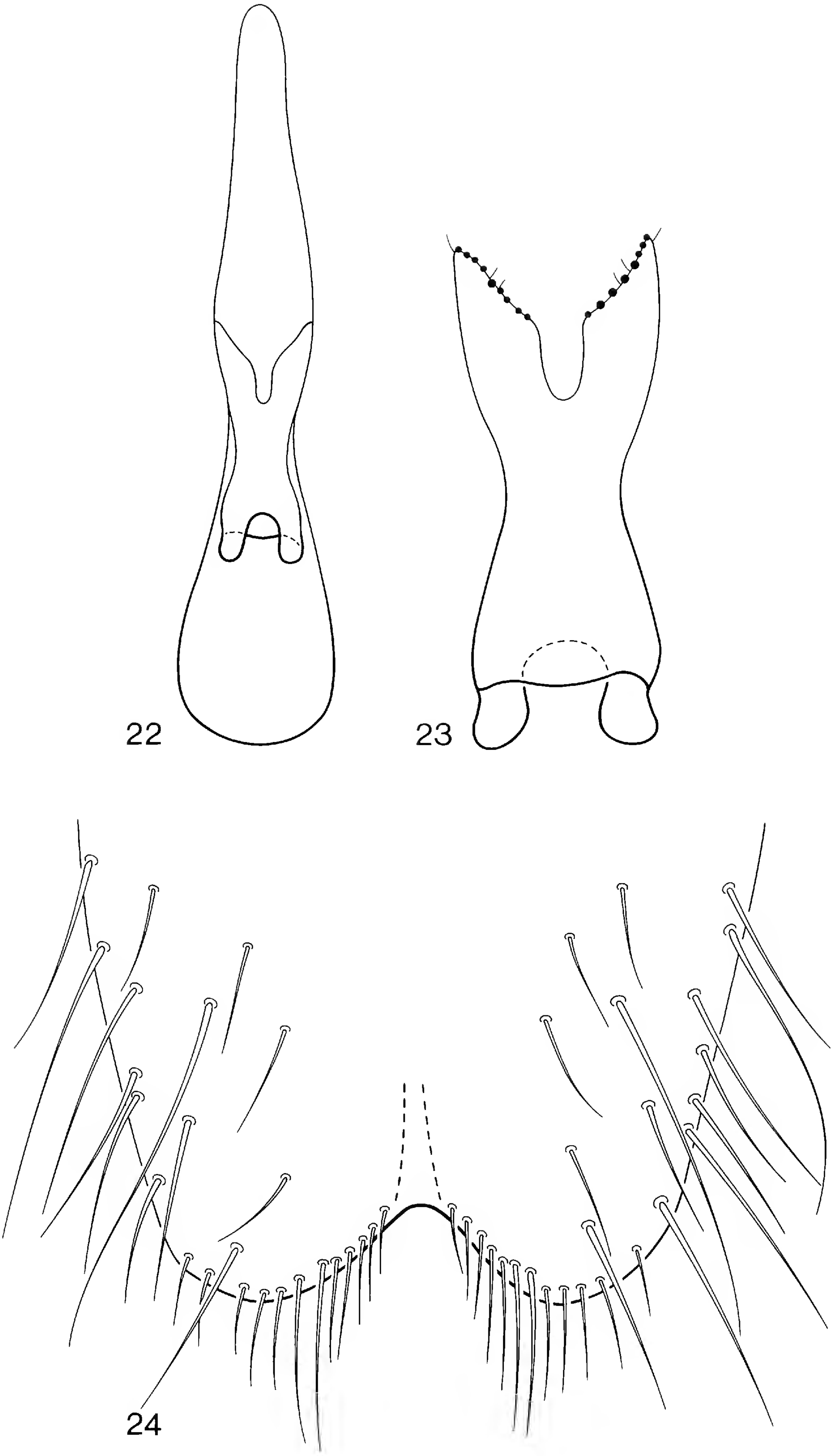
Etymology.—The specific name is the name of a Pythagorean celebrated on account of the friendship between him and Phintias.

8. ***Gabrius abas***, NEW SPECIES
(Figs. 22–24)

Holotype (male) and allotype (female).—"Japan Gumma Pr. 5 km E Usui Pass 900 m 25.VII.80 A. & Z. Smetana." In the Canadian National Collection, Ottawa (CNC No. 17183).



Figures 19–21. *Gabrius damon.* 19. Aedoeagus. 20. Underside of paramere. 21. Apical portion of sternite of male pygidium.



Figures 22–24. *Gabrius abas*. 22. Aedoeagus. 23. Underside of paramere. 24. Apical portion of sternite of male pygidium.

Paratypes.—Same data as holotype (6); Gumma Pr., 6 km E Usui Pass, 750 m, 20.VII.80 A. & Z. Smetana (2); Gumma Pr., Usui Bypass, 700 m, 20.VII.81, A. & Z. Smetana (1).

Externally very similar to *G. subdepressus* and differing only by its smaller size, by the characters on the aedoeagus and in having slightly different male secondary sexual characters.

Male.—Sternite of pygidium rather deeply triangularly emarginate, small triangular area before emargination flattened and smooth; lateroapical margins of emargination bearing rather strong and long setae becoming gradually shorter both medially and laterally (Fig. 24). Aedoeagus very similar in general shape to that of *G. io,* however, different in some details in shape of median lobe and paramere; branches of paramere separated mediobasally by moderately deep, U-shaped emargination; shorter than basal portion of paramere and each with sensory tubercles arranged in a similar way as those of *G. io* (Figs. 22, 23).

Length 5.0–5.7 mm.

Distribution.—*Gabrius abas* is at present known only from around Usui Pass near Karuizawa in Gumma Prefecture (Central Honshu).

Bionomics.—All specimens of the original series were taken by sifting fallen leaves and other debris along creeks.

Discussion.—The male secondary sexual characters on the pygidium of *G. abas* are almost identical to those of *G. damon,* however, the setae on the lateroapical margins of the emargination are in general shorter in *G. abas.*

One paratype in the original series of *G. abas* has only six punctures in one of the dorsal rows on pronotum.

Etymology.—The specific name is the name of the twelfth king of Argos, son of Lyncaeus and Hypermnestra, grandson of Danaus, father of Acrisius and grandfather of Perseus.

9. ***Gabrius demades,*** New Species

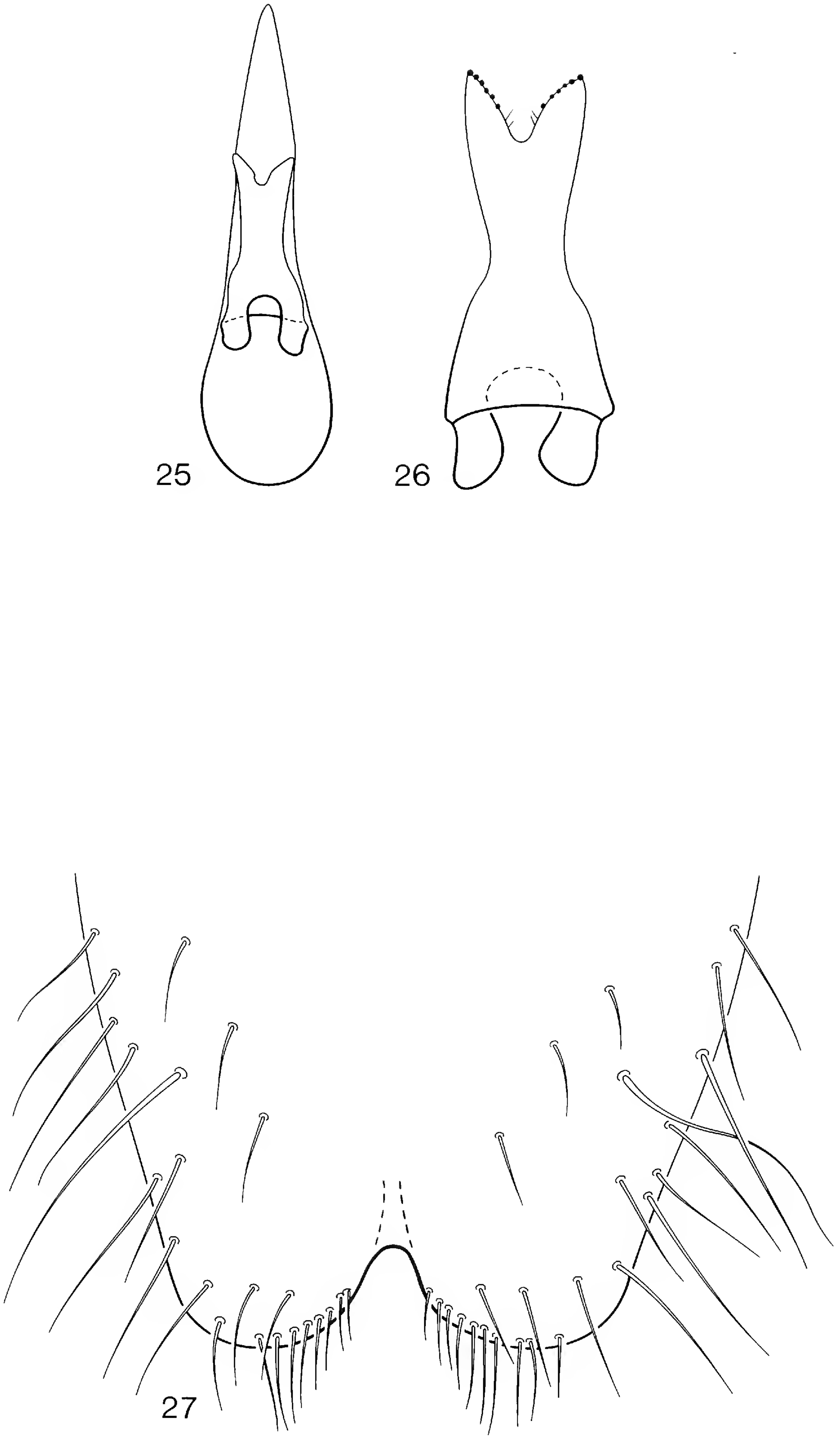
(Figs. 25–27)

Holotype (male) and allotype (female).—"Japan Toyama Pr. Tateyama Mts. Bijodaira 1000 m 28.VII.80 A. & Z. Smetana." In the Canadian National Collection (CNC No. 17184).

Paratypes.—Same data as holotype (4); Nikko Nat. Park, below Konsei Pass (W side), 1500–1600 m, 15.VII.80, A. & Z. Smetana (2); Toyama Pr., Arimine, Kaminikawa, 1100 m, 29.VII.80, A. & Z. Smetana (1); Ehime Pr., Ishizuchi Nat. Park, Mt. Ishizuchi, 12.VIII.80, Cl. Besuchet (MHNG) (4).

General habitus of a species from Nigritulus-group. Elytra and to lesser extent also head and pronotum with slight metallic lustre. Antennae brunneous with two basal segments testaceous or entirely testaceous, legs rufotestaceous with inner portions of metatibiae occasionally darkened. Eyes rather small, index length of eyes to length of temples in dorsal view equals 7:14. Dorsal rows of pronotum with six punctures each, occasionally one additional puncture present unilaterally.

Male.—Sternite of pygidium moderately deeply triangularly emarginate, small triangular median area before emargination flattened and smooth; lateroapical margins of emargination bearing fairly strong but not long setae becoming gradually finer and shorter medially (Fig. 27). Aedoeagus elongate with apical portion of median lobe evenly and almost conically tapered toward fairly acute apex.



Figures 25–27. *Gabrius demades*. 25. Aedoeagus. 26. Underside of paramere. 27. Apical portion of sternite of male pygidium.

Paramere rather short, with two stout and very short branches apically, separated from each other by almost semicircular notch; sensory tubercles on underside of paramere arranged along apical margin of each branch (Figs. 25, 26).

Length 4.0–4.5 mm.

Distribution.—*Gabrius demades* is as present known from a few localities in the Nikko National Park, in the mountains of the Toyama Prefecture (Honshu), and in the Ishizuchi National Park (Shikoku).

Bionomics.—The specimens of the original series were taken by sifting wet leaf litter and moss along creeks (Nikko N.P. and Kaminikawa) and by sifting debris around bases of old trees in an undisturbed deciduous forest (Bijodaira).

Discussion.—Except for one specimen with seven punctures in one of the dorsal rows on pronotum, all remaining specimens have six punctures in these rows.

Etymology.—The specific name is the name of the famous Athenian rhetorician Demades, a contemporary of Demosthenes.

10. *Gabrius philo,* New Species

(Figs. 28–30)

Holotype (male) and allotype (female).—"Japan Nikko N.P. Ryuzu 16.VII.80 1400 m, A. & Z. Smetana." In the Canadian National Collection, Ottawa (CNC No. 17185).

Paratypes.—Same data as holotype (1); Nagano Pr., Shiga, 1500 m, 23.VII.80, A. & Z. Smetana (1); Nagano Pr., J. E. Kogen N. Park, Shiga, 1500 m, 23.VII.80, I. Löbl (MHNG) 14; Toyama Pr., Arimine, Kaminikawa, 1100 m, 29.VII.80, A. & Z. Smetana (2); same I. Löbl (MHNG) 2; Kyoto Pref., Seryo-Toge, 13 km N Kyoto, 500–600 m, 6.VIII.80, I. Löbl (MHNG) 2, Ehime Pr., via Mt. Ishizuchi, 1000 m, 14.VII.80, I. Löbl (MHNG) 4.

Externally very similar to *G. demades* but differing by slightly larger size, by slightly larger eyes (index length of eyes to length of temples in dorsal view equals 7:18), by the characters on the aedoeagus and by the different male secondary sexual characters.

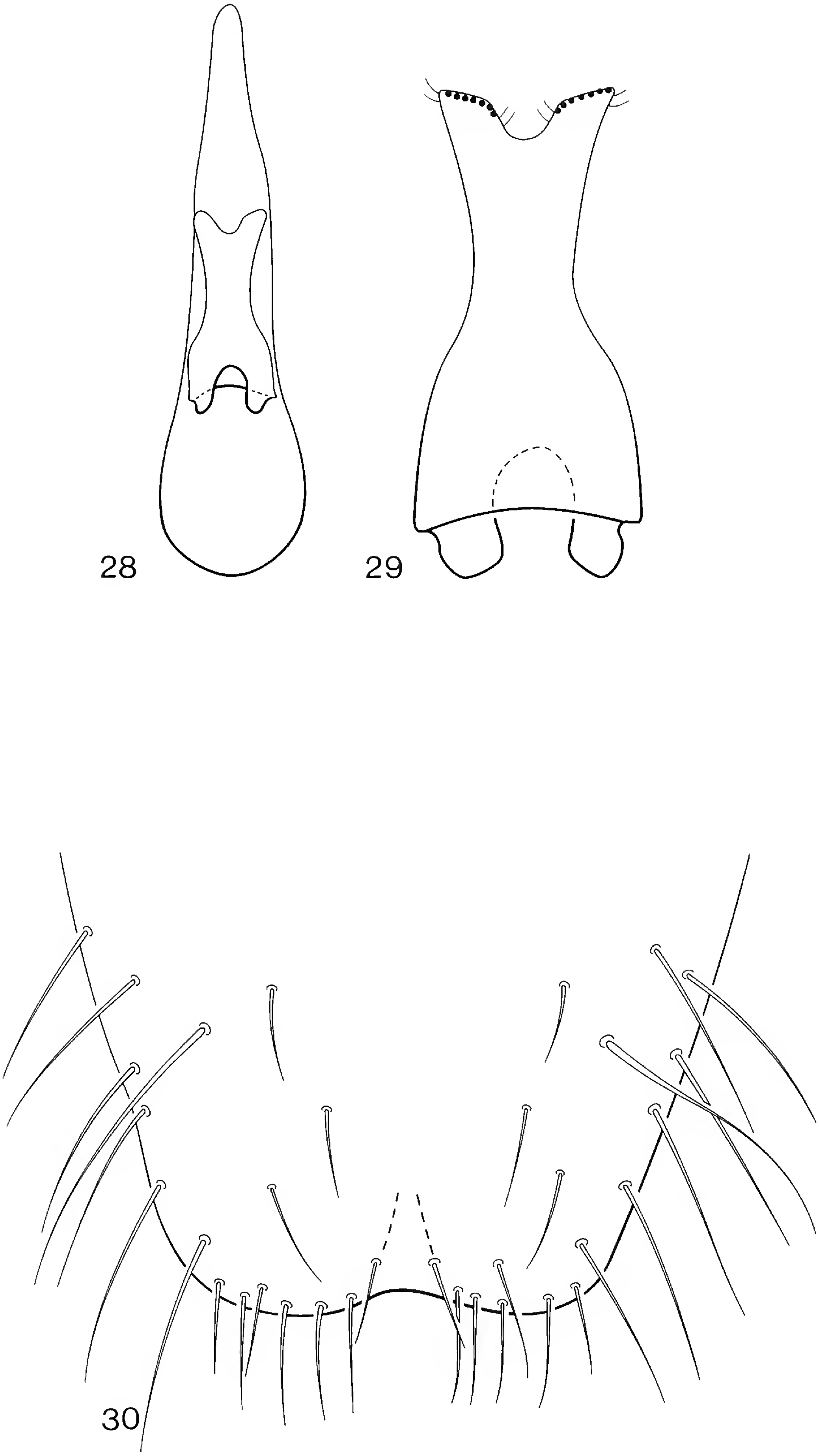
Male.—Sternite of pygidium shallowly, almost arcuately emarginate apically, small triangular median area before emargination flattened and smooth; margins of emargination without accumulation of strong setae (Fig. 30). Aedoeagus, including paramere, very similar to that of *G. demades,* however, in general larger with apical portion of median lobe more robust, not conically narrowed anteriorly and with obtusely rounded apex (Fig. 28); paramere as in Figure 29.

Length 4.8–5.2 mm.

Distribution.—*Gabrius philo* is at present known from the Nikko National Park, from the Nagano and Toyama Prefectures (Honshu), and from the Ehime Prefecture (Shikoku).

Bionomics.—The specimens of the type series were collected by sifting wet moss and debris around seepages in an old hardwood forest (Nikko N.P.), in debris along a creek (Shiga) and by sifting wet moss and various debris at a small creek (Kaminikawa).

Discussion.—The paramere of *G. philo* is very similar to that of *G. kuanshanensis;* however, in *G. philo* the notch in the middle of the apical margin of the paramere is shallower and less wide, and the sensory tubercles on the apical margin of the paramere are larger and more crowded (Figs. 29, 32).



Figures 28–30. *Gabrius philo.* 28. Aedoeagus. 29. Underside of paramere. 30. Apical portion of sternite of male pygidium.

Etymology.—The specific name is the name of an academic philosopher of Athens, teacher of Cicero.

11. *Gabrius kuanshanensis* (Bernhauer, 1914)
(Figs. 31–33)

Philonthus kuanshanensis Bernhauer, 1914:66.
Gabrius kuanshanensis; Smetana, 1973:132.
Gabrius kuanshanensis; Coiffait, 1974:33, Fig. 12G, H, I; 79.

Material studied.—See Smetana, 1973:132. For the description and other information about this species see Smetana, 1973:132–133 and Coiffait, 1974:33, 79–80.

See Figures 31–33 for details of the sternite of the male pygidium and the aedoeagus. Note particularly the arrangement of the sensory tubercles on the paramere of the aedoeagus.

Distribution.—*Gabrius kuanshanensis* is at present known only from "Chi-Kuan-Shan" (=Jiguanshan?) and from Chinkiang (=Chenjiang?) in the Peoples Republic of China. It has not yet been found in Japan, however, it may occur there.

Discussion.—*Gabrius kuanshanensis* is, in all characters, including the aedoeagus, very similar to *G. sharpianus;* however, the latter differs by having a swelling on the dorsal face of the apical portion of the median lobe of the aedoeagus. As a matter of fact, the seven specimens in the Bernhauer collection under the name *P. kuanshanensis* described in detail by myself (Smetana, 1973:132) and mentioned also by Coiffait (1974:79) belong to two different species. Of the three males from "Chinkiang," the aedoeagi of two of them agree with drawings of the aedoeagus of *G. kuanshanensis* given both by myself (Smetana, 1973:131, Fig. 6) and by Coiffait (1974:33, Fig. 12G, H, I). However, I recently dissected the third male and found that the aedoeagus agrees with that of *G. sharpianus.*

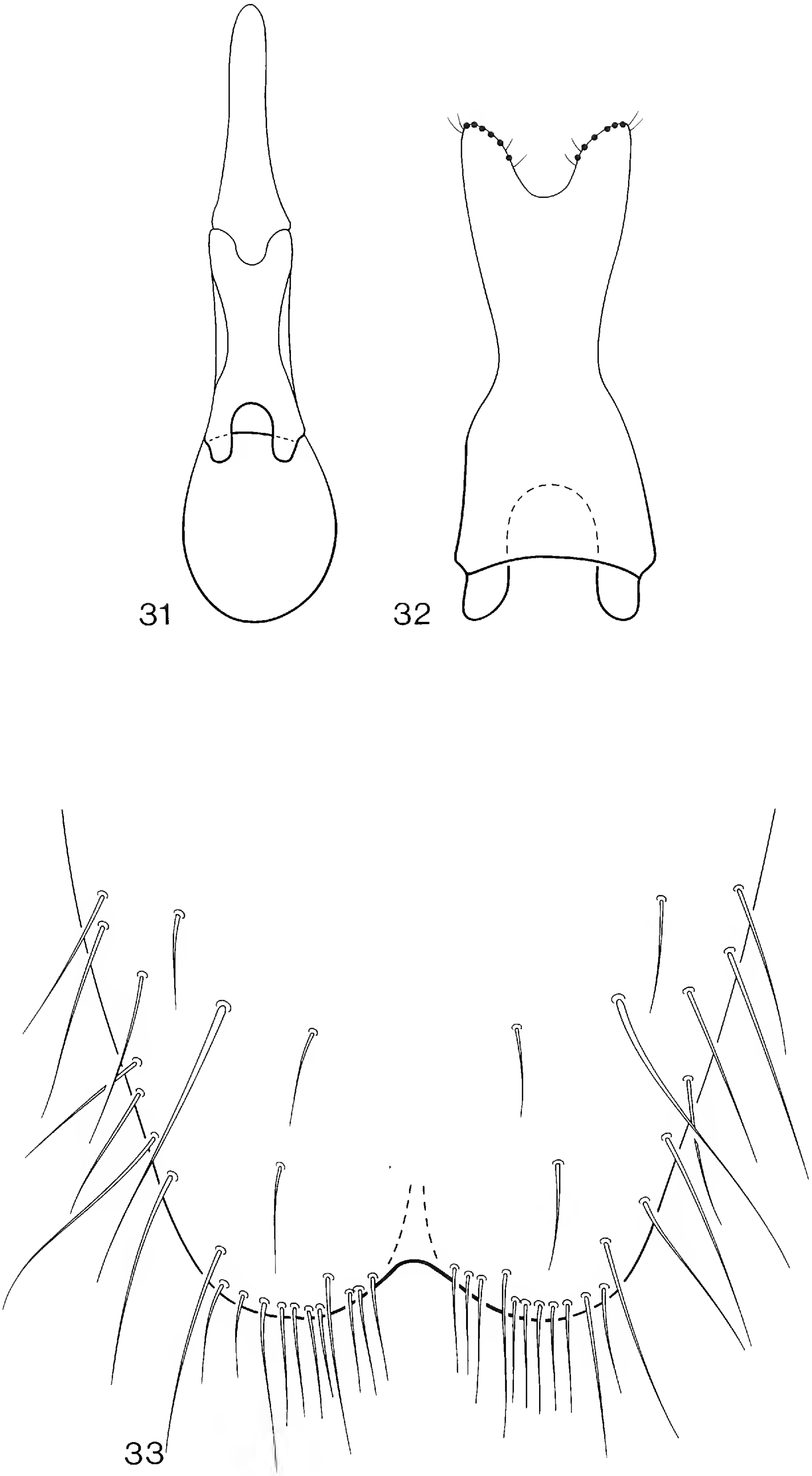
Gabrius kuanshanensis is also similar to *G. philo*; however, the latter differs by having the sternite of the male pygidium shallowly emarginate and by some details in the shape of the median lobe and of the paramere (see Figs. 29, 32, and the discussion under *G. philo*).

I erroneously considered the only original specimen of *G. kuanshanensis* in the Bernhauer collection (see Smetana, 1973:132) as the holotype of this species. The specimen cannot be in fact considered as the holotype (see Bernhauer, 1914:67). It is therefore hereby designated as the lectotype; the label "Lectotype Philonthus kuanshanensis Bernh. Smetana des. 1981" has been attached to it.

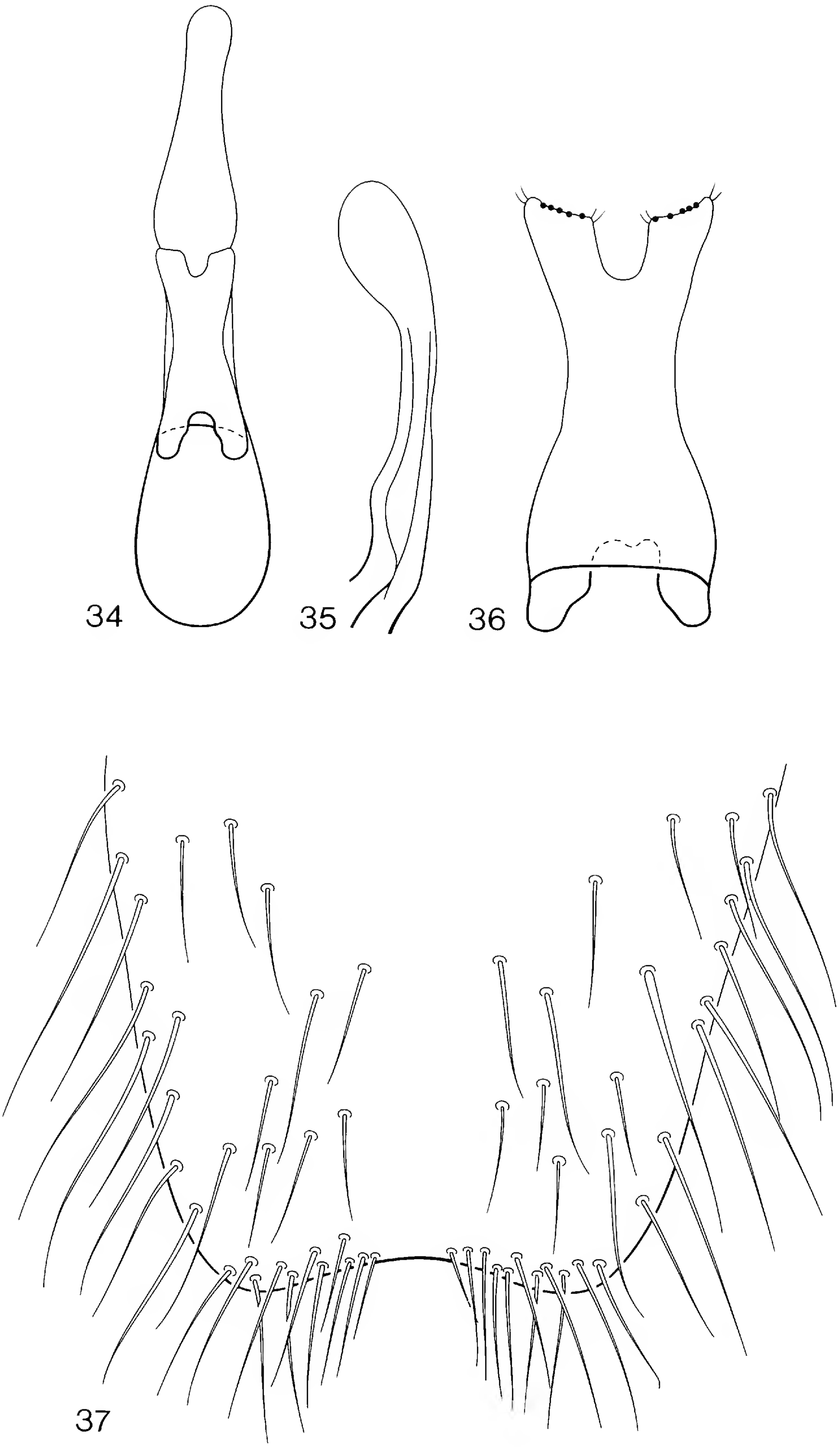
12. *Gabrius sharpianus* (Cameron, 1930)
(Figs. 34–37)

Philonthus sharpianus Cameron, 1930:207.
Philonthus conicus Bernhauer, 1939:99 (n. syn.).
Gabrius demarcatus Tottenham, 1940:68.
Gabrius sharpianus; Smetana, 1960:305.

Material studied.—Japan: Gifu Pref., 8 km SW Gero, Hwy 257, 450 m, 31.VII.80, A. & Z. Smetana (16); Gifu Pref., 9 km S Gero, Hwy 41, 475 m, 31.VII.80, A.



Figures 31–33. *Gabrius kuanshanensis*. 31. Aedoeagus. 32. Underside of paramere. 33. Apical portion of sternite of male pygidium.



Figures 34–37. *Gabrius sharpianus.* 34. Aedoeagus. 35. Apical portion of median lobe in lateral view. 36. Underside of paramere. 37. Apical portion of sternite of male pygidium.

& Z. Smetana (3); Gifu Pref., 8 km SE Osaka, 750 m, 1.VIII.80, I. Löbl (MHNG) 1; Gumma Pref., 5 km E Usui Pass, 900 m, 25.VII.80, A. & Z. Smetana (4); Gumma Pref., 6 km E Usui Pass, 750 m, 20.VII.80, A. & Z. Smetana (3); same, I. Löbl (MHNG) 2; Gumma Pref., 7 km E Usui Pass, 850 m, 24.VII.80, A. & Z. Smetana (5); same, I.Löbl (MHNG) 3; Gumma Pref., 4 km SW Tsumagoi, 1050 m, 18.VII.80, A. & Z. Smetana (3); same, I. Löbl (MHNG) 4; Nagano Pref., Shiga, 1500 m, 23.VII.80, A. & Z. Smetana (1); Kyoto Pref., Kyoto, 18–20.VIII.80, Cl. Besuchet (MHNG) 15; Kyoto Pref., Kyoto, Mt. Hiei, 800 m, 2.VIII.80, Cl. Besuchet (MHNG) 5; Kyoto Pref., Seryo-Toge, 13 km N Kyoto, 500–600 m, 6.VIII.80, Cl. Besuchet (MHNG) 2; Nara Pref., Nara, 7, 10 and 11.VIII.80, A. & Z. Smetana (24); same, 27–31.VII.80, Cl. Besuchet (MHNG) 12; Toyama Pref., 10 km SE Unazuki Hot Spa, 400 m, 27.VII.80, A. & Z. Smetana (2). Peoples Republic of China: "Nordwestl. China Chinkiang Col. Reitter" (1). Additional localities in Japan can be found in Smetana, 1960:305.

For the description and other information about this species, including the synonymy and type material of *G. sharpianus* and *G. demarcatus,* see Smetana, 1960:305–306.

See Figures 34–37 for details of the sternite of the male pygidium and the aedoeagus. Note especially the arrangement of sensory tubercles on the paramere of the aedoeagus.

Type material of G. conicus.—The Bernhauer collection in the Field Museum of Natural History, Chicago, contains two conspecific females under the name of *Philonthus conicus.* They are labelled: Spec. No. 1. "Tsushima Japan"/"conicus Brnh. Typ."/"conicus Bernh. Typus"/"Chicago NHMus M. Bernhauer Collection." Spec. No. 2: "Nordwestl. China Chinkiang Col. Reitter"/"conicus Bernh. Cotypus"/"Chicago NHMus M. Bernhauer Collection." Specimen No. 1 is hereby designated as the lectotype of *G. conicus;* the label "Lectotype Philonthus conicus Bernh. Smetana des. 1981" has been attached to this specimen. Both specimens are considered indistinguishable from specimens of *G. sharpianus* and the name *G. conicus* should be considered as a synonym of *G. sharpianus;* my corresponding determination label was attached to each of the two original specimens.

Bionomics.—Most specimens collected in Japan in 1980 were taken by sifting wet moss, fallen leaves and other debris, including old flood debris, along creeks; some were also taken by sifting fallen leaves and other floor debris on wet areas in an old mixed forest (Nara).

Distribution.—*Gabrius sharpianus* is known from "Chinkiang" in the Peoples Republic of China and from numerous localities in Japan on Honshu (Gifu, Gumma, Nagano, Nara and Toyama Prefectures) and on Kyushu (Nagasaki Prefecture).

Discussion.—*Gabrius sharpianus* is in all characters, including the aedoeagus, very similar to *G. kuanshanensis;* however, the aedoeagus of the latter differs, in addition to some minor differences, particularly by the absence of the globular swelling of the dorsal face of the apex of the median lobe which is quite characteristic of *G. sharpianus.*

The specimen from "Chinkiang" mentioned above is one of the seven specimens originally deposited in the Berhnauer collection under the name *P. kuanshanensis* (see also the discussion under *G. kuanshanensis*).

13. *Gabrius ophion,* New Species

(Figs. 38–40)

Holotype (male) and allotype (female).—"Japan Gumma Pr. 7 km E Usui Pass 850 m, 24.VII.80 A. & Z. Smetana." In the Canadian National Collection, Ottawa (CNC No. 17186).

Paratypes.—Gifu Pr., 8 km SW Gero, Hwy. 257, 450 m, 31.VII.80, A. & Z. Smetana (1); Nikko Nat. Park, Lake Chuzenjiko, Chisan-Shukuhakusho 1300 m, 15.VII.80, A. & Z. Smetana (2); Kyoto Pr., Seryo-Toge, 13 km N Kyoto, 500–600 m, 6.VIII.80, Cl. Besuchet (MHNG) 2; Kuril Islands, Kunashir Island, Mendeleevo, 9.IX.72, Pototskaya (1).

Externally very similar to *G. demades* and differing only by slightly larger eyes (index length of eye to length of temple in dorsal view equals 10:17), by characters on the aedoeagus and in having different male secondary sexual characters.

Male.—Sternite of pygidium with wide and rather shallow, obtusely traingular emargination, apical margin with numerous setae gradually becoming shorter and weaker towards middle (Fig. 40). Aedoeagus very long, median lobe very elongate but relatively wide, gradually narrowed anteriorly, apically rather suddenly narrowed into obtuse apex. Paramere with apical margin with small median emargination and one deeper and much wider emargination on each side; sensory tubercles on underside of paramere arranged along apical margin, leaving small median emargination free (Figs. 38, 39).

Length 4.2–4.9 mm.

Distribution.—*Gabrius ophion* is at present known from a few localities in the Nikko National Park, in the Gifu, Gumma and Kyoto Prefectures (Honshu), and from one locality on the Kunashir Island in the Kuril Islands.

Bionomics.—Most specimens of the original series were collected in wet leaf litter and other debris (including old flood-debris) along creeks; some were taken by sifting a pile of decaying grass (Nikko N.P.). The specimen from the Kunashir Island was reared from a pupa found on a dead *Abies* spec. tree.

Discussion.—The species is quite distinctive by the characteristic shape of the paramere.

One paratype from Japan has one additional puncture in one of the dorsal rows on the pronotum.

The specimen from the Kunashir Island is quite teneral.

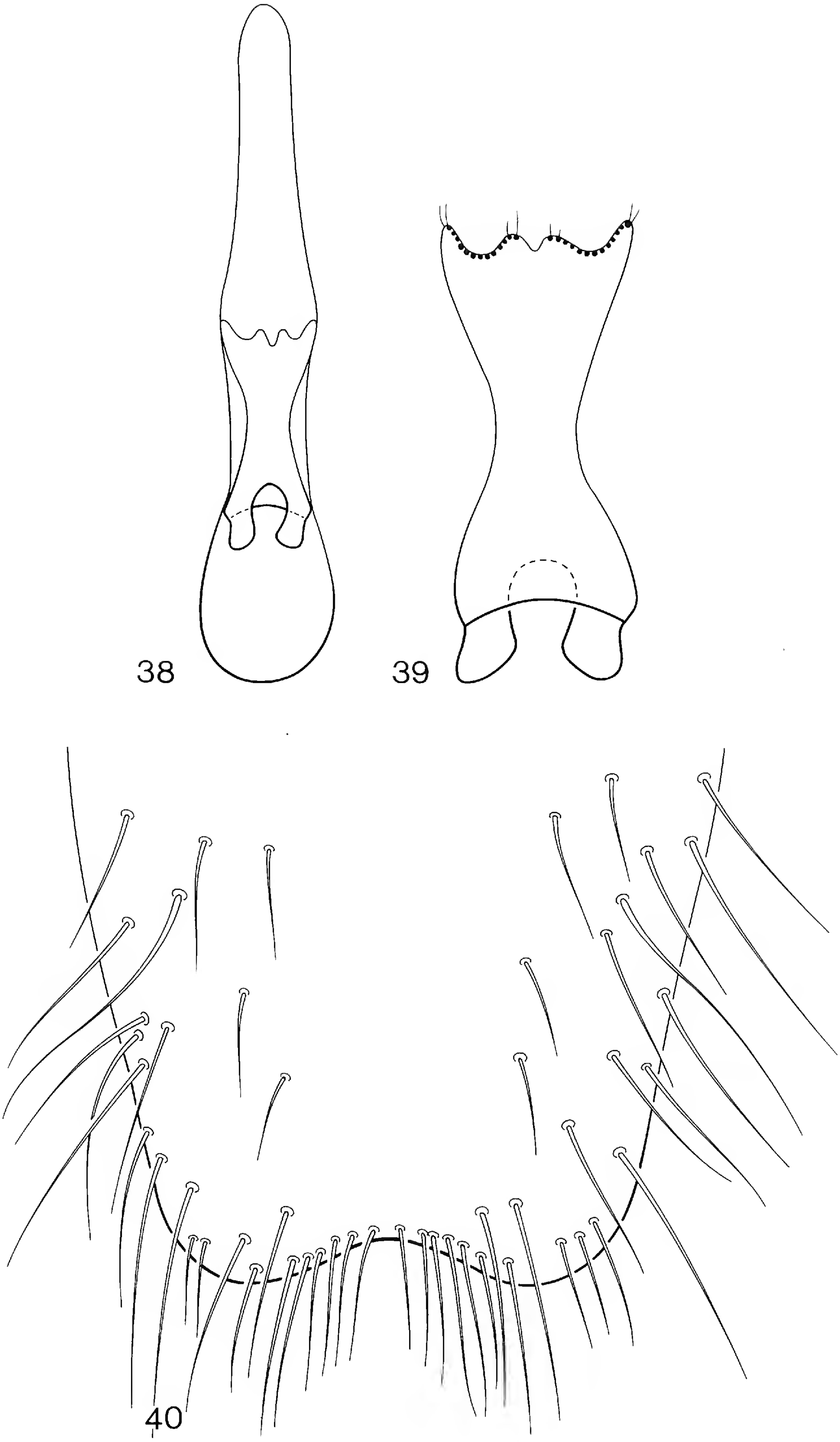
Etymology.—The specific name is the name of the Centaur Ophion who was the father of Amycus.

14. *Gabrius nepos,* New Species

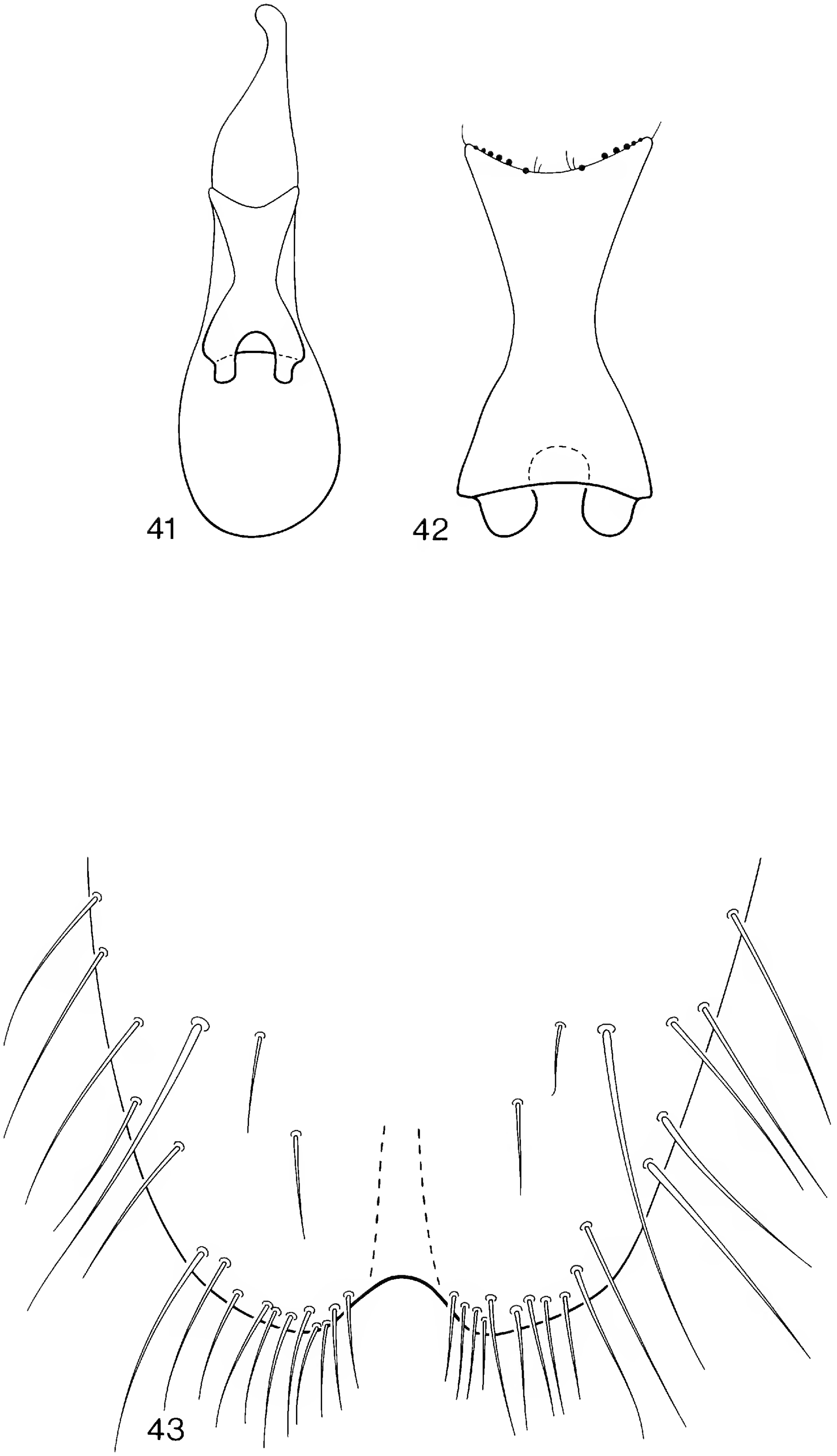
(Figs. 41–43)

Holotype (male) and allotype (female).—"Japan Gumma Pr. Usui Bypass 700 m 20.VII.80, A. & Z. Smetana." In the Canadian National Collection, Ottawa (CNC No. 17187).

Paratypes.—Same data as holotype (5); Gifu Pr., 8 km SW Gero, Hwy 257, 450 m, 31.VII.80, A. & Z. Smetana (3); Gifu Pr., 9 km S Gero, Hwy 41, 475 m, 31.VII.80, A. & Z. Smetana (3); Gifu Pr., 8 km SE Osaka, 750 m, 1.VIII.80, A. & Z. Smetana (1); Toyama Pr., Arimine, Kaminikawa, 1100 m, 29.VII.80, A. &



Figures 38–40. *Gabrius ophion*. 38. Aedoeagus. 39. Underside of paramere. 40. Apical portion of sternite of male pygidium.



Figures 41–43. *Gabrius nepos*. 41. Aedoeagus. 42. Underside of paramere. 43. Apical portion of sternite of male pygidium.

Z. Smetana (2); Mie Pr., Hirakura, 20. or 21.VI.61, Y. Watanabe (4); Ehime Pr., Ishizuchi N. Park, Omogo, 12.VIII.80, Cl. Besuchet (MHNG) 3.

Externally very similar to *G. demades* and differing only in characters on the aedoeagus and in having different male secondary sexual characters.

Male.—Sternite of pygidium with rather narrow and not deep, obtusely arcuate emargination, small triangular median area before emargination flattened and smooth; with group of setae at each side of emargination (Fig. 43). Aedoeagus with median lobe asymmetrical, apical portion of median lobe fairly narrow, distinctly hook-like curved and obtuse apically. Paramere strongly widened anteriorly, anterior margin broadly and shallowly arcuately emarginate, sensory tubercles on underside of paramere situated at apical margin and gradually disappearing towards middle (Figs. 41–42).

Length 4.0–4.8 mm.

Distribution.—*Gabrius nepos* is at present known from several localities in Gifu, Gumma and Toyama Prefectures (Honshu), and one locality in Ehime Prefecture (Shikoku).

Bionomics.—The specimens of the original series were taken by sifting wet moss, fallen leaves and other debris along creeks, those from around Gero were sifted from old flood debris at a creek.

Discussion.—The species is quite distinctive by the characteristic shape of the paramere and by the assymmetrical, hook-like curved apical portion of the median lobe.

One paratype has one additional puncture in one of the dorsal rows on the pronotum.

Etymology.—The specific name is the name of a Roman historian, the friend of Cicero, Atticus and Catullus.

ACKNOWLEDGMENTS

The original specimens of some species described by Bernhauer and by Sharp have been made available to me through the kindness of Dr. L. Watrous, Field Museum of Natural History, Chicago and Mr. G. Kibby, British Museum (Natural History), London. Their assistance is gratefully acknowledged.

I thank Mr. Y. Watanabe, Tokyo, for allowing me to study, many years ago, the Japanese species of *Gabrius* and letting me keep some specimens in my collection. I also thank my colleagues, Drs. E.C. Becker and J.M. Campbell in the Coleoptera Unit of the Biosystematics Research Institute for their suggestions and criticisms of the manuscript, and Mr. G. Sato for carefully finishing all the drawings in this paper.

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Hour of Mating Flight in Three Species of Ants (Hymenoptera: Formicidae)[1]

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The mating flights of ants usually occur at a time of day characteristic for the species (Hölldobler, 1976; Kannowski, 1963; Talbot, 1946). Also there is apparently a genus likeness in time of flight (McCluskey, 1973, 1974); but for study at this taxonomic level, records for more species are desirable. For one species reported here, the hour is very different from most other records in its genus.

The flights all occurred in or near our yard 1 km up Reche Canyon (elevation 350 m), near Colton, San Bernardino County, California. The observations of the first species below were made by both of us, those of the second by ESM, and the third by Esther McCluskey.

SOLENOPSIS MANIOSA WHEELER

Mallis (1938) states that the mating flights are in the late afternoon of a warm day, and we have often seen the winged castes out of the nest on summer evenings. The purpose here is to make a more quantitative statement. In Figure 1A are assembled the flight records for a number of nests and days. A few of these records were the basis for the "1815" flight hour given in Figure 1 of McCluskey (1974) (there called *S. xyloni*).

The hour of peak flight is shown by an "x" for each record; the mean was 1750. The span of time from the earliest (1630) to the latest (1855) ant seen to fly is shown by the short bar underneath. Flights occurred only in the shade, between 25 and 32°C (temperature at 1 m from surface). Any given flight often lasted only a small fraction of an hour, but was preceded by a build-up of workers and alates. Alates flying per minute varied from less than one to many.

For several nests in July 1979 both light intensity and ground-level temperature were observed. At least for the limited number of nests and days compared, nest-to-nest or day-to-day variability of these measurements did not appear to explain the variability in time of flight (nearly an hour). Peak flight occurred at the same time as peak number of alates out. However, for some days or nests there were no flights seen, even when the number out was 10 or more at once, as if flight requires something beyond that which initiates exit from the nest. (As DKM says, "the ants fly when they feel like it.")

No winged ants were even seen outside the nest on any of the 10 mornings briefly observed (see Fig. 1B for two of these days), even if unusually warm and humid.

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[1] Species kindly determined by Roy Snelling.

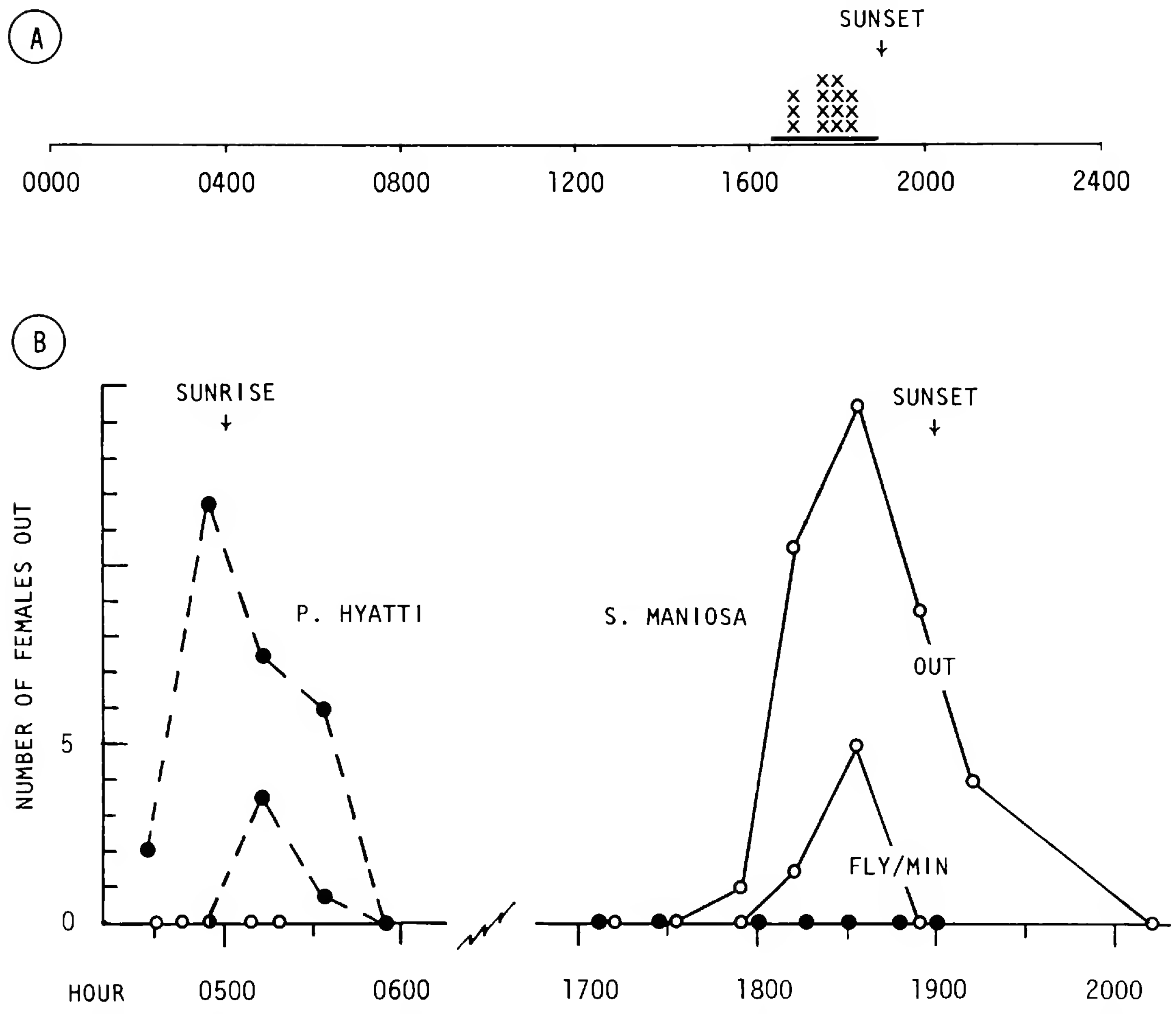

Figure 1. A. Flight hours of *S. maniosa.* Each x represents hour (PST) of peak number flying/minute for 1 nest for 1 day. Horizontal bar underneath runs from earliest to latest hour any ant was seen to fly. The 14 flights are from 7 nests and 11 days between 20 June and 24 July during years 1973–1979. B. Hour of surface appearance and of flight for 1 nest each of 2 species (between 13 and 26 July 1978): ● = *P. hyatti*; ○ = *S. maniosa.* Upper curve in each case represents number out of nest (points are shown for other end of day, but are all zero and are not connected by OUT line). Lower curve represents number flying/minute; ordinate scale there is 0.2 per division instead of 1 per division as for number out.

Pheidole Hyatti Emery

Early one morning I happened to see winged females at a nest under a fruit tree and, thinking them to be *S. maniosa,* was surprised at such a flight hour. A few minutes later we saw ants hovering over a bare area of the yard 50 m from the nest. Both these ants and those at the nest turned out to be *P. hyatti.*

The hovering or swarming area was observed for several days beginning just before sunrise at about 0500. Only females were seen flying. They were from 1 to at least 3 m above the ground, and varied in number from zero to five at any given time. The number was undiminished at the last observation about 0600. The sun was then beginning to reach the area. On two occasions a male was seen with a female on the ground beneath, one of the pairs in copulation. (The latter as well as ants from the nest were used for species determination.) No ants were seen flying there in the evenings.

In Figure 1B is shown the nest flight activity for several days, and for comparison, that of a nest of *S. maniosa* on two of the same days. The flight hour of the *P. hyatti* colony (peak at 0520) was at the opposite end of the day from that of *S. maniosa*. Only females were seen at either nest. For each species the number of workers around the nest was far higher at the flight hour than at the opposite end of the day, when there were no females out at all. Another contrast between the flight hours was the temperature, 18–19°C for *P. hyatti* and 30–27° for *S. maniosa*. Neither nest was in the sun at flight time.

The present record adds a second morning species for this genus. The compilation of flight hour records for *Pheidole* by McCluskey (1974) included seven species. All of these flew in the late afternoon or evening except one in the early morning. And even in that species, flight from the nest itself was not seen and could have occurred in the late evening (Williams and Illingworth, 1935).

Pheidole Pilifera Pacifica Wheeler

About 1430 on 3 November 1959 Esther McCluskey discovered a mating swarm of this species upon bicycling through it along an open lane. Again the next afternoon there was swarming, lasting until after 1530. Twenty or 30 males were flying around each female, and occasionally a copulating pair would fall to the ground (several such pairs were collected for species determination). It was partly cloudy and the air temperature was 19°C. These records were the basis for the "1530" flight hour given in Figure 1 of McCluskey (1974).

Comparison of Mating Swarms in *Pheidole*

The mating aggregations reported here for two species of *Pheidole* resemble those more completely described by Wilson (1957) for *P. sitarches* as well as one briefly noted by Williams and Illingworth (1935) for *P. megacephala*. In all four species the swarms were relatively low, and over bare areas. This is in contrast to some other ants, where swarms occur on or above tall objects or high in the air (Sudd, 1967).

Three of these four species of *Pheidole*, and another, *pallidula* (Goetsch, 1957), were alike in that mating pairs dropped out of the swarms to the ground. In *P. megacephala*, however, Williams saw the pairs continue to fly in the swarm.

The time relation between flight from the nest and swarming is not well known. In none of the five species of *Pheidole* mentioned above was nest flight hour reported except for *P. hyatti* described here. In this case flight at the mating area continued from before until after the flight at the one nest seen.

Summary

For comparison at higher taxon levels there is need for records of more species. The "evening" flight time of *Solenopsis maniosa* is documented by 14 different day or nest flight records. The mean peak flight hour was 1750, the earliest flight starting at 1630 and the latest ending at 1855 just before sunset; all were in the shade.

Flights from one nest of *Pheidole hyatti* on several of the same days in July as *S. maniosa*, were centered at 0520, just after sunrise but in the shade. A mating aggregation of the same species hovered at a nearby spot on the same mornings. Morning flight records are unusual for *Pheidole*.

A swarm of *Pheidole pilifera pacifica* was also seen but in November and at about 1500. Like *P. hyatti* and certain previously-reported species in the genus, the swarming was over a bare area, it was low, and mating pairs dropped to the ground beneath.

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Observations on the Biology of *Eremapis parvula* Ogloblin an Anthophorid Bee with a Metasomal Scopa (Hymenoptera: Anthophoridae)

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Abstract.—Observations are presented on nests, floral host preferences and phenology of *Eremapis parvula* Ogloblin, a monotypic exomalopsine bee from the deserts of northern Argentina. Dense nest aggregations were located in fine alluvial soil deposits along a sandy river bank. Individual nests are constructed by a single female and show many features observed in the related genus *Exomalopsis*. A distinctive feature of *Eremapis* nest cells is the ringlike deposition of fecal pellets. *Eremapis* appears to be an oligolege of *Prosopis* (Fabaceae) and the phenology of local bee populations is synchronized with the flowering of various taxa of that genus. Pollen is transported on unusual keeled setae on the metasomal sterna as well as in the scopa of the hind legs.

Eremapis is a monotypic genus of tiny (female body length 3.8–4.2 mm) bees endemic to the arid Monte Desert and adjacent portions of the western Chaco of Argentina (Ogloblin, 1956). It forms, along with the related monotypic genera *Teratognatha* of northern Argentina and *Chilimalopsis* of northern Chile, a distinctive group within the Exomalopsini which may represent the remnants of a relatively primitive stock within that taxon (Michener and Moure, 1957; Toro, 1976). Nothing has been published on the biology of any of these three genera. The information I present here on *Eremapis parvula* Ogloblin may be of importance in examining evolutionary trends within the Exomalopsini, a group of considerable biological diversity.

During the six month southern spring–summer (Oct.–Mar.) flowering seasons of 1972–1973 and 1973–1974, I was able to study the phenology and floral relationships of *Eremapis parvula* in the vicinity of Andalgala, Catamarca, Argentina, as part of my larger study of the flower-visiting insects of this region. No nests were discovered near Andalgala, but during a trip through the central and southern portions of the Monte Desert, I discovered several large nesting aggregations and excavated numerous nests. The data on nesting habits of *Eremapis* presented here are based on observations taken near this site as well as from observations made on nest-containing soil examined in the laboratory. Philip Torchio supplied additional notes based on material from the nest site. Eggs, larvae, and pupae recovered from the nests were deposited with Mr. Torchio for description.

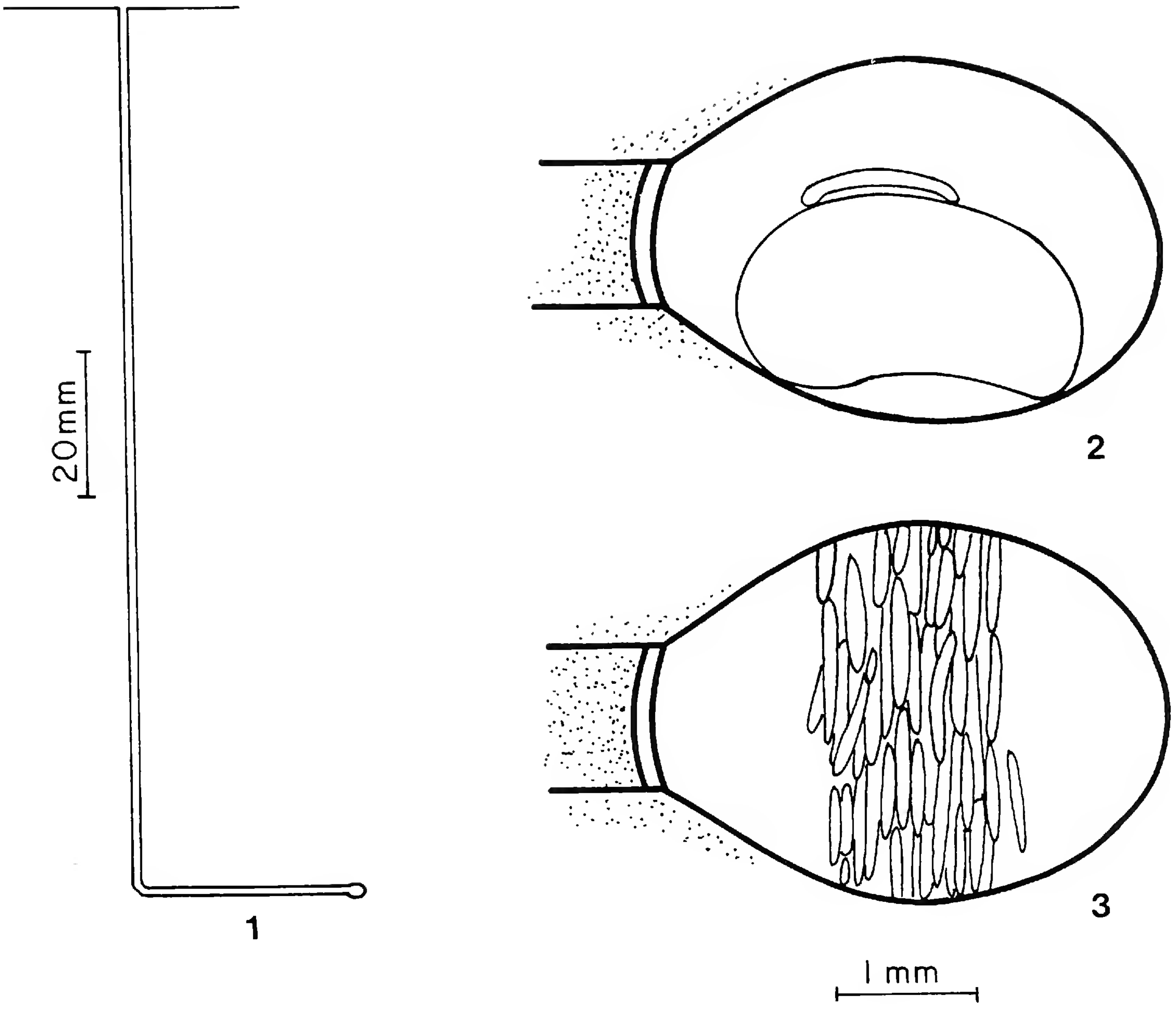
NESTING SITES AND NEST ARCHITECTURE

On 17 November 1973, three nesting aggregations were discovered along the banks of the Rio Huaco near the Termas Aguas Hedionados, approximately 30 km north of San Jose de Jachal, San Juan, Argentina. The area is covered with desert scrub vegetation and the river itself was lined with bushes of *Baccharis* spp. (Asteraceae) and small *Prosopis* (Fabaceae) trees intermixed with shrubs of *Schinus* sp. (Anacardiaceae), *Larrea divaricata* (Cavanilles), *Bulnesia retama* (Hooker and Arnott) Griseb., *Plectrocarpa* sp. (Zygophyllaceae), and *Atamisquea emarginata* Hooker and Arnott (Capparaceae). The soil near the river was predominantly bare, loose sand. The nests were restricted to encrusted areas in low depressions which were filled with silt during periods of high water. The nest sites proper were devoid of vegetation but the entire area was surrounded by low *Prosopis* trees which would have caused partial shading. The crust of the soil surface of the nest-containing depressions was between 6 and 8 mm thick and underlain by a moist silt layer about 15 to 18 cm deep. Beneath this layer was pure sand. The largest nesting aggregation occupied a depression that was 8 m long and 1.5 m wide that was completely covered with numerous low conical tumuli from the closely packed nests. No turrets were observed. Between 8 and 11 open nests were present per 100 cm area suggesting a population of over 8000 females in this one aggregation.

Nest openings were made directly into the crust or through pre-existing cracks in the crust. The burrows were unlined, 0.9–1.0 mm in diameter, and descended vertically for 12–15 cm. After reaching a depth of about 15 cm, the burrows turned abruptly giving rise to horizontal laterals that extended about 3–4 cm before terminating in single, oval, apparently unlined cells (Fig. 1). The short amount of time available for excavating and the density of the nests prevented an accurate determination of the number of cells per nest, but it is assumed that completed nests are multicellular. No linear series or clusters of cells were found and, in fully provisioned cells, the laterals were filled with soil. A few cells were found in the upper 5 cm of the silty soil and several others were found at the silt-sand interface or just slightly under the interface in the sand. Although the nest site was discovered at dusk, numerous males and females were visible, flying over the nest site or resting on the soil surface. Only single females were found within open nests. The presence of numerous old cells in the soil samples indicated that the nest site had been used in previous years.

Individual cells were oval, approximately 3–4 mm long and 2–2.5 mm wide with the long axis roughly parallel to the connecting lateral (Fig. 2). They were apparently unlined and could not be extracted from the soil matrix. The cell cap was thin (0.3–0.6 mm) and apparently also unlined. In each case, the provisions were molded pollen masses with no free liquid. The smooth, slightly elongate pollen masses were approximately 2.0 mm long and 1.5 mm tall and deep. The ventral surface of the pollen masses was flattened and slightly concave. In some cells, new pollen balls appeared to have the end nearest the cap slightly raised, reminiscent of pollen balls made by some species of *Exomalopsis* (Raw, 1977; Rozen, 1977), although this feature was not observed in all cases. Without exception, the pollen masses consisted solely of *Prosopis* pollen. Cells containing eggs as well as all stages of immatures were found. Dark pupae and adults were absent in closed cells. Most cells excavated contained developing larvae still feeding on the provisions.

The elongate egg (about 1 mm long) was placed on the dorsal portion of the pollen mass, parallel to the long axis of the cell (Fig. 2). The egg contacted the



Figures 1–3. Nests of *Eremapis parvula*. 1. Diagram of a typical open nest. 2. Cell, pollen mass, and egg. 3. Cell with ring of fecal smears.

pollen mass only at its tips with the middle portion arched away from the provisions. No distinct grooves or indentations in the pollen mass for egg placement were noted. Early instars moved around the middle of the pollen mass resulting in distinct feeding grooves which commonly resulted in a dumbbell-shaped pollen mass as the feeding progressed. In the last developmental stages, larvae completely encircled the reduced pollen mass with their body axes aligned perpendicular to the long axes of the cells.

Several cells contained larvae that had initiated defecation but which still contained portions of the pollen ball. In most cells with fecal smears, the pollen mass had been completely consumed suggesting that *Eremapis,* like many exomalopsines, may initiate defecation before completion of feeding. Feces were deposited as narrow, flattened strips 0.42–0.64 mm long and 0.10– 0.12 mm wide and 0.02–0.03 mm high. Approximately 90% of the feces were laid down around the center of the cell and most strips were parallel to equator of the cell thus forming a distinct ring that could be removed intact from the cell (Fig. 3).

Following defecation and deposition of a light yellow material (probably Mal-

Table 1. Host records for *Eremapis parvula*.[1]

Family	Taxon	No. of females	No. of males	Total
Fabaceae	*Prosopis chilensis*	128	59	187
Fabaceae	*Prosopis flexuosa*	1	35	36
Fabaceae	*Prosopis torquata*	18	25	43
Fabaceae	*Mimozyganthus carinatus*	—	1	1
Rhamnaceae	*Zizyphus mistol*	—	16	16
Capparaceae	*Atamisquea emarginata*	—	2	2
Olacaceae	*Ximenia americana*	—	4	4
Euphorbiaceae	*Jatropha excisa*	—	1	1
Zygophyllaceae	*Larrea divaricata*	—	2	2
Zygophyllaceae	*Larrea cuneifolia*	—	1	1
		147	146	293

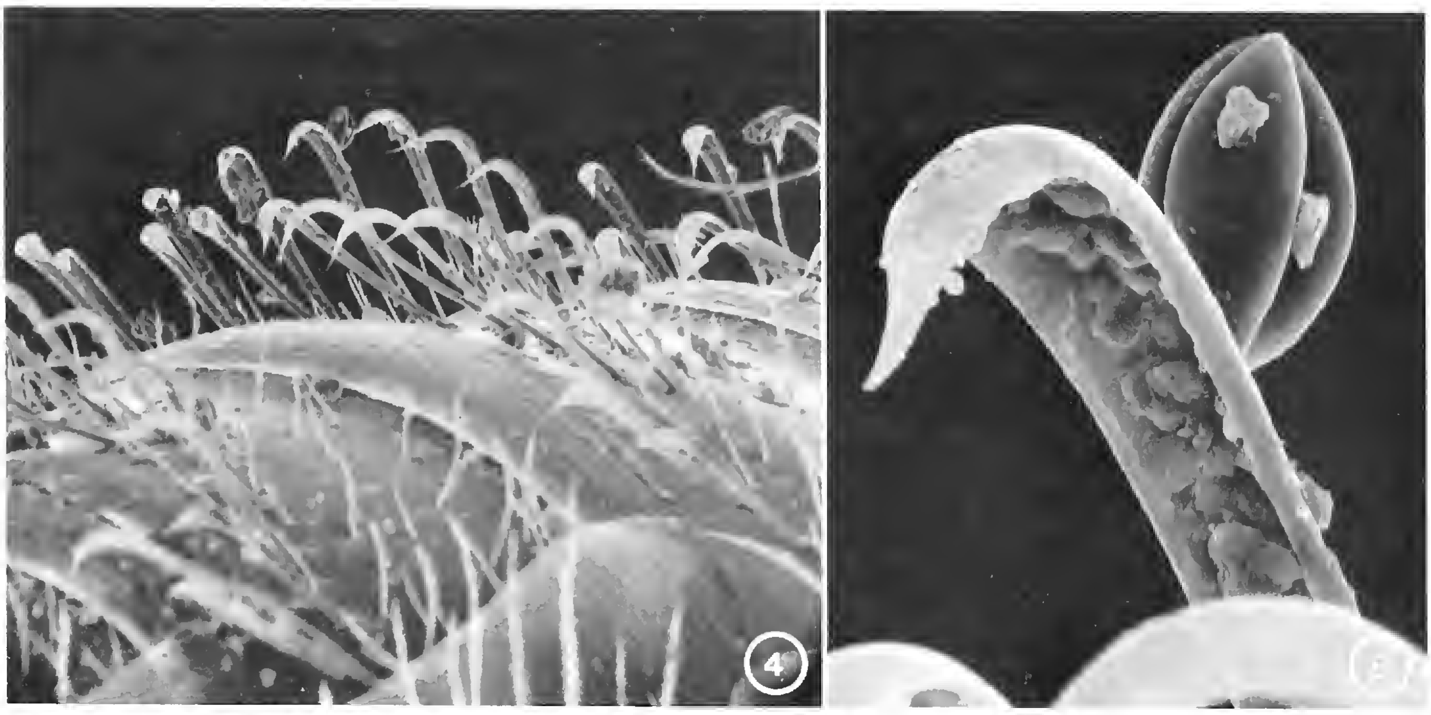
[1] Records from the Bols6n de Pipanaco, Catamarca, Argentina summed over two seasons, 1971–1972, 1972–1973.

pighian excreta) on the bottom of the cell, the larva laid down a complete, transparent, single-layered cocoon. The cocoon followed the contours of the cell except at the periphery of the cell cap where it curved into the center face of the cap rather than precisely following the contours of the cell. Fecal material was not incorporated into the cocoon, but did adhere firmly to it.

PHENOLOGY AND FLORAL ASSOCIATIONS

All available data indicate that *Eremapis parvula* collects only the pollen of species of *Prosopis*. During the two seasons of collecting in the Bolson de Pipanaco in which Andalgala is located, males of *Eremapis* were taken at the flowers of a number of plant taxa, but females were observed only on *Prosopis* flowers (Table 1). Microscopic examination of both scopal loads and nest provisions revealed only *Prosopis* pollen. In the vicinity of Andalgala, *Eremapis* was collected from 19 October to 6 January. This long flight period (79 days) for a desert species is somewhat misleading as individual populations appear to be active for no more than 30–40 days (based on collection records for individual sites). In fact, there appear to be two flight periods, the first involving populations associated with the synchronous early (Oct.–Nov.) flowering of the large phreatophytic trees of *Prosopis chilensis* (Molina) Stunz and *P. flexuosa* de Candolle (both in section *Algarobia*) and the second involving populations that foraged on the later blooming *Prosopis torquata* (Lagasca) de Candolle (section *Strombocarpa*). Flowering of the phreatophytic species of *Prosopis* is largely independent of local rainfall, but flowering of *Prosopis torquata* is closely tied to rainfall and local patterns of runoff.

Female *Eremapis* showing minimal wing wear were found associated with both the early blooming and the later blooming species. The relatively long flight period could thus be due to multivoltinism (suggested by the presence of pupae in the active nests at Rio Huaco) or, more likely, the staggered emergence of univoltine populations responding to environmental cues which facilitated synchrony of emergence with the different species of *Prosopis* growing in different habitats.



Figures 4, 5. Metasomal scopal hairs of female *Eremapis parvula*. 4. Rows of specialized setae on sterna 2, 3, and 4 forming part of the metasomal scopa (×175). 5. Tip of an individual scopal seta with *Prosopis* pollen grain (×350).

MATING

Copulation was not observed. Males were frequently observed hovering about *Prosopis* inflorescences that were being visited by females. Occasionally males pounced on foraging females, but their overtures were always rebuffed. These observations suggest that at least some mating may take place at the flowers. Males were also present at the Rio Huaco nest site although no mating activity was noted.

POLLEN TRANSPORT

Most pollen collected by female *Eremapis* is transported on the sparsely branched scopal hairs of the hind tibia and basitarsi, a scopa very similar in structure to that of various *Ancyloscelis* species. However, a significant amount of pollen is also transported in an auxillary metasomal scopa formed by sparse bands of specialized, falcate setae on the second to the fifth sterna (Figs. 4 and 5). Examination of pollen bearing females at the Rio Huaco site indicated that females with metasomal pollen loads always had at least some pollen in the basitarsal scopa although not all pollen bearing females had metasomal pollen loads. The presence of females with metasomal pollen loads at the nest indicated that the metasomal scopae are not just specialized structures that are used to gather pollen or accumulate it before loading it into the scopa on the legs. Metasomal scopa are also found in several paracolletine bees associated with *Prosopis* in Argentina (Simpson et al., 1977) although in some of these cases, the metasomal scopa may be used more for collecting pollen than for its transport.

DISCUSSION

The nesting biology of the Exomalopsini has most recently been reviewed by Torchio (1974). Subsequently, additional data have been provided by Michener

(1974), Vogel (1974), Rozen (1977), Raw (1977), and Parker (in press). My interpretation of Torchio's analysis is that the only biological characteristic that consistently separated the Exomalopsini from the other anthophorids was the presence of oval shaped cells. Since oval-shaped cells are probably a primitive character for the "higher" bees, there are no derived biological characters that distinguish the group. *Eremapis* shows a number of characters that appear to be primitive both within the Exomalopsini and the Anthophorinae in general. These include: nests in soil; absence of turrets; unlined burrows; oval cells; molded provisions with the egg placed on the surface opposite that attached to the walls; and a complete cocoon. The apparent absence a secreted cell lining would be a derived character but, as a loss character, is of limited phylogenetic significance. Moreover, absence of a secreted lining was not rigorously established. The initiation of defecation before completion of larval feeding is a derived trait for bees (Stephen, Bohart and Torchio, 1969), but may be primitive for anthophorids. The most distinctive and perhaps only derived character of the nests of *Eremapis* is the ringlike arrangement of deposited feces.

Nest architecture of *Eremapis* appears to be very similar to that described for *Exomalopsis* with a vertical main burrow and distinct laterals. Cell orientation in different species of *Exomalopsis* varies from consistently horizontal (Raw, 1977), at a 40–45 degree angle (Raw, 1977; Rozen, 1977) from horizontal, or may be variable (Rozen and MacNeill, 1957). Defecation may occur before the completion of feeding (Rozen, 1977) and fecal matter may (Rozen and MacNeill, 1957; Rozen, 1977) or may not (Raw, 1977) be included in the cocoon. Biological characters uniting *Exomalopsis* and separating it from *Eremapis* include the characteristically molded provisions with a foot-like projection and the secreted, waxlike lining. Additionally, most, but not all, *Exomalopsis* appear to be communal (several females per nest) or even semi-social. *Ancyloscelis* nests lack the typical vertical main burrow with a horizontal lateral arrangement, but may show complicated branching patterns. *Ancyloscelis* nests may (Michener, 1954; J. G. Rozen, pers. comm.) or may not (Torchio, 1974; Michener, 1974) possess an obviously secreted lining. Cocoon structure in *Ancyloscelis* appears to be very similar to that of *Eremapis* in that it is one-layered and fragile (Torchio, 1974; Michener, 1974) and contacts the central but not the lateral portions of the cell closure. In *Ancyloscelis,* the feces are deposited as a complete, thin layer (Torchio, 1974; Michener, 1974) rather than in discrete strips characteristic of *Eremapis* or *Exomalopsis* (Rozen and MacNeill, 1957; Raw, 1977; Rozen, 1977).

Paratetrapedia and *Tapinotaspis* differ from *Eremapis, Ancyloscelis* and *Exomalopsis* in that their eggs are oriented perpendicular rather than parallel to the long axis of the cells. *Paratetrapedia* and *Tapinotaspis* also differ in that their provisions are molded into a ball-like form. According to Vogel (1974), but not Claude-Joseph (1926), provisions in *Tapinotaspis caerulea* Friese are formed into a ball-like mass with a distinct basal layer filling the bottom of the cell.

Data on the biology of other exomalopsine genera are largely fragmentary or non-existent, but suggest considerable diversity (Torchio, 1974). Distinct waxlike cell linings are present in the cells of *Tapinotaspis* (Claude-Joseph, 1926; Vogel, 1974) as well as in those of *Monoeca* and *Paratetrapedia* (Michener and Lange, 1958). Data on the nesting biology of *Eremapsis* are entirely consistent with its placement in the Exomalopsini and suggest a relatively close alignment to *Exomalopsis* and more distantly, to *Ancyloscelis,* but the monophyletic, as opposed to paraphyletic, nature of the Exomalopsini is open to question.

Although the host relationships of most exomalopsines are poorly known, most appear to be polylectic. Oligolecty is well established and perhaps universal in *Ancyloscelis* and is known in the subgenera *Anthophorisca* and *Anthophorula* of *Exomalopsis* (Timberlake, 1980; pers. obs.) and may occur in some *Tapinotaspis* (A. Moldenke, pers. comm.), but none of these groups include bees oligolectic on the Fabaceae. An undescribed *Isomalopsis* is commonly associated with *Prosopis* in northern Argentina, but this bee also collects pollen of *Acacia* (Fabaceae) and *Atamisquea.* With its specialized mouth parts, one might also expect oligolecty in *Teratognatha* although its host relationships are unknown. A character, presumably primitive, allying *Eremapis* with *Exomalopsis, Isomalopsis, Ancyloscelis* and probably *Caenonomada* and separating it from *Paratetrapedia, Chalepogenus,* some *Lanthanomellisa, Tapinotaspis* and probably *Monoeca* is the absence of floral oil collection (Vogel, 1974; Neff and Simpson, 1981).

The presence of a functional metasomal scopae in *Eremapis* is undoubtedly a *de novo* specialization, but it is of interest as the absence of such a scopa is considered to be an important character separating the Anthophoridae from the Megachiliidae and Fedeliidae. Specialized metasomal arrays of branched setae (Thorp, 1979; pers. obs.) are found in various *Svastra* and *Xenoglossodes* (Eucerini) associated with the Asteraceae, but in these cases they appear to be primarily involved in pollen collection with pollen transport as a secondary function. The distinctive metasomal setal arrays found in certain *Tapinotaspis* are believed to be involved in floral oil collection rather than pollen collection or transport (Neff and Simpson, 1981).

The combination of primitive and derived biological traits seen in *Eremapis* appears to support Michener and Moure's conclusion (Michener and Moure, 1957) based on adult morphology, that *Eremapis* is a survivor of a primitive stock of the Exomalopsini. No derived biological characters link *Eremapis* with the oil-collecting bees of the *Paratetrapedia-Tapinotaspis* complex although this group is still poorly known biologically. *Eremapis* does show various similarities to *Exomalopsis* and *Ancyloscelis* but these primarily involve primitive characters. The relationship of the cocoon to the cell cap may be a derived character linking *Ancyloscelis* and *Eremapis,* but characters such as this have not been sufficiently surveyed to allow any firm conclusions to be drawn.

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Ambracyptus, A New Name for *Paracyptus* Seevers (Coleoptera: Staphylinidae)

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Seevers (1971) erected a monotypic genus, *Paracyptus,* for *P. minutissima,* a new species of rove beetle found in amber from Chiapas, Mexico. This generic name, however, was previously used by Cameron (1944) for another genus of staphylinid beetle from India. *Paracyptus* Seevers, 1971, is, therefore, a junior homonym of *Paracyptus* Cameron, 1944. I herein propose to replace *Paracyptus* Seevers with *Ambracyptus* Lundgren, **new name.** The sole species affected becomes *Ambracyptus minutissimus* (Seevers), **new combination.**

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Studies of the Tribe Bembidiini (Coleoptera: Carabidae): Lectotype Designations and Species Group Assignments for *Bembidion* Species Described by Thomas L. Casey and Others

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Many species of the genus *Bembidion* were dealt with by Lindroth (1963) in his monumental "Ground Beetles of Canada and Alaska," synonymies were given, and species were described and assigned to species groups. Later, Lindroth (1975) designated lectotypes for the Casey names which pertain to species of the northern United States and Canada. However, this left more than 100 Casey names and several others by LeConte, Hayward, Dejean, Chaudoir et al. not yet covered with regard to taxonomy, nor species group assignment.

As in the case of Tachyina (Erwin, 1974), another group worked on by Casey, little can be done before this "housekeeping" task is undertaken and a good working list of names becomes available. Lindroth (1963) provided an excellent beginning with his arrangement of species groups. Using this arrangement, I have assigned all remaining species described from north of Panama to species groups, provided synonymies of names not dealt with by Lindroth, and I note distributions, where possible, extracted from USNM specimens.

These data then provide a working list for use in NABFP, the USDA/SI Coleoptera Catalogue, and monographic studies now under way (Erwin and Kavanaugh, 1980, 1981) and are compiled here as an aid to those projects.

Of *Bembidion* names for the Americas north of Colombia all are here dealt with except some of the species of *Cyclolopha* and two Motschulsky names. G. Perrault has dealt with *Cyclolopha* (MS) and designated lectotypes, etc. Two of these are mentioned here, as is one other he did not deal with. The Motschulsky names *B. obscuromaculatum* (Mots, 1859:130) and *B. laterimaculatum* Mots. (1859:130) are undoubted members of the *dorsale* group. Lindroth (1963:211) mentions the first species but does not give any clues as to its relationships. From Motschusky's descriptions and the probable locality (Fort Ross, California) I suspect both names will apply to *B. indistinctum* Dejean, however the types must be examined.

METHODS

Methods are the same as mentioned before (Erwin, 1974). Most of the material studied resides in the USNM (Smithsonian Institution, Washington, D.C. 20560), however some other museum acronyms are used too. These are as follows:

BMNH—British Museum (Natural History); London; P. Hammond, and N. Stork.
CAS—California Academy of Sciences, San Francisco, California; D. H. Kavanaugh.

MCZ—Museum of Comparative Zoology, Harvard, Cambridge, Massachusetts; M. Thayer, A. Newton, S. Foster.
MNHP—Muséum National d'Histoire Naturelle, Paris; H. Perrin.

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I heartily thank all the above curators and their respective staffs for aid in locating type material or providing data from type labels. I also thank Noreen Connell and Linda Sims of my own staff for aid during preparation of this paper.

***Bembidion acticola* Casey**

Bembidion acticola Casey, 1884:63. Lectotype: USNM #37042, male, here selected. Type-area: New Jersey, USA.
Bembidion argutum Casey, 1918:123. **New Synonymy.** Lectotype: USNM #37045, male, here selected. Type-area: Rhode Island, USA.
Bembidion assensum Casey, 1924:41. **New Synonymy.** Lectotype: USNM #37406, female, here selected. Type-area: Near Brooklyn, New York, USA.

Notes.—This species belongs in the *contractum* group; its members are found along the Atlantic Coast from Long Island south to Maryland.

***Bembidion actuosum* Casey**

Bembidion actuosum Casey, 1918:65. Lectotype: USNM #36899, female, here selected. Type-area: Boulder County, Colorado, USA.
Bembidion debilicolle Casey, 1924:34. **New Synonymy.** Lectotype: USNM #36935, female, selected and labelled by Lindroth in 1972 but unfortunately left out of his paper (Lindroth, 1975), therefore credited here. Type-area: Lake County, Oregon, USA.

Notes.—See Lindroth (1963:318) for details of distribution and note that Lindroth used Casey's second name for this species.

***Bembidion adductum* Casey**

Bembidion adductum Casey, 1918:149. Lectotype: USNM #37062, male, here selected. Type-locality: Paraiso Hot Springs, Monterey County, California, USA.
Bembidion relictum Casey, 1918:153. **New Synonymy.** Holotype: USNM #37067, male. Type-locality: Truckee, California, USA.

Notes.—This species belongs in the *quadrimaculatum* group; its members are found in central California.

[*Bembidion aegrotum* Casey, see *B. quadrulum*]

***Bembidion alpinianum* Casey**

Bembidion alpinianum Casey, 1924:30. Holotype: USNM #36883, female. Type-area: Nevada County, California, USA.

Notes.—This species belongs in the *nigrum* group and is found in California.

[*Bembidion amnicum* Casey, see *B. nubiculosum*]

[*Lymneops angusticeps* Casey, see *B. laticeps*]

[*Bembidium apicale* Jacquelin du Val, see *B. spretum*]

Bembidion approximatum **(LeConte)**

Ochthedromus approximatus LeConte, 1852:187. Lectotype: MCZ #5526, male, here selected. Type-locality: San Diego, California, USA.
Bembidion cernans Casey, 1918:100. **New Synonymy.** Lectotype: USNM #36997, female, here selected. Type-locality: San Diego, California. USA.
Bembidion haustum Casey, 1924:38. **New Synonymy.** Holotype: USNM #37000, female. Type-area: Alameda County, California, USA.

Notes.—There is no difference between Casey's and LeConte's types.

Bembidion aratum **(LeConte)**

Ochthedromus aratus LeConte, 1852:189. Lectotype: MCZ #3343, female, here selected. Type-area: Gila River Valley, Arizona, USA.
Bembidium scintillans Bates, 1882:150. **New Synonymy.** Lectotype: BMNH, female, here selected. Type-locality: Capulalpam, Mexico.
Bembidion vinnulum Casey, 1918:116. **New Synonymy.** Lectotype: USNM #37029, female, here selected. Type-area: "Arizona (southern)," USA.
Bembidion definitum Casey, 1918:166. **New Synonymy.** Holotype: USNM #37030, male. Type-locality: Tucson, Arizona, USA.

Notes.—This species belongs in the *incrematum* group and is found in the southwestern USA south through Mexico to Honduras. The two Casey names are based on color variants.

[*Bembidion argutum* Casey, see *B. acticola*]

[*Bembidion assensum* Casey, see *B. acticola*]

[*Bembidion augurale* Casey, see *B. consuetum*]

Bembidion auxiliator **Casey**

Bembidion auxiliator Casey, 1924:38. Lectotype: USNM #36964, male, here selected. Type-area: San Joaquin County, California, USA.

Notes.—This "species" belongs in the *patruele* group which is in need of a complete revision. Many forms are found in the southwestern USA and Mexico, for example *B. conspersum* Chd. and their taxonomic limits are poorly understood.

[*Bembidion aversans* Casey, see *B. rupicola*]

Bembidion avidum **Casey**

Bembidion avidum Casey, 1918:53. Lectotype: USNM #36886, male, here selected. Type-locality: Reno, Nevada, USA.

Notes.—This species belongs in the *nigrum* group and is found in the Basin and Range Province of the western United States.

[*Bembidion badiipenne* Casey, see *B. mexicanum*]

[*Bembidion bellulum* Casey, see *B. scopulinum*]

Bembidion californicum **Hayward**

Bembidion californicum Hayward, 1897:84. Lectotype: MCZ #16290, female, here selected. Type-locality: Pomona, California, USA.

Bembidion innocuum Casey, 1918:63. **New Synonymy.** Lectotype: USNM #36894, male, here selected. Type-locality: Hoopa Valley, Humboldt County, California, USA.

Notes.—This species was treated by Lindroth (1963) only in his key and he placed it in the *semistriatum* group. Its range is now known to extend from Humboldt County south to Riverside County in California.

[*Bembidion caliginosum* Casey, see *B. insulatum*]

Bembidion callens **Casey**

Bembidion callens Casey, 1918:112. Lectotype: USNM #37033, female, here selected. Type-locality: Tucson, Arizona, USA.

Notes.—This species belongs in the *obtusangulum* group and is found in the southwestern USA.

[*Bembidion callidum* Casey, see *B. quadrulum*]

[*Bembidion canonicum* Casey, see *B. mexicanum*]

[*Bembidion cernans* Casey, see *B. approximatum*]

[*Bembidicidium chevrolati* Gemminger and Harold, see *B. spretum*]

Bembidion citulum **Casey**

Bembidion citulum Casey, 1918:66. Lectotype: USNM #36925, male, here selected. Type-locality: Colonia Garcia, Sierra Madre, Chihuahua, Mexico.

Notes.—This species belongs in the *grapei* group; its members are flightless, densely microsculptured, and resemble members of *B. texanum.* It is probable that its range is restricted to the Sierra Madre of Mexico.

[*Bembidion civile* Casey, see *B. constrictum*]

Bembidion ciudadense **Bates**

Bembidion ciudadense Bates, 1891:263. Lectotype: BMNH, male, here selected. Type-locality: Ciudad, Durango, Mexico.

Notes.—This species belongs in the *transversale* group and is found on the Mexican altiplano.

Bembidion clemens **Casey**

Bembidion clemens Casey, 1918:159. Lectotype: USNM #37080, female, here selected. Type-locality: Provo, Utah, USA.

Bembidion vapidum Casey, 1918:160. **New Synonymy.** Lectotype: USNM #37073, male, here selected. Type-locality: Mt. Diablo, Contra Costa County, California, USA.

Bembidion disparile Casey, 1918:161. **New Synonymy.** Lectotype: USNM #37074, male, here selected. Type-locality: Santa Barbara, California, USA.

Bembidion invidiosum Casey, 1918:162. **New Synonymy.** Lectotype: USNM #37081, male, here selected. Type-area: "Road between Fort Wingate and Jemez Springs, New Mexico," USA.

Bembidion remotum Casey, 1918:162. **New Synonymy.** Lectotype: USNM #37086, male, here selected. Type-locality: Paraiso Hot Springs, Monterey County, California, USA.

Notes.—This species belongs in the *anguliferum* group and is found in the western USA. Lindroth's *B. pseudocautum* appears to be closely related and subsequent studies may show it to be conspecific.

[*Bembidion cogitans* Casey, see *B. texanum*]

Bembidion cognatum **Dejean**

Bembidium cognatum Dejean, 1831:168. Holotype: MNHP, female. Type-area: Mexico.

Notes.—This species, with convergent frontal furrows, forms its own group. Its relationship to other groups is, at present, unclear.

Bembidion coloradense **Hayward**

Bembidium coloradense Hayward, 1897:98. Lectotype: MCZ #16295, female, here selected. Type-area: Vicinity of Rico, Dolores County, Colorado, USA.

Notes.—Lindroth (1963) adequately discusses this species but did not designate a lectotype.

Bembidion conspersum **Chaudoir**

Bembidion conspersum Chaudoir, 1868:244. (New name for *B. tessellatum* LeConte 1852:188, not Brullé, 1838:44.)

Bembidium tessellatum LeConte, 1852:188, not Brullé, 1838:44. Lectotype: MCZ #5532, female, here selected. Type-locality: San Diego, California, USA.

Bembicidium xanthostictum Gemminger and Harold, 1868:424. (New name for *tessellatum* LeConte.)

Notes.—This species belongs in the *dorsale* group; its members are found throughout California.

Bembidion constrictum **LeConte**

Bembidium constrictum LeConte, 1848:462. (New name for *contractum* Dejean.)

Bembidium contractum Dejean, 1831:123, not Say, 1823:85.

Bembidion vernula Casey, 1884:62. **New Synonymy.** Holotype: USNM #37038, female. Type-area: Cape May, New Jersey, USA.

Bembidion festinans Casey, 1918:121. **New Synonymy.** Lectotype: USNM #37043, female, here selected. Type-area: Texas, USA.

Bembidion civile Casey, 1918:124. **New Synonymy.** Lectotype: USNM #37044, female, here selected. Type-locality: Brownsville, Texas, USA.

Notes.—This species belongs in the *contractum* group as set forth by Lindroth (1963). The species is an Atlantic and Caribbean coastal form which ranges from Nova Scotia, Canada, south to Texas. Casey's names are based on forms within the variable species.

Bembidion consuetum **Casey**

Bembidion consuetum Casey, 1918:93. Lectotype: USNM #36955, female, here selected. Type-locality: Gualala River, Mendocino County, California, USA.

Bembidion augurale Casey, 1924:38. **New Synonymy.** Lectotype: USNM #36954, male, here selected. Type-locality: San Francisco, California, USA.

Notes.—This species belongs to the *dorsale* group and is found around the Bay Area near San Francisco, California, USA.

[*Bembidion continens* Casey, see *B. idoneum*]

[*Bembidium contractum* Dejean, see *B. constrictum*]

Bembidion cordatum **LeConte**

Bembidium cordatus LeConte, 1848:457. Lectotype: MCZ #5522, female, here selected. Type-area: New York, USA.

Bembidion placabile Casey, 1918:119. **New Synonymy.** Lectotype: USNM #37034, male, here selected. Type-locality: Big Spring, Howard County, Texas, USA.

Notes.—This species belongs to the *dorsale* group; its members are found between the Rocky and Appalachian Mountain systems from Manitoba to Texas.

Bembidion cubanum **Darlington**

Bembidion cubanum Darlington, 1937:121. Holotype: MCZ #22491, male. Type-locality: Sierra de Rangel, Pinar del Rio Province, Cuba, 1500′.

Notes.—This species belongs in the *vernale* group; its members are similar to those of *B. mexicanum* and are found only on the island of Cuba.

Bembidion curtulatum **Casey**

Bembidion curtulatum Casey, 1918:39. Lectotype: USNM #36859, male, selected by Lindroth, 1975. Type-locality: Hoopa Valley, Humboldt County, California, USA.

Bembidion effetum Casey, 1918:40. **New Synonymy.** Lectotype: USNM #36861, female, here selected. Type-locality: Soda Springs, Anderson Valley, Mendocino County, California, USA.

Bembidion flebile Casey, 1918:41. **New Synonymy.** Lectotype: USNM #36867, female, by Lindroth 1975:117. Type-locality: Santa Rosa, California, USA.

Notes.—This species belongs in the *planiusculum* group and was well described by Lindroth (1963). Unfortunately, Lindroth did not study the type of *B. effetum* which has page priority over *B. flebile,* and he did not decide definitely that the teneral male type of *curlulatum* Casey was conspecific. I believe it to be and it has page priority.

[*Bembidion daphnis* Casey, see *B. nubiculosum*]

[*Bembidion debilicolle* Casey, see *B. actuosum*]

[*Bembidion definitum* Casey, see *B. aratum*]

[*Bembidion delectum* Casey, see *B. wickhami*]

[*Bembidion demissum* Casey, see *B. egens*]

[*Bembidion denveranum* Casey, see *B. nebraskense*]

[*Bembidion derisor* Casey, see *B. indistinctum*]

[*Bembidion disparile* Casey, see *B. clemens*]

[*Bembidion docile* Casey, see *B. rapidum*]

Bembidion durangoense **Bates**

Bembidium durangoense Bates, 1891:263. Lectotype: BMNH, female, here selected. Type-locality: Villa Lerdo, Durango, Mexico.

Bembidion gilae Lindroth, 1963:246. **New Synonymy.** Holotype: MCZ #32536, male. Type-locality: San Carlos, Gila River Valley, Arizona, USA.

Notes.—This species belongs in the *coxendix* group; its members are found in the southwestern USA and northern Mexico.

[*Bembidion editum* Casey, see *B. patruele*]

[*Bembidion efficiens* Casey, see *B. idoneum*]

Bembidion egens **Casey**

Bembidion egens Casey, 1918:132. Lectotype: USNM #37016, male, here selected. Type-locality: Jemez Springs, New Mexico, USA.

Bembidion demissum Casey, 1918:133. **New Synonymy.** Lectotype: USNM #37019, female, here selected. Type-locality: "near Benson, Arizona," USA.

Notes.—This species belongs in the *versicolor* group which is badly in need of study.

Bembidion evidens **Casey**

Bembidion evidens Casey, 1918:93. **New Synonymy.** Lectotype: USNM #36956, male, here selected. Type-locality: Milford, Utah, USA.

Notes.—This species belongs in *dorsale* group and is known from Utah.

[*Bembidion expositum* Casey, see *B. indistinctum*]

[*Bembidion extensum* Casey, see *B. falsum*]

Bembidion falsum **Blaisdell**

Bembidion falsum Blaisdell, 1902:76. Lectotype: CAS #2661, male, here selected. Type-area: Mendocino County, California, USA.

Bembidion extensum Casey, 1918:42. **New Synonymy.** Lectotype: USNM #36870, female, here selected. Type-locality: Soda Springs, Anderson Valley, Mendocino County, California, USA.

Bembidion kincaidi Hatch, 1950:100. **New Synonymy.** Locality: USNM #75671, male. Type-locality: Mt. Baker, Oregon, USA.

Notes.—This species belongs in the *planiusculum* group; its members are found in the Coastal and Cascade Mountains.

[*Bembidion fastidiosum* Casey, see *B. pedicellatum*]

[*Notaphus fastidiosus* LaFerté, see *B. spretum*]

[*Bembidion festinans* Casey, see *B. constrictum*]

Bembidion festivum **Casey**

Bembidion festivum Casey, 1918:45. Lectotype: USNM #36874, female, here selected. Type-locality: Santa Barbara, California, USA.

Notes.—This species belongs in the *mundum* group; its members are found in California and Oregon.

[*Bembidion flebile* Casey, see *B. effetum*]

Bembidion flohri **Bates**

Bembidium flohri Bates, 1878:602. Lectotype: MNHP, male, here selected by G. E. Ball and so labelled by him in 1972. Type-area: "Mexico, near the capitol."

Bembidion henshawi Hayward, 1897:87. **New Synonymy.** Lectotype: MCZ #16292, male, here selected. Type-area: Salt Lake, Utah, USA.

Notes.—This species belongs in the *scudderi* group; its members are halophilus and occur from the Mexican transverse volcanic belt north to Manitoba.

[*Bembidion formale* Casey, see *B. indistinctum*]

[*Bembidion franciscanum* Casey, see *B. indistinctum*]

[*Bembidion frugale* Casey, see *B. impotens*]

[*Bembidion fugitans* Casey, see *B. rapidum*]

[*Bembidion gilae* Lindroth, see *B. durangoense*]

Bembidion grandiceps **Hayward**

Bembidium grandiceps Hayward, 1897:70. Holotype: Not located at MCZ. Type-locality: Unknown.

Notes.—This species belongs in the *planum* group; its range extends from Massachusetts to Kansas, south to Texas. For some reason, the type of this species did not arrive at MCZ with the rest of the Horn collection, although Hayward clearly states that is where he put the type.

Bembidion grandicolle **(LeConte)**

Ochthedromus grandicollis LeConte, 1852:189. Holotype: MCZ #5539, female. Type-locality: San Diego, California, USA.

Notes.—This species belongs in the *obtusangulum* group; its members are known from southern California.

Bembidion grapei **Gyllenhal**

Bembidion grapei Gyllenhal, 1827:403. See Lindroth, 1963:319.
Bembidion scrutatum Casey, 1918:64. **New Synonymy.** Lectotype: USNM #36987, male, here selected. Type-locality: Eldora, Colorado, USA.

Notes.—This Holarctic species has many synonyms in the New and Old Worlds; Lindroth (1963) neglected to mention this one.

Bembidion graphicum **Casey**

Bembidion graphicum Casey, 1918:108. See Lindroth (1963, 1975) for details.
Bembidion lassulum Casey, 1918:118. **New Synonymy.** Holotype: USNM #37040, female. Type-locality: Tucson, Arizona, USA.

Notes.—Lindroth adequately discusses this species but neglected to mention this Casey synonym.

[*Bembidion gratuitum* Casey, see *B. impotens*]

Bembidion hageni **Hayward**

Bembidium hageni Hayward, 1897:87. (New name for *sexpunctatum* LeConte 1852:186.)
Bembidium sexpunctatum LeConte, 1852:186. Holotype: MCZ #99, female. Type-area: Colorado River, California, USA.

Notes.—This species belongs in the *obtusangulum* group; its members are found in southwestern USA.

[*Benbidion haustum* Casey, see *B. approximatum*]

[*Bembidion henshawi* Hayward, see *B. flohri*]

Bembidion hilare **Casey**

Bembidion hilare Casey, 1918:44. Lectotype: USNM #36873, male, here selected. Type-locality: Cloverdale, Sonoma, California, USA.

Notes.—This species belongs in the *mundum* group; its members are found in California.

Bembidion idoneum **Casey**

Bembidion idoneum Casey, 1918:90. Lectotype: USNM #36946, male, here selected. Type-area: Mendocino County, California, USA.
Bembidion obsequens Casey, 1918:90. **New Synonymy.** Lectotype: USNM #36947, male, here selected. Type-area: Lake County, California, USA.
Bembidion efficiens Casey, 1918:90. **New Synonymy.** Lectotype: USNM #36949, female, here selected. Type-locality: Mokelumne Hill, Calaveras County, California, USA.
Bembidion continens Casey, 1918:91. **New Synonymy.** Lectotype: USNM #36948, female, here selected. Type-area: Siskiyou County, California, USA.

Notes.—This species belongs in the *dorsale* group; its range extends throughout the western United States in the mountainous regions.

[*Bembidion imbelle* Casey, see *B. impotens*]

Bembidion impotens **Casey**

Bembidion impotens Casey, 1918:129. (New name for *B. pictum* LeConte 1848: 461, not Duftschmid 1812:218). See Lindroth, 1963, 1975.

Bembidion frugale Casey, 1918:130. **New Synonymy.** Lectotype: USNM #37006, male, here selected. Type-locality: Fort Yuma, California, USA.

Bembidion imbelle Casey, 1918:130. **New Synonymy.** Lectotype: USNM #37007, male, here selected. Type-locality: Dallas, Texas, USA.

Bembidion gratuitum Casey, 1918:130. **New Synonymy.** Lectotype: USNM #37004, male, here selected. Type-area: Arizona, USA.

Bembidion virgatulum Casey, 1918:131. **New Synonymy.** Lectotype: USNM #37003, male, here selected. Type-locality: Reno, Nevada, USA.

Bembidion indigens Casey, 1918:133. **New Synonymy.** Lectotype: USNM #37017, male, here selected. Type-area: Federal District, Mexico.

Bembidion pullulum Casey, 1918:133. **New Synonymy.** Lectotype: USNM #37018, male, here selected. Type-locality: Amecameca, Mexico.

Notes.—This highly variable species belongs in the complex *versicolor* group; its members are found in the southwestern USA and Mexico north to Canada. Detailed study may reveal cryptic species in the complex.

Bembidion incertum **Motschulsky**

Bembidium incertum Motschulsky, 1845:350. See Lindroth (1963:272).

Bembidion testatum Casey, 1918:30. **New Synonymy.** Lectotype: USNM #36842, male, here selected. Type-area: Lake Tahoe, California, USA.

Notes.—Lindroth (1963) adequately discusses this species however he neglected to deal with this Casey synonym.

[*Bembidion indigens* Casey, see *B. impotens*]

Bembidion indistinctum **Dejean**

Bembidium indistinctum Dejean, 1831:67. See Lindroth (1963:361).

Bembidion derisor Casey, 1918:99. **New Synonymy.** Lectotype: USNM #36986, female, here selected. Type-area: Eastern shore of San Francisco Bay, California, USA.

Bembidion expositum Casey, 1918:101. Lectotype: USNM #36999, male, here selected. Type-locality: Tehachapi Pass, California, USA.

Bembidion formale Casey, 1918:101. **New Synonymy.** Lectotype: USNM #36995, male, here selected. Type-locality: San Francisco, California, USA.

Bembidion reconditum Casey, 1918:102. **New Synonymy.** Lectotype: USNM #36996, male, here selected. Type-locality: San Diego, California, USA.

Bembidion franciscanum Casey, 1918:102. **New Synonymy.** Lectotype: USNM #36991, male, here selected. Type-locality: Alameda, California, USA.

Bembidion ornatellum Casey, 1918:102. **New Synonymy.** Lectotype: USNM #36992, male, here selected. Type-locality: Alameda, California, USA.

Notes.—This species, a highly variable one, belongs in the *dorsale* group; its members occur in the southern half of California in coastal localities and coastal hills as far east as the Tehachapi.

[*Bembidion innocuum* Casey, see *B. californicum*]

[*Bembidion inquietum* Casey, see *B. texanum*]

Bembidion insulatum **(LeConte)**

Ochthedromus insulatus LeConte, 1852:186. See Lindroth (1963:362) for details.
Bembidion caliginosum Casey, 1918:119. **New Synonymy.** Lectotype: USNM #37035, male, here selected. Type-locality: Douglas, Arizona, USA.

Notes.—Lindroth (1963) adequately discusses this species but did not mention this Casey synonym.

[*Bembidion invidiosum* Casey, see *B. clemens*]

Bembidion jacobianum **Casey**

Bembidion jacobianum Casey, 1918:101. **New Synonymy.** Lectotype: USNM #36993, female, here selected. Type-locality: San Diego, California, USA.
Bembidion procax Casey, 1918:103. **New Synonymy.** Lectotype: USNM #36994, male, here selected. Type-locality: San Diego, California, USA.

Notes.—This species belongs in the *dorsale* group; its members are found in southern California.

Bembidion jamaicense **Darlington**

Bembidion jamaicense Darlington, 1934b:76. Holotype: USNM #75334, male. Type-area: Jamaica, Greater Antilles.

Notes.—This species belongs in the *vernale* group and is found only on the island of Jamaica.

Bembidion jucundum **Horn**

Bembidium jucundum Horn, 1895:230. Lectotype: CAS #1, male, here selected. Type-locality: San Jose del Cabo, Baja California, Mexico.

Notes.—This species belongs in the *spaeroderum* group; its members are known only from the type locality.

[*Bembidion lassulum* Casey, see *B. graphicum*]

Bembidion latebricola **Casey**

Bembidion latebricola Casey, 1918:100. Lectotype: USNM #36998, male, here selected. Type-area: "Arizona (probably southern)," USA.

Notes.—This species belongs in the *aeneicolle* group which is badly in need of revision; the distribution of this species is unknown, even the type area, as given by Casey, is obscure.

Bembidion laticeps (LeConte)

Lymnaeum laticeps LeConte, 1858:61. Holotype: MCZ #5562, female. Type-locality: San Diego, California, USA.

Lymneops angusticeps Casey, 1918:169. **New Synonymy.** Lectotype: USNM #46903, male, here selected. Type-locality: San Pedro, California, USA.

Notes.—This species belongs in the *nigropiceum* group (Erwin and Kavanaugh, 1980a); its members are found on the seashore along the California coast.

[*Ochthedromus laticollis* LeConte, see *B. nubiculosum*]

Bembidion luculentum Casey

Bembidion luculentum Casey, 1918:122. Lectotype: USNM #37050, male, here selected. Type-area: Indian River, Florida, USA.

Bembidion prosperum Casey, 1918:122. **New Synonymy.** Lectotype: USNM #37049, female, here selected. Type-locality: Lake Worth, Florida, USA.

Notes.—This species belongs in the *contractum* group; its members are found in the southeastern USA.

[*Bembidium lugubre* LeConte, see *B. mexicanum*]

Bembidion macrogonum Bates

Bembidium macrogonum Bates, 1891:262. Lectotype: BMNH, male, here selected. Type-locality: Cordova, Vera Cruz, Mexico.

Notes.—This species belongs in the *transversale* group; it is presently known only from Mexico.

Bembidion marinianum Casey

Bembidion marinianum Casey, 1924:29. Lectotype: USNM #36893, female here selected. Type-area: Marin County, California, USA.

Notes.—This species belongs in the *semistriatum* group and is found in central California.

[*Bembidion mediocre* Casey, see *B. patruele*]

Bembidion mexicanum Dejean

Bembidium mexicanum Dejean, 1831:126. Lectotype: MNHP, male, here selected by G. E. Ball and so labelled by him in 1972. Type-area: Mexico.

Bembidium lugubre LeConte, 1857:6. Holotype: MCZ #5511, female. Type-area: "Valley of the Rio Grande."

Bembidium stabile LeConte, 1879:508. **New Synonymy.** Lectotype: MCZ #5512, male, here selected. Type-locality: La Veta, Colorado, USA.

Bembidion badiipenne Casey, 1918:60. **New Synonymy.** Lectotype: USNM #36913, female, here selected. Type-area: Road between Fort Wingate and Jemez Springs, New Mexico, USA.

Bembidion vafrum Casey, 1918:60. **New Synonymy.** Lectotype: USNM #36921, male, here selected. Type-area: "Arizona (probably southern)," USA.

Bembidion canonicum Casey, 1918:61. **New Synonymy.** Holotype: USNM #36920, male. Type-area: Arizona, USA.

Bembidion retectum Casey, 1918:61. **New Synonymy.** Lectotype: USNM #36923, male, here selected. Type-locality: St. George, Utah, USA.

Notes.—This highly variable species belongs in the *vernale* group and its range extends from Utah to Central America.

Bembidion modocianum **Casey**

Bembidion modocianum Casey, 1924:29. Lectotype: USNM #36882, male, here selected. Type-area: Modoc County, California, USA.

Notes.—This species belongs in the *nebraskense* group; its members are known thus far only from the type locality.

Bembidion nebraskense **LeConte**

Bembidium nebraskense LeConte, 1863:19. Holotype: MCZ #5506, female. Type-area: "Nebraska, near the Rocky Mountains," USA.

Bembidion denveranum Casey, 1918:64. **New Synonymy.** Lectotype: USNM #36898, male, here selected. Type-area: Boulder County, Colorado, USA.

Bembidion tractabile Casey, 1918:64. **New Synonymy.** Lectotype: USNM #36901, female, here selected. Type-area: Utah, USA.

Notes.—This species was adequately discussed by Lindroth (1963) but he did not cover these Casey synonyms.

[*Bembidion negligens* Casey, see *B. rapidum*]

Bembidion nevadense **Ulke**

Bembidium nevadense Ulke, 1875:811. (See Lindroth, 1963, for details.)

Bembidion viaticum Casey, 1918:65. **New Synonymy.** Lectotype: USNM #36884, female, here selected. Type-area: New Mexico, USA.

Notes.—Lindroth adequately discusses this species but did not cover this Casey synonym.

Bembidion nogalesium **Casey**

Bembidion nogalesium Casey, 1924:42. Lectotype: USNM #37020, female, here selected. Type-locality: Nogales, Santa Cruz County, Arizona, USA.

Notes.—This "species" belongs in the *patruele* group which is in need of a complete revision (see *B. auxiliator*).

Bembidion nubiculosum **Chaudoir**

Bembidium nubiculosum Chaudoir, 1868:244. (New name for *O. laticollis* LeConte, not Duftschmid, 1812:19.)

Ochthedromus laticollis LeConte, 1852:187, not Duftschmid. Lectotype: MCZ #5523, male, here selected. Type-area: Colorado River, California, USA.

Bembidion daphnis Casey, 1918:120. **New Synonymy.** Lectotype: USNM #37036, male, here selected. Type-locality: El Paso, Texas, USA.

Bembidion amnicum Casey, 1918:121. **New Synonymy.** Lectotype: USNM #37037, male, here selected. Type-locality: Brownsville, Texas, USA.

Notes.—This variable species belongs in the *dorsale* group; its members are found throughout the southwestern USA and northern Mexico.

[*Bembidion obsequens* Casey, see *B. idoneum*]

Bembidion operosum Casey

Bembidion operosum Casey, 1918:103. Lectotype: USNM #36960, female, here selected. Type-locality: Santa Cruz, California, USA.

Notes.—This species belongs in the *patruele* group and is found in California.

Bembidion oppressum Casey

Bembidion oppressum Casey, 1918:40. Lectotype: USNM #36866, male, here selected. Type-locality: Duncan's Mill, Sonoma County, California, USA.

Notes.—This species belongs in the *planiusculum* group; its members are known from central California in the coastal range.

[*Bembidion ornatellum* Casey, see *B. indistinctum*]

[*Bembidion particeps* Casey, see *B. viridicolle*]

Bembidion patruele Dejean

Bembidium patruele Dejean, 1831:69. (See Lindroth, 1963, for details.)
Bembidion mediocre Casey, 1918:107. **New Synonymy.** Holotype: USNM #36967, male. Type-area: "Atlantic regions," USA.
Bembidion editum Casey, 1918:125. **New Synonymy.** Lectotype: USNM #37041, male, here selected. Type-area: "New Jersey (near the Delaware River)," USA.

Notes.—This species was adequately covered by Lindroth (1963) but he did not discuss these two Casey synonyms.

Bembidion pedicellatum LeConte

Bembidium pedicellatum LeConte, 1857:6. Holotype: MCZ #5551, male. Type-area: Lancaster County, Pennsylvania, USA.
Bembidion strigulosum Casey, 1918:150. **New Synonymy.** Lectotype: USNM #37068, male, here selected. Type-locality: Washington, D.C., USA.
Bembidion fastidiosum Casey, 1918:150. **New Synonymy.** Lectotype: USNM #37069, male, here selected. Type-locality: St. Louis, Missouri, USA.

Notes.—This species was adequately discussed by Lindroth (1963:383) who also hinted at the synonymy of Casey's names.

Bembidion perbrevicolle Casey

Bembidion perbrevicolle Casey, 1924:25. Lectotype: USNM #36826, female, here selected. Type-area: Placer County, California, USA.

Notes.—This species belongs in the *nebraskense* group; its members are known from the foothills of the Sierra Nevada of California.

Bembidion pernotum **Casey**

Bembidion pernotum Casey, 1918:62. Lectotype: USNM #36922, female, here selected. Type-locality: Jemez Springs, New Mexico, USA.

Notes.—This species belongs in the *transversale* group; its members are found in the American southwest and will likely be found also in Mexico.

Bembidion pimanum **Casey**

Bembidion pimanum Casey, 1918:98. Lectotype: USNM #36982, female, here selected. Type-area: "near Benson, Arizona," USA.

Notes.—This "species" belongs in the *patruele* group which is in need of a complete revision.

[*Bembidion placabile* Casey, see *B. cordatum*]

Bembidion placeranum **Casey**

Bembidion placeranum Casey, 1924:28. Holotype: USNM #36865, female. Type-area: Placer County, California, USA.

Notes.—This species belongs in the *incertum* group and is found in the foothills of the Sierra Nevada of California.

Bembidion placitum **Bates**

Bembidium placitum Bates, 1878:602. Type-area: "Mexico, near the capital."

Notes.—I was unable to locate the type series of this species in MNHP where it should be, however, I saw 3 specimens "ex Sallé" in BMNH that Bates mentions (1882:151). The species belongs in the *scudderi* group and is found in Mexico.

Bembidion platynoides **Hayward**

Bembidium platynoides Hayward, 1897:78. Lectotype: MCZ #16287, male, here selected. Type-locality: Pomona, California, USA.
Bembidion sedulum Casey, 1918:70. **New Synonymy.** Lectotype: USNM #36931, male, here selected. Type-area: "Southern California," USA.

Notes.—This species was adequately discussed by Lindroth (1963) but he neglected to mention this Casey synonym.

Bembidion portoricense **Darlington**

Bembidion portoricense Darlington, 1939:86. Holotype: MCZ #23507, male. Type-locality: El Yunque, Puerto Rico, Greater Antilles.

Notes.—This species belongs in the *vernale* group and is known only from the island of Puerto Rico.

Bembidion praecinctum **LeConte**

Bembidium praecinctum LeConte, 1879:509. Holotype: MCZ #5547, female. Type-locality: Alamosa, Colorado, USA.
Bembidion veridicum Casey, 1918:152. **New Synonymy.** Lectotype: USNM #37066, male, here selected. Type-locality: Elko, Nevada, USA.

Notes.—This species was adequately discussed by Lindroth (1963) but he merely hinted at Casey's synonymy.

[*Bembidion procax* Casey, see *B. jacobianum*]

[*Bembidion prosperum* Casey, see *B. luculentum*]

[*Bembidion provanum* Casey, see *B. semipunctatum*]

[*Bembidion pullulum* Casey, see *B. impotens*]

Bembidion quadrimaculatum (Linné)

Cicindela quadrimaculata Linné, 1761:211. (See Lindroth, 1963, for details.)
Bembidion tenax Casey, 1918:152. **New Synonymy.** Lectotype: USNM #37065, male, here selected. Type-locality: Fort Wingate, New Mexico, USA.

Notes.—This species was adequately discussed by Lindroth (1963) but he did not cover this Casey synonym.

Bembidion quadrulum LeConte

Bembidium quadrulum LeConte, 1861:340. Lectotype: MCZ #5498, male, here selected. Type-area: "East of Fort Colville," Oregon, USA.
Bembidion callidum Casey, 1918:50. **New Synonymy.** Lectotype: USNM #36878, male, here selected. Type-locality: Truckee, California, USA.
Bembidion tritum Casey, 1918:50. **New Synonymy.** Lectotype: USNM #36879, female, here selected. Type-area: Boulder County, Colorado, USA.
Bembidion aegrotum Casey, 1918:51. **New Synonymy.** Lectotype: USNM #36880, male, here selected. Type-area: Colorado, USA.

Notes.—This species was adequately discussed by Lindroth (1963) but he did not cover these Casey synonyms.

Bembidion rapidum (LeConte)

Ochthedromus rapidus LeConte, 1848:453. Lectotype: MCZ #5533, female, here selected. Type-area: "Rocky Mountains" as given by LeConte, restricted by Lindroth (1963:363) to Colorado Springs, Colorado, USA.
Bembidion docile Casey, 1918:126. **New Synonymy.** Lectotype: USNM #37055, female, here selected. Type-area: "Arizona (probably southern)," USA.
Bembidion negligens Casey, 1918:127. **New Synonymy.** Holotype: USNM #37052, male. Type-locality: El Paso, Texas, USA.
Bembidion fugitans Casey, 1918:127. **New Synonymy.** Lectotype: USNM #37053, male, here selected. Type-area: "Arizona (probably southern)," USA.

Notes.—This species was adequately discussed by Lindroth (1963) but he neglected to cover these Casey synonymys.

[*Bembidion reconditum* Casey, see *B. indistinctum*]

[*Bembidion relictum* Casey, see *B. adductum*]

[*Bembidion remotum* Casey, see *B. clemens*]

Bembidion renoanum **Casey**

Bembidion renoanum Casey, 1918:72. Lectotype: USNM #36932, male, here selected. Type-locality: Reno, Nevada, USA.

Notes.—This species belongs in the *bimaculatum* group and is known only from the type locality.

[*Bembidion retectum* Casey, see *B. mexicanum*]

Bembidion rubiginosum **LeConte**

Bembidium rubiginosum LeConte, 1879:508. Holotype: MCZ #5541, female. Type-locality: Garland, Colorado, USA.

Notes.—This species belongs in the *muscicola* group and is known only from the type locality.

Bembidion rucillum **Darlington**

Bembidion rucillum Darlington, 1939:85. Holotype: MCZ #23506, male. Type-locality: Loma Rucilla, Dominican Republic, Greater Antilles (8000′).

Notes.—This species belongs in the *vernale* group and is known only from the Dominican Republic.

Bembidion rupicola **(Kirby)**

Peryphus rupicola Kirby, 1837:53. (See Lindroth, 1963, for details.)
Bembidion aversans Casey, 1924:35. **New Synonymy.** Lectotype: USNM #36941, female, here selected. Type-area: Mexico.

Notes.—Lindroth (1963) adequately covered this species but did not discuss this Casey synonym.

Bembidion satellites **Bates**

Bembidium satellites Bates, 1884:291. Lectotype: BMNH, female, here selected. Type-locality: Peña Blanca, Panama.

Notes.—This species belongs in the *vernale* group; its members are found in upland habitats from northern Costa Rica to western Panama.

Bembidion scenicum **Casey**

Bembidion scenicum Casey, 1918:159. Lectotype: USNM #37079, male, here selected. Type-area: Lake Tahoe, California, USA.

Notes.—This species belongs in the *anguliferum* group and is known only from the type-area.

[*Bembidium scintillans* Bates, see *B. aratum*]

Bembidion scopulinum **(Kirby)**

Peryphus scopulinum Kirby, 1837:53. (See Lindroth, 1963, for details.)
Bembidion bellulum Casey, 1918:71. **New Synonymy.** Holotype: USNM #36902, female. Type-locality: Las Vegas, New Mexico, USA.

Notes.—This species was adequately discussed by Lindroth (1963:342) but he neglected to mention this Casey synonym. This species is widespread and enough material is presently available in museums to provide a good basis for a geographic study.

[*Bembidion scrutatum* Casey, see *B. grapei*]

[*Bembidion sedulum* Casey, see *B. platynoides*]

Bembidion semifasciatum **Say**

Bembidium semifasciatum Say, 1834:438. Type: Lost. Type-locality: Mexico.

Notes.—This rather well-described species belongs in the *dorsale* group. Designation of a Neotype should await a revision of the Mexican *Bembidion* or the *dorsale* group.

Bembidion semiopacum **Casey**

Bembidion semiopacum Casey, 1924:39. Holotype: USNM #36965, female. Type-area: San Joaquin County, California, USA.

Notes.—This species belongs in the complex *patruele* group which badly needs revision; members of *B. semiopacum* are known from California's central valley.

Bembidion semipunctatum **Donovan**

Bembidium semipunctatum Donovan, 1806:22. (See Lindroth, 1963:367, for details.)

Bembidion provoanum Casey, 1918:105. Lectotype: USNM #36966, female, here selected. Type-locality: Provo, Utah, USA.

Notes.—This species was discussed adequately by Lindroth (1963) but he did not mention this Casey synonym.

[*Bembidium sexpunctatum* LeConte, see *B. hageni*]

Bembidion sparsum **Bates**

Bembidium sparsum Bates, 1882:151. Lectotype: BMNH, male, here selected. Type locality: Oaxaca, Mexico.

Notes.—This species belongs in the *dorsale* group; its members are found in low lying habitats and coastal localities from Sonora, Mexico south to Nicaragua on the west coast, to Vera Cruz on the east coast, Jamaica, Hispaniola, and in Colombia.

Bembidion sphaeroderum **Bates**

Bembidium sphaeroderum Bates, 1882:147. Lectotype: BMNH, male, here selected and previously labelled by G. Perrault. Type-locality: Jalapa, Mexico.

Notes.—This species belongs in the *sphaeroderum* group and is known only from Mexico.

Bembidion sphaerulifer **Bates**

Bembidium sphaerulifer Bates, 1891:261. Lectotype: MNHP, male, here selected and previously labelled by G. Perrault. Type-locality: Ventanas, Durango, Mexico.

Notes.—This species belongs in the *sphaeroderum* group and is known only from Mexico.

Bembidion spretum **Dejean**

Bembidium spretum Dejean, 1831:70. Holotype: MNHP, female. Type-area: Mexico.
Notaphus fastidiosus LaFerté-Sénectère, 1841:49, not Jacquelin du Val, 1851:563.
Bembidium apicale Jacquelin du Val, 1856:23, not Ménétriés, 1832:137.
Bembidicidium chevrolati Gemminger and Harold, 1868:409, new name for *B. apicale* Jacquelin du Val.

Notes.—This species belongs in the *dorsale* group and is widespread in Mexico and the Caribbean area.

[*Bembidium stabile* LeConte, see *B. mexicanum*]

[*Bembidion strigulosum* Casey, see *B. pedicellatum*]

Bembidion subaerarium **Casey**

Bembidion subaerarium Casey, 1924:31. Lectotype: USNM #36896, male, here selected. Type-locality: Blue Lakes, Alpine County, California, USA.

Notes.—This species belongs in the *nigrum* group and is known only from the type locality.

Bembidion subangustatum **Hayward**

Bembidium subangustatum Hayward, 1897:83. Type-area: Arizona and New Mexico, USA.

Notes.—The type series of this species could not be located in MCZ where it should be deposited. From the description I judge it to be a member of the *grapei* group.

Bembidion submaculatum **Bates**

Bembidium submaculatum Bates, 1882:149. Lectotype: BMNH, male, here selected. Type-locality: Oaxaca, Mexico.

Notes.—This species belongs in the *incrematum* group and is known from Mexico.

[*Bembidion temperans* Casey, see *B. triviale*]

[*Bembidion tenax* Casey, see *B. quadrimaculatum*]

[*Bembidium tessellatum* LeConte, see *B. conspersum*]

[*Bembidion testatum* Casey, see *B. incertum*]

Bembidion texanum **Chaudoir**

Bembidium texanum Chaudoir, 1868:240. Lectotype: MNHP, male, by Lindroth, 1963. Type-area: Texas, USA.

Bembidion cogitans Casey, 1918:69. **New Synonymy.** Lectotype: USNM #36928, male, here selected. Type-area: "?Indiana," USA.

Bembidion inquietum Casey, 1918:67. **New Synonymy.** Lectotype: USNM #36924, here selected. Type-locality: Jemez Springs, New Mexico, USA.

Notes.—This species was adequately discussed by Lindroth (1963:325) but he neglected to mention these synonyms.

Bembidion tigrinum **LeConte**

Bembidium tigrinum LeConte, 1879:509. Holotype: MCZ #5521, female. Type-area: "Southern California," USA.

Notes.—This species belongs in the *tigrinum* group and is found along the California coast.

[*Bembidion tractabile* Casey, see *B. nebraskense*]

[*Bembidion tritum* Casey, see *B. quadrulum*]

Bembidion triviale **Casey**

Bembidion triviale Casey, 1918:134. Lectotype: USNM #37008, male, here selected. Type-area: Lake County, California, USA.

Bembidion temperans Casey, 1918:135. **New Synonymy.** Lectotype: USNM #37009, female, here selected. Type-area: Lake County, California, USA.

Notes.—This species belongs in the *patruele* group and is found in central California.

Bembidion turquinum **Darlington**

Bembidion turquinum Darlington, 1937:122. Holotype: MCZ #22492, male. Type-locality: Pico Turquino, north side, Cuba, 4500′–6000′, Greater Antilles.

Notes.—This species belongs in the *vernale* group and is found solely on Cuba.

[*Bembidion vafrum* Casey, see *B. mexicanum*]

[*Bembidion vapidum* Casey, see *B. clemens*]

[*Bembidion veridicum* Casey, see *B. praecinctum*]

Bembidion vernale **Bates**

Bembidium vernale Bates, 1882:149. Lectotype: BMNH, male, here selected. Type-locality: Peña Blanca, Panama.

Notes.—This species belongs in the *vernale* group; its members are found in upland habitats from Guatemala to Panama. It probably also occurs in Mexico, but I saw no specimens from there.

[*Bembidion vernula* Casey, see *B. constrictum*]

[*Bembidion viaticum* Casey, see *B. nevadense*]

[*Bembidion vinnulum* Casey, see *B. aratum*]

[*Bembidion virgatulum* Casey, see *B. impotens*]

Bembidion viridicolle (LaFerté)

Notaphus viridicollis LaFerté-Sénectère, 1841:48. (See Lindroth, 1963:374, for details.)

Bembidion particeps Casey, 1918:124. **New Synonymy.** Lectotype: USNM #37039, female, here selected. Type-area: "Arizona (probably southern)," USA.

Notes.—Lindroth (1963) adequately discussed this species but he did not cover this Casey synonym.

Bembidion vividum **Casey**

Bembidion vividum Casey. 1884:66. Lectotype: USNM #37048, female, here selected. Type-area: Cape May, New Jersey, USA.

Notes.—This species belongs in the *contractum* group and is found along the coast of the mid-northern Atlantic.

Bembidion vulcanium **Darlington**

Bembidion vulcanium Darlington, 1934:157a. Holotype: MCZ #19625, male. Type-locality: Volcan Irazu, 2800–3000 m, south slope, Costa Rica.

Notes.—This species belongs in the *vernale* group and is found in higher elevation throughout central Costa Rica.

Bembidion vulpecula **Casey**

Bembidion vulpecula Casey, 1918:126. Lectotype: USNM #37047, female, here selected. Type-locality: Brownsville, Texas, USA.

Notes.—This species belongs in the *dorsale* group and is known from the American southwest and Mexico.

Bembidion wickhami **Hayward**

Bembidium wickhami Hayward, 1897:112. Lectotype: MCZ #16299, male, here selected. Type-locality: Dunsmuir, California, USA.

Bembidion delectum Casey, 1918:44. **New Synonymy.** Lectotype: USNM #36872, male, here selected. Type-locality: Gilroy Hot Springs, Santa Clara County, California, USA.

Bembidion carlhi Erwin and Kavanaugh, 1981:37. **New Synonymy.** Holotype: CAS #13657. Type-locality: Steamboat Creek at Steamboat Falls, 410 m, Douglas County, Oregon, USA.

Notes.—This species belongs in its own group and is known from Oregon and California. While this paper was in press, Erwin and Kavanaugh (1981) revised the *erasum* group of species and in so doing described as new, *Bembidion carlhi* Erwin and Kavanaugh, 1981. Unfortunately, this species had already been described by Hayward (1897) as *B. wickhami,* therefore *carlhi* is a junior synonym of Hayward's name. Kavanaugh and I thank Dr. Kenneth Cooper for pointing out this error.

[*Bembicidium xanthostictum* Gemminger and Harold, see *B. conspersum*]

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Biological Notes on the Bee *Exomalopsis crenulata* Timberlake (Hymenoptera: Anthophoridae)

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Abstract.—Nests of a ground nesting anthophorid bee, *Exomalopsis crenulata* Timberlake, are described. Females nested gregariously and made jug-like cells attached singly to lateral burrows. The nesting site had been used for more than 1 year. This bee used mainly *Eriogonum* pollens to provision its nests. A description of the nesting site, arrangement, and description of the cells is presented. A parasitic bee, *Hypochrotaenia* (*Micronomada*) *gutierreziae* (Cockerell), was found in some *Exomalopsis* cells.

Exomalopsis is a moderately sized group of New World anthophorid bees that are primarily Neotropical in their distribution. In the United States these small bees (2.5 to 7.5 mm) are grouped into 4 subgenera and 47 species. The nesting habits of *Exomalopsis* are known only for three species (*E.* (*Anthophorisca*) *chionura* Cockerell, Rozen 1957; *E.* (*Pheanomalopsis*) *solani* Cockerell, Linsley, 1954; *E.* (*Anthophorula*) *torticornis* Cockerell, Hicks, 1936): all nest in the ground in gregarious or communal nests. Flower visitation records have been summarized by Timberlake (1980) who reports that some species of *Exomalopsis* visit a wide variety of flowers (e.g., *E. solani, E. similis* Cresson) but others are oligoleges of composites (*E. chionura*) and mallows (*E . sidae* Cockerell).

A recently described species, *E.* (*Anthophorula*) *crenulata* Timberlake (Timberlake, 1980) was commonly collected in southern Utah on *Eriogonum* flowers in the summers of 1979 and 1980. Many nests of this bee were discovered in the fall of 1980. This paper describes the nest architecture, cells, nest associates, and host plants of *E. crenulata.*

NESTING SITE

The location of the *Exomalopsis* nesting site was 2.1 km E of Little Gilson Butte, approximately 40 km N of Hanksville, Emery Co., Utah. Here, the San Rafael Desert is marked by numerous moving crescent dunes that are surrounded by large areas of stabilized sandy soil. The vegetation is diverse, and perennial shrubs (*Eriogonum, Chrysothamnus, Gutierrezia*) and forbs (*Oenothera, Helianthus, Senecio*) are abundant.

The nesting site was discovered on the sides and the base of a low mound of soil which is the refuse of an attempt at mining (Fig. 1). The soil composing the mound was sandy beneath but on the surface and 15 cm beneath it was hard and baked. Many female bees were observed entering the numerous nesting holes found in this mound; activity was greater in the afternoon and more than one female entered and exited the same hole.

NEST ARCHITECTURE

The descriptions of the nests were made from clusters of cells that were excavated and studied later in the laboratory. Our brief visit and a sandstorm prevented detailed nest excavations at the site. However, many details of the nesting biology were obtained from the nest samples and the limited measurements taken at the nest site.

Entrance.—The nest entrances were small (3 mm wide), oval-shaped openings clustered close together in the hard surface (Fig. 2). None of the entrances were covered by a turret.

Burrows.—The burrows were larger (3.5 mm wide) just beneath the surface and consisted of a maze of similarly sized tunnels that were interconnected at the cell level approx. 30 cm beneath the surface. The burrows were lined by finely masoned soil of about 0.5 mm thickness with a glazed appearance; the linings were easily distinguished from the surrounding soil layers (Fig. 3). The composition of the glaze is not known, but it was not waxy because applied water droplets easily impregnated the lining.

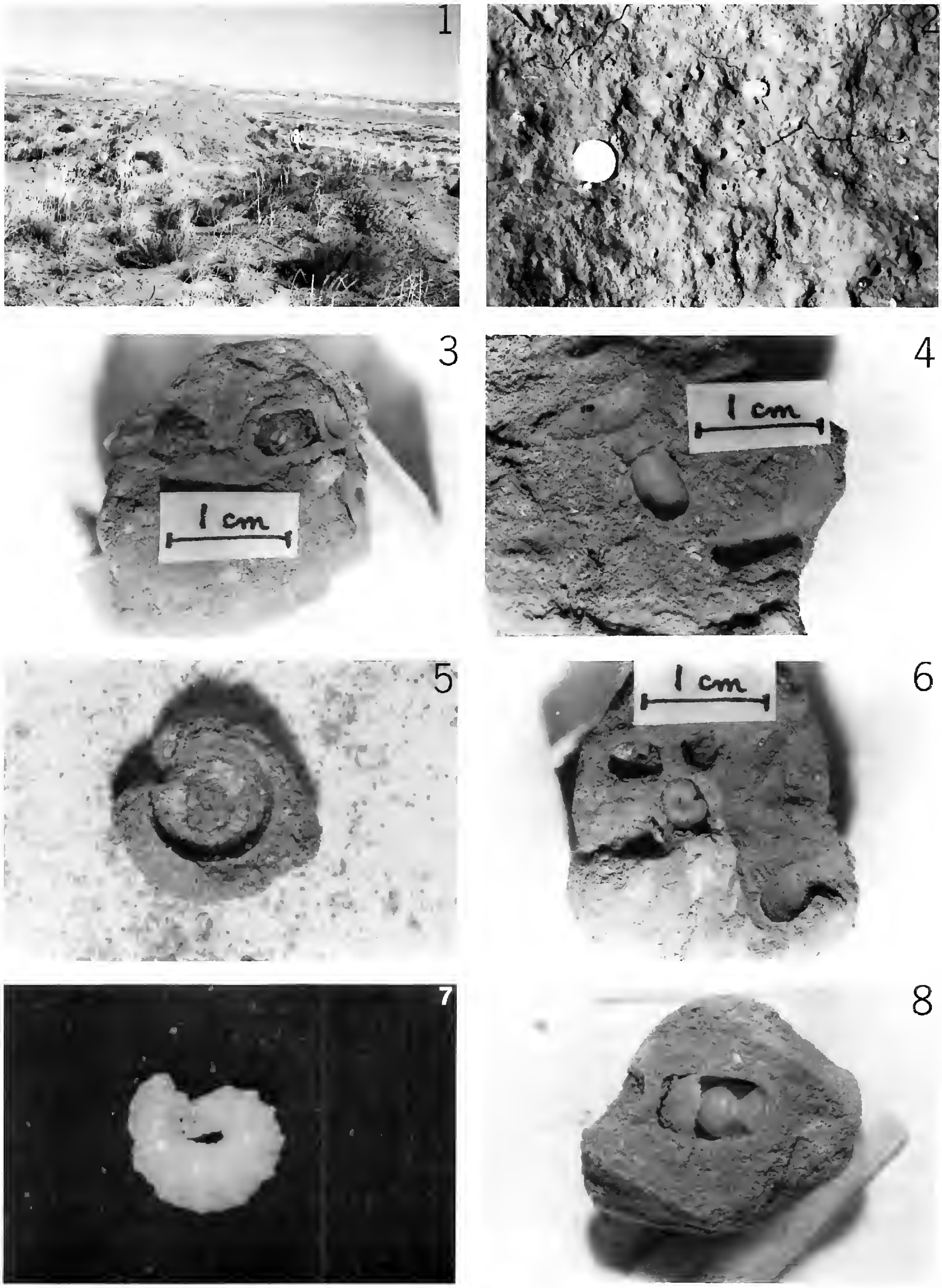
There was no pattern in burrow orientation since burrows were constructed on all planes and ran in many directions. It is of interest to note that the nesting site had been used in previous years; many old, exited, and refilled cells were found adjacent to newly provisioned cells and old and new cells were connected to the same lateral burrow.

Cells.—The cells diverged from the lateral burrows at an angle of 90° to 180° (Fig. 4) and were attached singly to the lateral burrows. Since the burrows were multi-directional, cell orientation to the surface plane was also multi-directional. Examination of several cells at different stages of construction revealed that a "typical" cell was made by first "roughing-out" a short elongate chamber off a lateral burrow and then lining the walls with a smooth, shiny paste of fine-grained soil (Fig. 4, arrow). The walls of the chamber were 0.5 to 1.5 mm thick. The finished cells were jug-shaped with the elongated neck region receiving the cell cap. The oval chambers that held the pollen loaf averaged 6.0 ± 0.3 mm in length and 3.7 ± 0.2 mm wide at the widest point ($n = 20$). The neck of this chamber was constricted to 3 mm and capped by a spiral plug of soil (with 4 coils) (Fig. 5). The cap was 0.7 ± 0.4 mm thick, U-shaped and smooth on the outer surface (Fig. 3, arrow) and was connected to the burrow by a short (0.8 to 3.4 mm) plug of compact soil. The inner surface of the cell was polished and shiny, but when water droplets were placed on it artificially, they were quickly absorbed.

NEST BIOLOGY

Provisions.—All cells with old provisions were moldy and the shape of the pollen loaf could not be clearly seen, but the loaf was cylindrical and attached to the cell wall by a small "foot" (Rozen, 1957). The free end of the provision projected towards the cell base. Egg placement was not observed, but several dead early instar larvae were found on the top of the loaf and near the "foot."

The pollens comprising the loaf and samples of pollen loads taken from foraging females were 99% *Eriogonum.*



Figures 1–8. 1. View of nesting site on the mound of soil N of Hanksville, Utah. Hills in the background are the San Rafael Swell. 2. Soil surface of nesting site and several oval nest entrances. 3. Jug-like cells of *Exomalopsis.* Note the smooth cell cap and the thin paper-like cocoon. 4. Single cells of *Exomalopsis* attached to lateral burrows. Note the thick soil plug connecting the cell to the lateral burrow. 5. Cell cap (ventral view) showing spiral construction. 6. Cell with coiled overwintering larva. 7. Mature larva; note the subapical ventral swelling. 8. Cell with cocoon and fecal pellets.

Larvae.—The mature overwintering larvae were creamy-white and coiled into a tight C-shape (Fig. 6). The larvae rested on the dorsal surface with the head oriented either towards the cell cap or bottom. The mature larva had prominent subapical swellings on the venter (Fig. 7).

Fecal pellets.—The fecal pellets were smeared against the cell walls in longitudinal irregularly shaped stripes. At the top of the cell several pellets were loose.

Cocoon.—A thin light tan to brown layer of silk was spun against the cell walls and over the smeared fecal pellets (Fig. 3). The thin, silk layer readily tore apart. The dome-shaped top of the cocoon was formed just beneath the cell cap (Fig. 8). The cocoon appeared to be made from a single layer of silk. All live larvae were found in cocoons and also, all the old exited cells contained traces of cocoon material.

NEST ASSOCIATES

A dozen females of the parasitic nomadine bee, *Hypochrotaenia* (*Micronomada*) *gutierreziae* (Cockerell), were collected as they flew about the nesting site. Several of them entered nests and remained for short intervals. In addition two *Exomalopsis* cells contained dead but unemerged adults of this parasite. Like other species of this group of parasites (Parker, 1981), the parasitic larva did not spin a cocoon and its fecal pellets were small and evenly scattered on the cell walls.

A female *Exomalopsis* was observed to attack one of these parasitic bees as it tried to enter a nest. In their brief struggle a forewing of the parasite was torn off by the host bee.

Many of the *Exomalopsis* cells had been robbed by small ants that frequented the nesting site. The ants made small tunnels among the cells and removed all the provisions, fecal pellets, and parts of the cocoon.

DISCUSSION

Some of the nesting habits of *E. crenulata* are similar to other *Exomalopsis*. All species make jug-like earthen cells, but the formation and the lining of the walls differ. Cells of *E. crenulata* were easily removed from the surrounding soil, the cell walls were easily distinguished by the fine-grained texture, and the inner cell walls were polished but not waxed; cells of *E. chionura* could not be removed intact nor be distinguished from the surrounding soil, and the inner walls were lined with wax and were nonpermeable to water droplets (Rozen, 1957). Cells of *E. crenulata* were attached singly to lateral burrows but other *Exomalopsis* cells were found in short chains (Claude-Joseph, 1926; Rozen, 1957). Although more than one female of *E. crenulata* used the same nest entrance, there were several hundred openings being used concurrently at the dense nesting site. This contrasts with *E. torticornis* and *E. solani* where several hundred females have been found using the same entrance (Hurd and Linsley, 1975). Floral affinities differ among *Exomalopsis* (Timberlake, 1980) and *E. crenulata* is another example of an oligolectic species (*Eriogonum*).

It is of interest to note that species of *Exomalopsis* that use a common nest entrance are polylectic and one, *E. solani*, is known to practice cooperative provisioning. Michener (1966) found that some *E. solani* females that were gathering pollen were not ready to lay eggs. Thus, the sharing of a common nest entrance, cooperative cell provisioning (Michener, 1966), and polylectic foraging may be steps in the evolution of a social organization among some species of *Exomalopsis.*

The host association for the parasitic bee, *H. gutierreziae,* is the first host record for this group of nomadine bees (species that have a flattened clypeus). Snelling (pers. comm.) reported that the specimens from *Exomalopsis* nests were the smallest he had examined. Perhaps this nomadine bee also parasitizes larger and related bees such as *Diadasia.*

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I am indebted to D. Veirs for the photographs used in this paper and to T. Griswold for field assistance. Thanks are due to those persons who made helpful suggestions on the manuscript—N. Youssef, Utah State University; E. G. Linsley, Univ. of California–Berkeley; R. R. Snelling, Los Angeles County Museum; and V. J. Tepedino of this laboratory. R. R. Snelling also identified the nomadine bee.

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A Systematic Study of the Genus *Camelopsocus* with Descriptions of Three New Species (Psocoptera: Psocidae)[1]

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Abstract.—Five species of *Camelopsocus* are diagnosed and keyed. All known distribution records are given for each species. *C. bactrianus,* n. sp. and *C. hiemalis,* n. sp. from southern California and *C. tucsonensis,* n. sp. from southern Arizona are described. The sexes of *C. bactrianus* and *C. hiemalis,* species which occur together, are associated by temporal and character concordance. Eggs, the embryonic oviruptor and surrounding structures, and the nymphal instars of *C. bactrianus* and *C. hiemalis* are described, but it is not yet possible to distinguish the two species in these stages. The two species are univoltine in southern California. Nymphs and adults occur from November to May. This phenology contrasts to that seen in *C. monticolus* and *C. similis* in the Rocky Mountains and desert ranges of New Mexico, where nymphs and adults appear in the summer. *Camelopsocus* is probably most closely related to *Oreopsocus* and *Atlantopsocus.*

Since the original discovery of *Camelopsocus* (Mockford, 1965), three additional species have been found. New distribution records of the two described species have been made, and observations of several characters not previously considered allow more precise determination of taxonomic relationships of the genus.

It is the purpose of this paper to describe the new species, to describe the egg, postembryonic stages, and phenology of two of the new species, to present new distribution records of the previously known species, to present a key to the species, and to reassess the taxonomic relationships of the genus.

The new species are from southern California and southern Arizona. They differ phenologically from the previously known species in that adults are restricted in their occurrence to the winter and spring. Adults of the two previously known species, which are found at relatively high altitudes in the Rocky Mountains, the desert ranges of New Mexico and Arizona, and the mountains and high plains of Mexico, occur only in summer in the northern part of this distribution (i.e., the United States), although they have been taken from late March through late December in Mexico.

MATERIALS AND METHODS

This study is based on observation of 236 adult specimens of which 187 represent the new species. In addition, 136 nymphs of *C. bactrianus,* n. sp. and *C. hiemalis,* n. sp. were observed. Whole specimens were placed for drawing in a

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Table 1. Measurements (μ), counts, and ratios for new species of *Amelopsocus*. Abbreviations are explained in text.

Species + sex	FW	HW	F	T	t_1	t_2	cten	f_1	f_2	f_3	IO/D	PO
bactiranus ♂	4971	3695	683	1462	303	204	18	693	702	595	1.90	0.95
bactrianus ♂	5168	1435	738	1559	406	216	17	772	803	681	2.05	1.01
bactrianus ♀	343	—	675	1278	301	208	—	488	520	459	2.85	0.84
bactrianus ♀	249	—	674	1257	281	206	—	456	508	436	2.60	0.94
hiemalis ♂	5129	3885	697	1382	318	194	9	691	661	571	2.07	0.91
hiemalis ♂	5100	3848	697	1543	388	202	9	796	697	638	2.06	0.93
hiemalis ♀	229	—	675	1163	261	204	—	434	390	354	2.79	0.86
hiemalis ♀	257	—	686	1179	255	193	—	457	446	407	—	—
tucsonensis♂	5347	4050	725	1552	388	172	15	796	730	656	1.88	1.03
tucsonensis ♂	5150	3948	695	1414	342	179	2	671	592	543	2.07	1.00
tucsonensis ♀	223	—	617	1069	230	182	—	375	331	300	2.60	0.84
tucsonensis ♀	190	—	637	1186	245	185	—	438	399	372	2.66	0.84

well slide filled with glycerine over cotton strands and were drawn with aid of a drawing tube on a dissecting microscope. Morphological observations were made on slide preparations in Hoyer's medium under a compound microscope. Color observations were made on whole specimens in alcohol with direct light under a dissecting microscope. Measurements were made with a filar micrometer. The micrometer unit was 0.987 μ.

The following abbreviations are used in the measurements (Table 1): FW = length of forewing; HW = length of hindwing; F = length of hind femur (this and all other leg measurements are made condyle to condyle); T = length of hind tibia; t_1, t_2 = length of hind tarsomeres in order from base; cten = number of ctenidia (comblike scales at bases of setae) on first hind tarsomere; f_1, f_2, f_3 = length of first three flagellomeres in order from base; IO/D = least distance between compound eyes divided by greatest antero-posterior diameter of eye in dorsal view; PO = transverse diameter of eye divided by its greatest antero-posterior diameter in dorsal view.

ASSOCIATION OF SEXES

In dealing with the taxonomy of species that are highly sexually dimorphic, one is faced with the problem of association of the sexes. The solution generally involves finding characters that are trans-sexually distributed. In *Camelopsocus* the dorsal abdominal turret of segment 5 marks both sexes of the genus, but if two or more species occur at one locality, the investigator must search for trans-sexual characters at the species level. Data on physical and temporal cooccurrence of the forms involved are also useful. The sexes of *C. monticolus* Mockford and *C. similis* Mockford were readily associated by several trans-sexual color markings differing between the species, and by presence of both sexes of one species at several localities where the other species was absent.

Adults of two species have been taken in Riverside County, California. Both species are currently known only from that county. For empirical analysis of associational data, we will consider the males as forms numbers 1 and 2, and the females as forms numbers 3 and 4.

Space-time associations are considered first. The four forms are known from

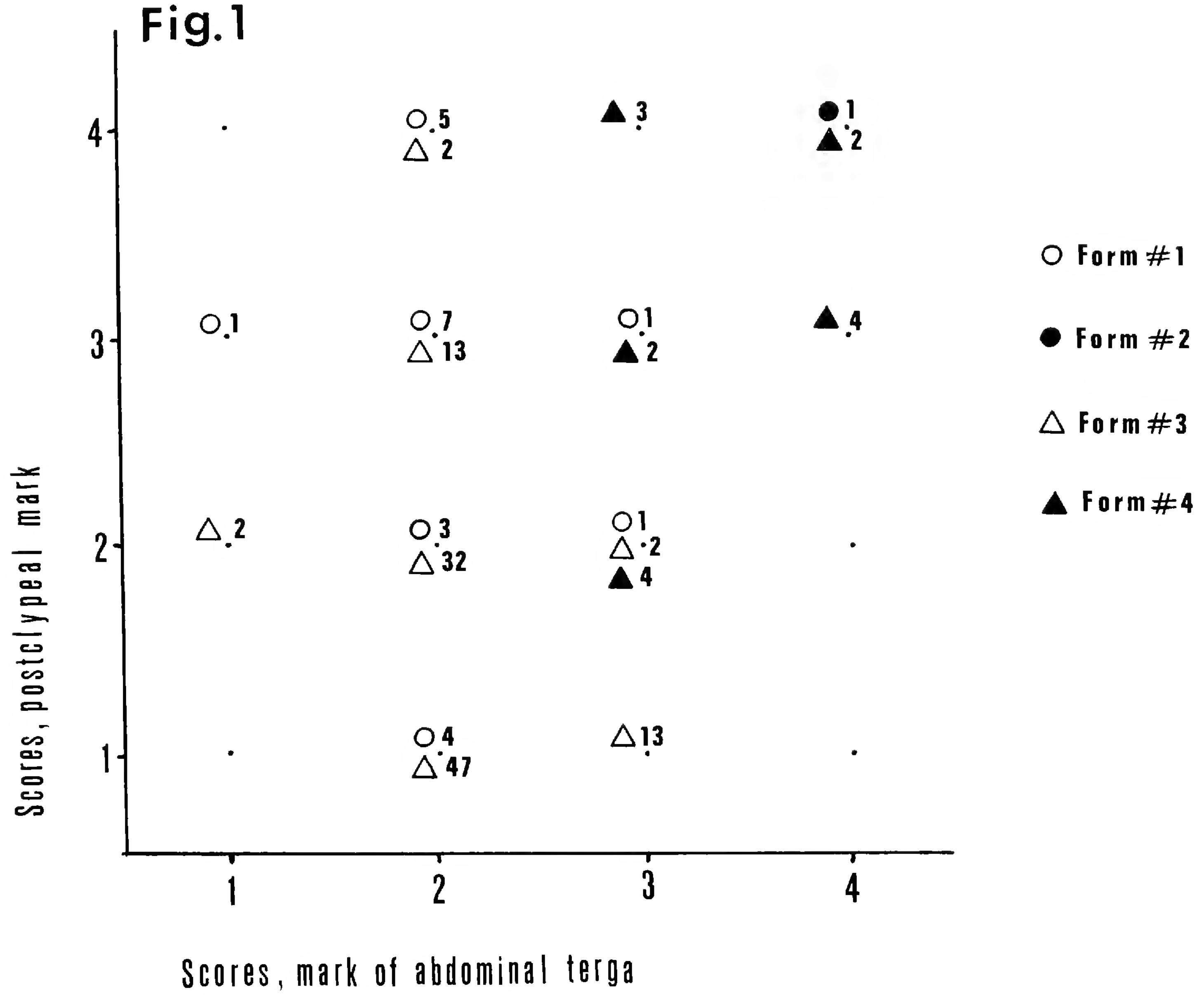
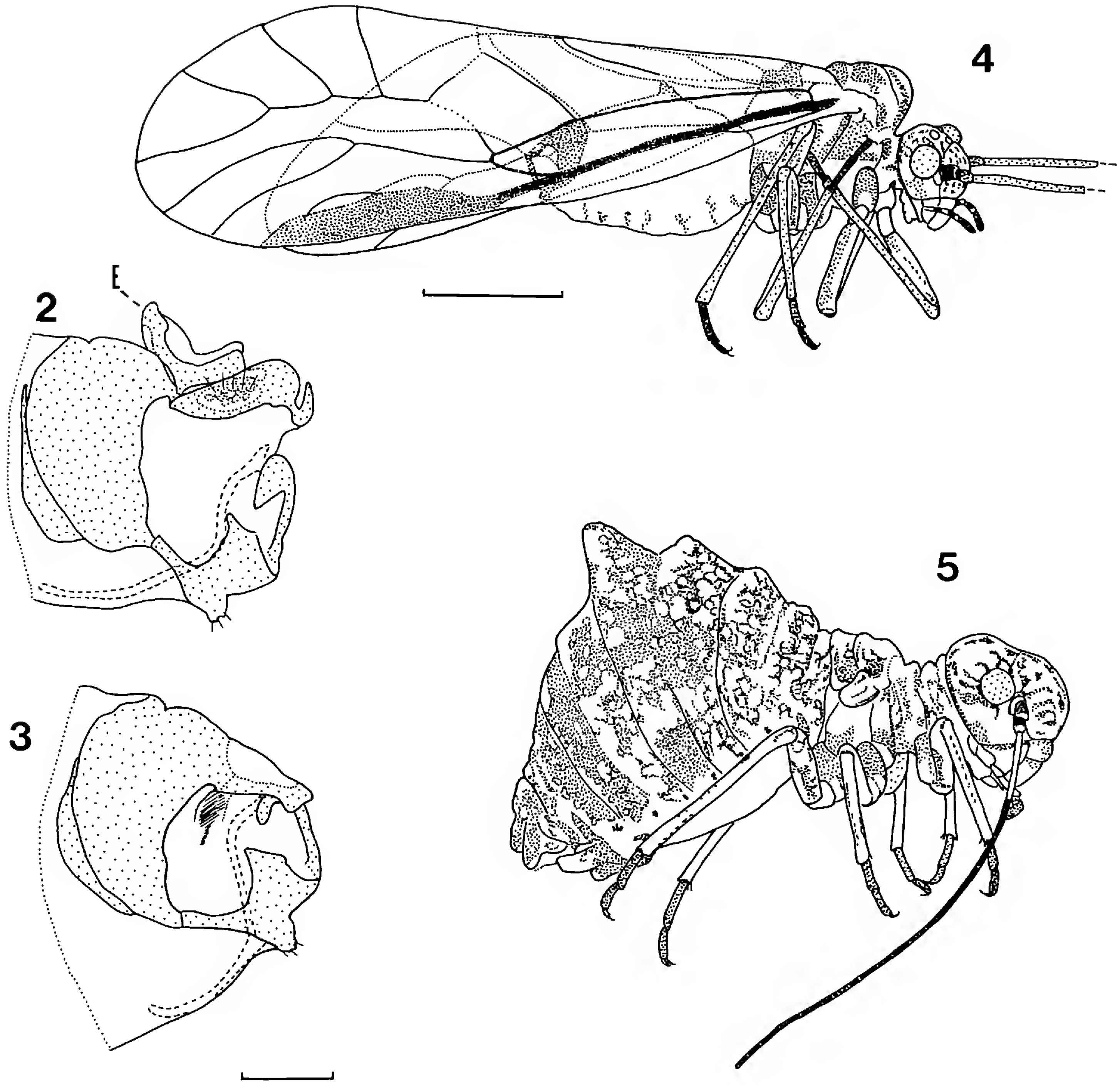


Figure 1. Distribution of four forms of *Camelopsocus* scored for two trans-sexual characters. The nodes at which data may fall are indicated by points; at those occupied by data the symbol for the form and the number of individuals are indicated. The characters and scoring procedures are discussed in the text.

three localities, but at two of the localities only one form is known, so that only the third offers associative data. Here collections of *Camelopsocus* have been made on 14 dates over a three-year period. Two forms, the trans-sexual pair 1 and 3, are known only from that locality. On six dates trans-sexual combinations were taken. Four of the six trans-sexual combinations were 1 + 3; one was 1 + 3 + 4, and one was 1 + 2 + 3 + 4. Therefore, the combination 1 + 3 was three times as frequent as 1 + 4 and six times as frequent as 2 + 3. Each of the dates of collection of trans-sexual combinations was separated from each of the others by at least ten days.

Material from Pima County, Arizona, representing a third species of *Camelopsocus,* bears on this question. The males of the Arizona species closely resemble form 2, and the females closely resemble form 4.

A search of the material for trans-sexual characters in which the species differ (i.e., 1 from 2, 3 from 4) revealed two: (1) distinctness of a longitudinal dark band along the dorsal midline of the abdominal terga from the turret of segment 5 to the clunium, and (2) extent of doubling of the median lineation of the postclypeus. Both of these characters were variable, and each was scored into four classes—



Figures 2–5. *Camelopsocus bactrianus*, n. sp. 2. ♂, terminal abdominal segments in open position, lateral view. E = epiproct. Scale of Figure 3. 3. Terminal abdominal segments in closed position, lateral view. Scale = 0.2 mm. 4. ♂, lateral view, antennae beyond first flagellomeres not shown. Scale = 1 mm. 5. ♀, lateral view. Scale of Figure 4.

the abdominal mark ranging from absent (1) to very dark (4) and the postclypeal mark ranging from completely divided (1) to completely solid (4). The results are shown graphically in Figure 1. They support an hypothesis of association of forms 1 and 3 as one species, 2 and 4 as a second. No trans-sexual characters were found which tended to support the opposite association.

All of the available data consistently support the same hypothesis of association. Therefore, I have designated forms 1 and 3 as one species, here called *C. bactrianus*, n. sp., and forms 2 and 4 as a second, here called *C. hiemalis*, n. sp.

DIAGNOSIS OF GENUS *CAMELOPSOCUS*

To the existing diagnosis (Mockford, 1965:3) should be added the following: male epiproct in form of a chair (Fig. 2, E), capable of rotation through about

90°, the extreme positions involving 1) paraprocts, seat of epiproct, and distal end of hypandrium exposed (open position, Fig. 2), and 2) paraprocts, seat of epiproct, and distal end of hypandrium hidden (closed position, Fig. 3).

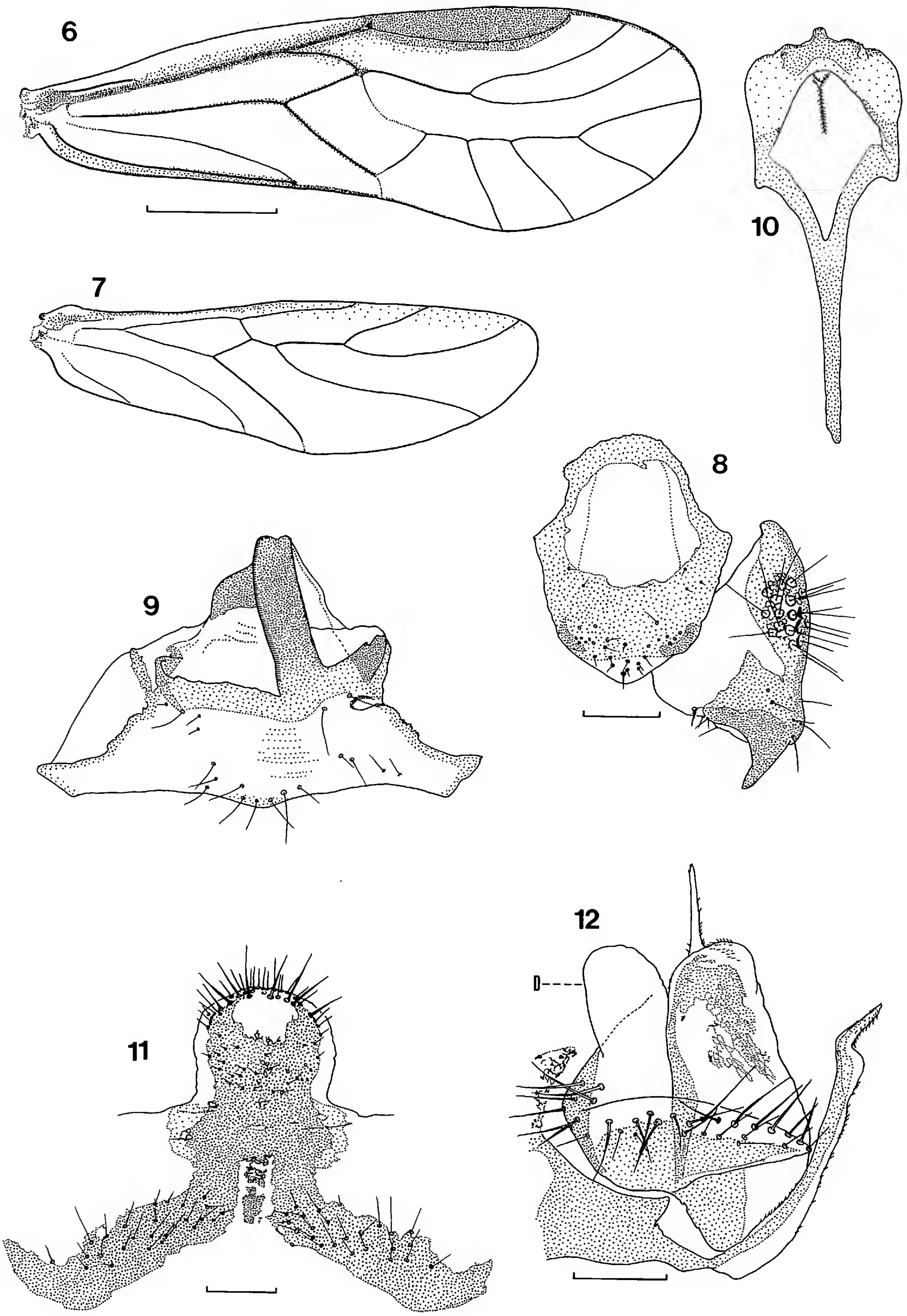
Camelopsocus bactrianus, New Species

Diagnosis.—Distal segment of maxillary palpus uniformly dark; first tarsomeres medium brown throughout. Male wings without or with extremely pale general tawny wash; pterostigma uniformly medium brown. Hypandrium (Fig. 9) with median strap broadest at base, tapering toward distal end; a small field of tubercle-based setae basal to median strap. Process of distal end of phallosome (Fig. 10) short, truncated apically, heavily sculptured, flanked by two heavily pigmented lobes of low, rounded relief. Region between arms of subgenital plate parallel-sided, near apex containing a pigmented band (Fig. 11); distal unpigmented area of plate variable in its extent.

Male.—Morphology. General facies as in Figure 4. Wing venation (Figs. 6, 7) typical of the genus. Epiproct (Fig. 8, slightly flattened) with margin most heavily sclerotized on posterolateral edges; dorsal edge of epiproct (uppermost in figure) slightly lobed laterally (seen on only one side in figure, the other side folded under in mounting). Paraproct (Fig. 8) with field of 24–34 trichobothria in two specimens counted.

Color (in alcohol). Compound eyes gray. Ground color of remainder of head and body creamy white; markings various shades of brown. Vertex of head with fields of medium brown spots bordering median ecdysial line nearly to ocelli, bordering median margin of each compound eye, and bordering entire posterior margin of head; ocelli with dark brown pigment cups on their inner margins; a medium brown transverse spot between ocelli and upper margin of postclypeus; postclypeal striations medium brown; maxillary palpi dark brown, first three segments colorless on their distal ends. Antenna with scape, pedicel, and basal third of first flagellomere pale brown; first flagellomere darkening to dark brown in distal two-thirds; remainder of antenna dark brown. Thorax dorsally medium to dark brown on notal lobes, creamy white on sutures; pleura variegated creamy white (from muscles showing through colorless cuticle) and medium to dark brown, creamy white above leg bases, along meso-metathoracic junction, on a large spot in ventral half of mesepisternum and on another in middle of metepisternum. Coxae medium brown, paling to colorless distally, except mesocoxa medium brown throughout; femora medium brown dorsally, creamy white ventrally; tibiae medium brown on inner faces, creamy white on outer faces with brown spots at bases of some setae. Tarsi medium brown. Forewings (Fig. 6) clear except pterostigma medium brown throughout, stigmasaum medium brown in basal two-thirds, white in distal third; some veins bordered in medium brown as indicated in figure; hindwings (Fig. 7) clear except with pale brown wash along anterior margin. Abdomen with preclunial segments largely dull white variegated, especially along sides, on turret, and along dorsal midline with purplish brown. Clunium and external genitalia medium to dark brown on heavily sclerotized areas, creamy white on membrane.

Female.—Morphology. Of typical micropterous facies of females of the genus (Fig. 5). Ocelli represented by two minute pigment spots. Tarsi lacking ctenidia. Subgenital plate (Fig. 11) with pigmented arms directed forward basally, bending



Figures 6–12. *Camelopsocus bactrianus,* n. sp. 6. ♂, forewing. Scale = 1 mm. 7. ♂, hindwing. Scale of Figure 6. 8. ♂, epiproct and paraproct. Scale = 0.1 mm. 9. ♂, hypandrium. Scale of Figure 11. 10. ♂, phallosome. Scale of Figure 11. 11. ♀, subgenital plate. Scale = 0.1 mm. 12. ♀, ovipositor valvulae. D = distal lobe of third valvula. Scale = 0.1 mm.

abruptly outward near their bases, abruptly narrowed and back-curved at their ends; region between bases of arms as described in diagnosis. Ovipositor valvulae as in Figure 12.

Color (in alcohol; for pattern in general, see Fig. 5). Comparable parts as described in male except ground color clear white; first flagellomere pale brown throughout; thoracic terga with broad white band along dorsal midline occupying about half width of each tergum, the terga dark brown laterally. Forewinglets white with two medium brown lines running from base to half or more length of winglet, these ending separately or converging; Anal angle of forewinglet brown; hindwinglets white. Preclunial abdominal segments variegated medium brown and white, mostly white ventrally.

Holotype ♂, allotype, 3 ♂ and 7 ♀ paratypes.—California: Riverside Co.: Sec. 32, T7S, R1E, 9 km south of Sage on Hwy. 3, 25 March 1976, beating jojoba (*Simmondsia chinensis* Link), collector not indicated. These types will be deposited in the collection of the Entomology Department, University of California, Riverside.

Additional paratypes (collector not known where not indicated).—Type locality, 26 February 1976, beating jojoba, 3 ♂, 6 ♀, J. D. Pinto; 18 March 1976, beating jojoba, 2 ♂, 23 ♀; 31 March 1976, beating jojoba, 6 ♀; 4 April 1976, beating jojoba, 3 ♂, 8 ♀; 9 April 1976, beating jojoba, 1 ♂, 13 ♀; 5 May 1976, beating jojoba, 2 ♀; 21 May 1976, beating jojoba, 2 ♀; 20 December 1976, beating jojoba, 1 ♂; 25 January 1977, beating jojoba, 3 ♀; 2 March 1977, beating jojoba, 1 ♂, 3 ♀; 23 March 1977, beating jojoba 4 ♀; 29 March 1977, beating jojoba, 16 ♀; 23 March 1978, 1 ♂; 1 April 1978, beating jojoba, 2 ♀; 14 March 1979, beating miscellaneous chaparral plants, 10 ♂, 15 ♀, E. L. Mockford and J. D. Pinto. Of these, the majority will be deposited in the collection of the Entomology Department, University of California, Riverside; 23 specimens (9 ♂, 14 ♀) will be deposited in my collection, and one pair will be deposited in the Florida State Collection of Arthropods, Gainesville.

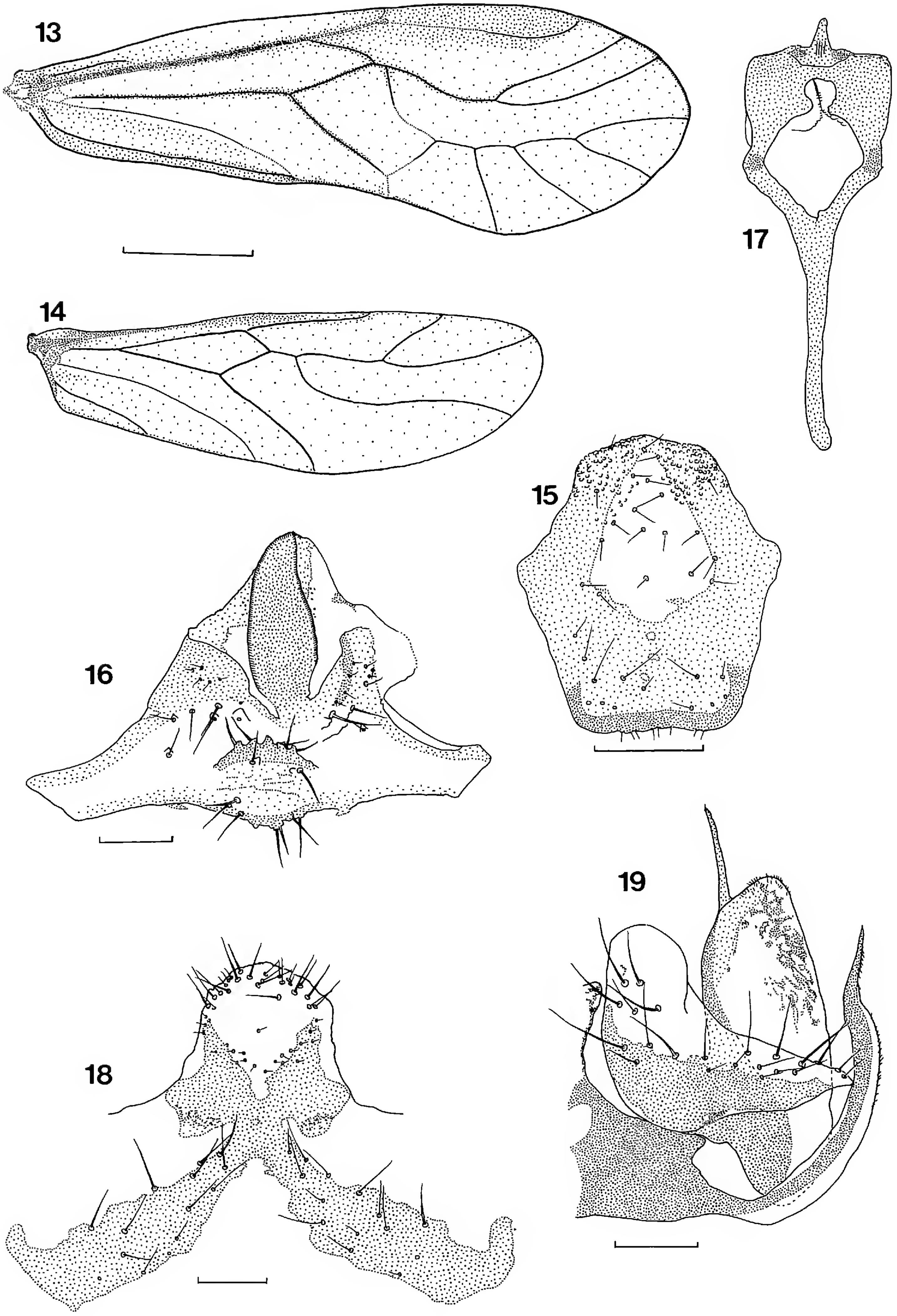
Note.—Numerous nymphs were taken in association with these adults but cannot yet be distinguished from nymphs of *C. hiemalis.*

Camelopsocus hiemalis, NEW SPECIES

Diagnosis.—Distal segment of maxillary palpus uniformly dark brown; first tarsomeres uniformly medium to dark brown throughout. Male wings (Figs. 13, 14) with general tawny wash; pterostigma uniformly medium brown, paler than in *C. bactrianus.* Hypandrium (Fig. 16) with median strap broadest before middle, tapering toward both ends; a field of tubercle-based setae basal to median strap, more extensive than in *C. bactrianus.* Process of distal end of phallosome (Fig. 17) tapering to a blunt point, flanked by two heavily pigmented lobes of low, rounded relief. Region between arms of subgenital plate (Fig. 18) tapering to apex; distal unpigmented area of plate continuing forward nearly to level of bases of arms.

Male.—*Morphology.* Wing venation (Figs. 13, 14) typical of the genus. Epiproct (Fig. 15, slightly flattened) with margin most heavily sclerotized along entire posterior edge; dorsal edge of epiproct (uppermost in figure) not lobed laterally. Paraproct with field of 21–24 trichobothria in two specimens counted.

Color (in alcohol). As described for *C. bactrianus* except brown markings of head dark brown; antennae dark brown throughout. Brown markings of thoracic



Figures 13–19. *Camelopsocus hiemalis,* n. sp. 13. ♂, forewing. Scale = 1 mm. 14. ♂, hindwing. Scale of Figure 13. 15. ♂, epiproct. Scale = 0.1 mm. 16. ♂, hypandrium. Scale = 0.1 mm. 17. ♂, phallosome. Scale of Figure 16. 18. ♀, subgenital plate. Scale = 0.1 mm. 19. ♀, ovipositor valvulae. Scale = 0.1 mm.

terga dark brown throughout; mesoparapsidal sutures medium brown (creamy white in *C. bactrianus*). Coxae dark brown; tibiae medium brown throughout. Wings (Figs. 13, 14) differing from *C. bactrianus* as described in diagnosis. Preclunial abdominal coloration in general darker.

Female.—Morphology. As described for female of *C. bactrianus* except subgenital plate (Fig. 18) with pigmented arms directed anterolaterad from their bases; other details of subgenital plate as described in diagnosis. Ovipositor valvulae as in Fig. 19.

Color (in alcohol). As described for female of *C. bactrianus* except tarsi generally darker; forewinglet white only on margin, its interior medium brown, hindwinglet white but in some individuals with a central brown spot.

Holotype ♂, allotype, 2 ♂ and 3 ♀ paratypes.—California: Riverside Co.: Sec. 32 T7S, R1E, 9 km south of Sage on Hwy. 3, 14 March 1979, beating miscellaneous chaparral plants, E. L. Mockford and J. D. Pinto. These types will be deposited in my collection.

Additional paratypes (collector not known where not indicated).—Type locality, 25 March 1976, beating jojoba, 1 ♀; 9 April 1976, beating jojoba, 1 ♀; 25 January 1977, beating jojoba, 1 ♀. 23 March 1977, beating jojoba, 1 ♀, 29 March 1977, beating jojoba, 2 ♀, California: Riverside Co.: Sec. 25, T6S, R5E, south of Black Hill on west side of Hwy. 74, 23 March 1978, beating jojoba, 1 ♀. California: Riverside Co.: Dripping Springs Campground on Hwy. 79, Cleveland National Forest, 14 March 1979, beating miscellaneous chaparral plants 6 ♀, E. L. Mockford and J. D. Pinto. Of these, six will be deposited in the collection of the Entomology Department, University of California, Riverside; two will be placed in the Florida State Collection of Arthropods, Gainesville, and four will be placed in my collection.

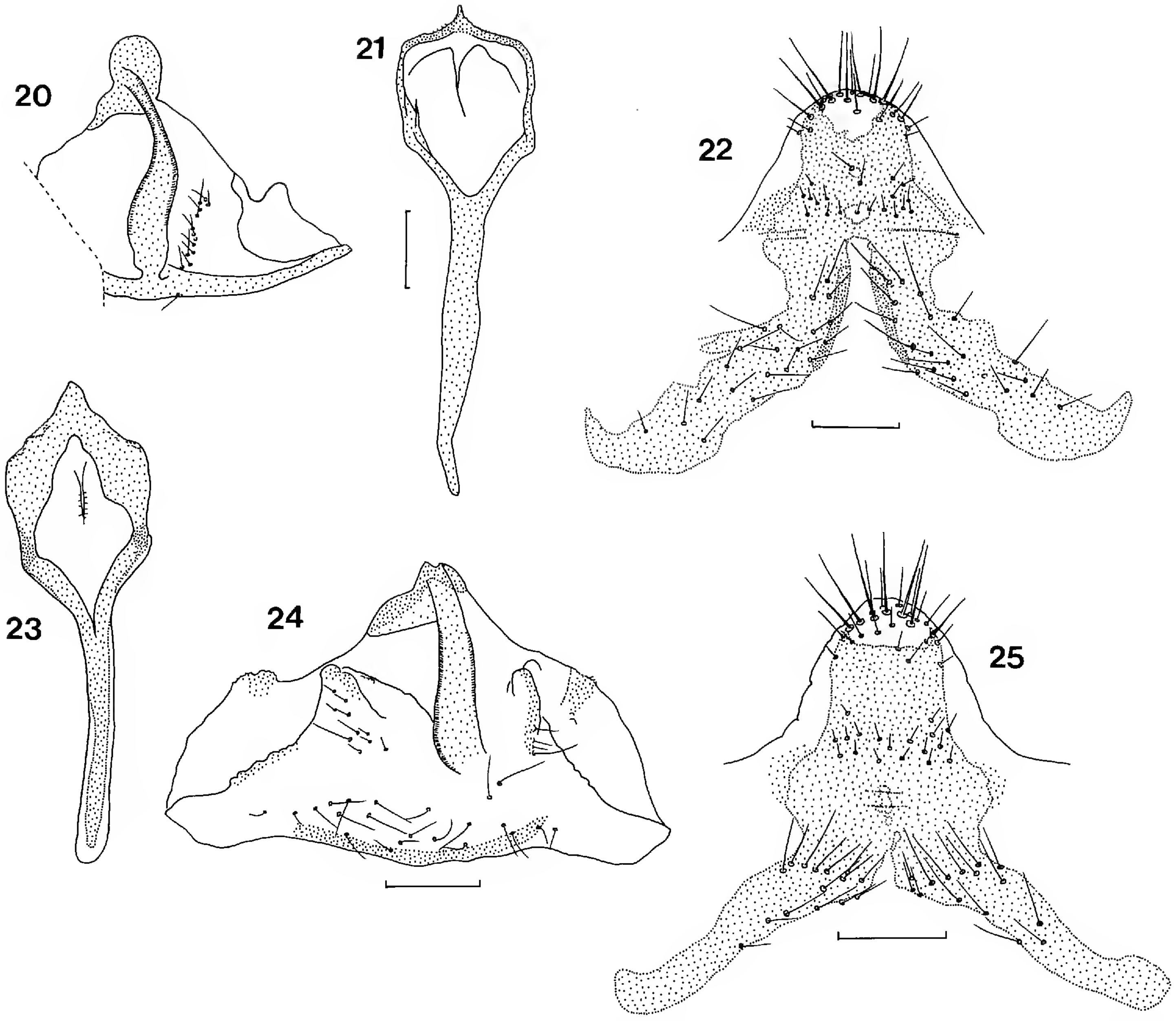
Additional records.—California: Riverside Co.: Riverside, 15 February 1940, on *Artemisia californica* (Hall) W. Watson, 1 ♂, P. H. Timberlake; 24 February 1950, on *Salvia apiana* Jepson, 1 ♂, P. H. Timberlake; 3 March 1952, on *Salvia apiana,* 1 ♂, P. H. Timberlake.

Camelopsocus monticolus **Mockford**

Camelopsocus monticolus **Mockford, 1965:4**

Diagnosis.—Distal segment of maxillary palpus ranging from medium brown on all but dull white anterior face to uniformly dark brown; first tarsomeres ranging from pale brown with darker base to uniformly medium brown. Male wings with only extremely pale general tawny wash. Pterostigma with median longitudinal dark line on paler brown background. Median strap of hypandrium (Fig. 20) broadest before middle, tapering toward both ends. Process of distal end of phallosome (Fig. 21) tapering distally to a point, with scaly sculpturing basally, lacking flanking lobes. Region between arms of subgenital plate (Fig. 22) parallel-sided in distal third, lacking a central pigmented band.

Records.—MEXICO: Durango: Hwy. 40, 38.6 km west of Durango, 16 July 1963, beating pines (*Pinus* sp.), 4 nymphs, E. L. Mockford and F. Hill; Nuevo Leon: 4 km south of San Roberto junction, Hwy. 57, el. 1900 m, 20 December 1978, beating branches and foliage of shrubs, 2 ♀, 1 nymph, A. N. Garcia Aldrete; Oaxaca: 8 km southeast of Nochixtlan, Hwy. 190, 21 August 1973, from persistent dead leaves of *Seloa* sp., 2 ♀, A. N. Garcia Aldrete; Zacatecas: 150 km north of



Figures 20–25. *Camelopsocus monticolus* Mockford and *C. similis* Mockford. 20. *C. monticolus* ♂, hypandrium (left side damaged in mounting). Scale of Figure 21. 21. *C. monticolus* ♂, phallosome. Scale = 0.1 mm. 22. *C. monticolus* ♀, subgenital plate. Scale = 0.1 mm. 23. *C. similis* ♂, phallosome. Scale of Figure 22. 24. *C. similis* ♂, hypandrium. Scale = 0.1 mm. 25. *C. similis* ♀, subgenital plate. Scale = 0.1 mm.

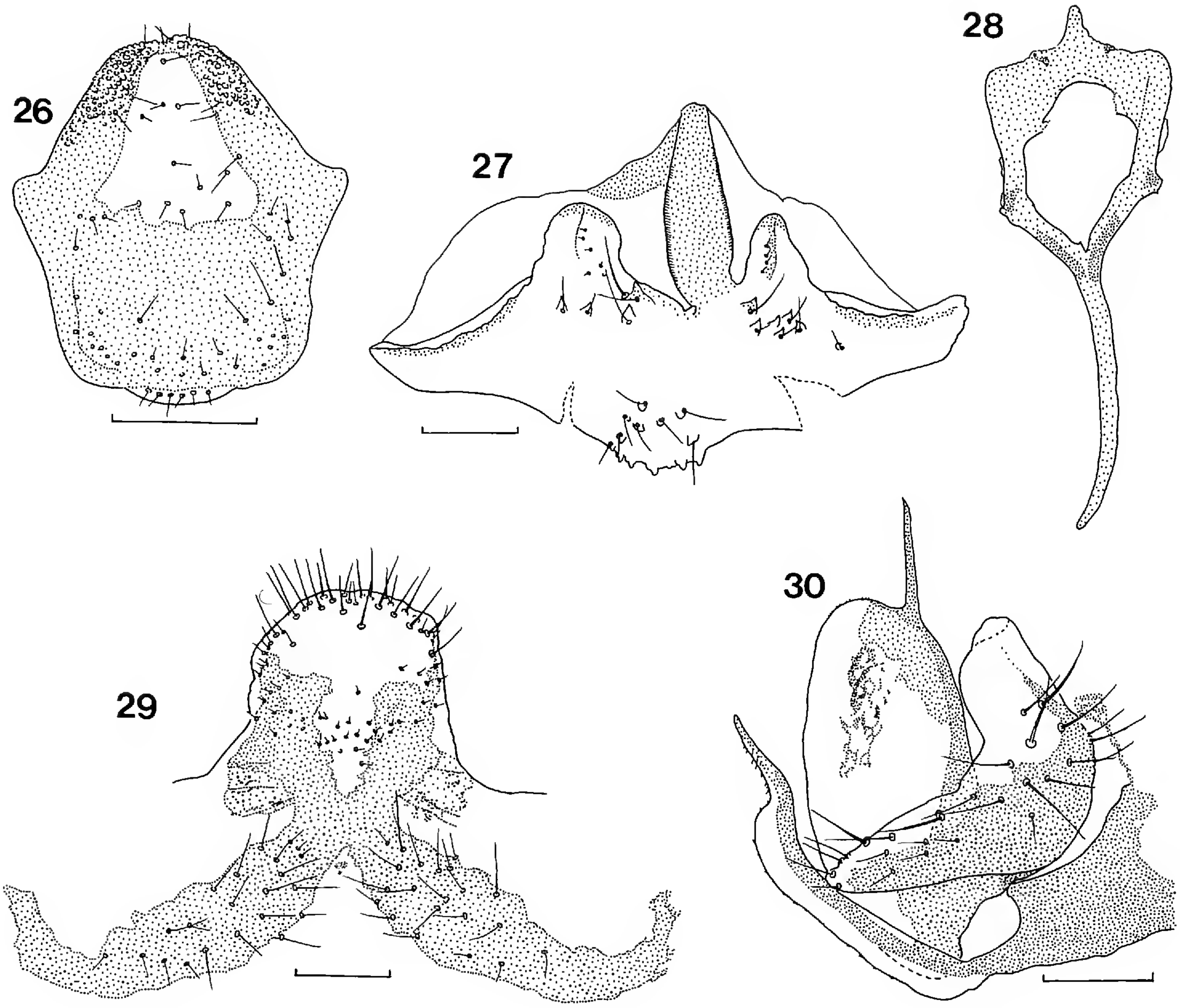
Zacatecas, 11 August 1969, beating grass under Cenizo (*Leucophyllum texanum* Bentham), 2 ♀, 3 nymphs, A. N. Garcia Aldrete. UNITED STATES: Arizona: Pima Co.: Catalina Hwy. at Bear Canyon Picnic Area, el. 1830 m, 19 July 1975, beating dead branches of oaks (*Quercus* sp.), 2 nymphs, E. L. Mockford; Colorado: Larimer Co.: Pingree Park, 20 August 1924, 1 nymph, C. R. Crosby; New Mexico: Catron Co.: 1 mile northwest of junction of Hwy. 180 and 12 (type locality), 6 July 1963, beating scrub oak (*Quercus* sp.), pine (*Pinus* sp.) and juniper (*Juniperus* sp.), 1 ♂ (holotype), 2 ♀ (allotype and paratype), 29 nymphs, E. L. Mockford and F. Hill. The types are in my collection.

Note: The forewing figure, Figure 7, in Mockford (1965) is erroneously labelled *C. similis* and is really this species.

***Camelopsocus similis* Mockford**

***Camelopsocus similis* Mockford, 1965:6**

Diagnosis.—Distal segment of maxillary palpus with round white spot covering most of anterior surface, remainder medium brown; first tarsomeres white except



Figures 26–30. *Camelopsocus tucsonensis,* n. sp. 26. ♂, epiproct. Scale = 0.1 mm. 27. ♂, hypandrium. Scale = 0.1 mm. 28. ♂, phallosome. Scale of Figure 27. 29. ♀, subgenital plate. Scale = 0.1 mm. 30. ♀, ovipositor valvulae. Scale = 0.1 mm.

medium brown at both ends (uniformly medium brown in a few males). Male wings with only extremely pale general tawny wash. Pterostigma uniform light to medium brown. Median strap of hypandrium (Fig. 24) widest basally, tapering toward tip. Process of distal end of phallosome (Fig. 23) broad basally, tapering toward pointed distal end, lacking flanking lobes. Region between arms of subgenital plate (Fig. 25) abruptly tapering to acuminate point distally.

Records.—MEXICO: Coahuila: 30 km south of Saltillo, Hwy. 57, el. 1900 m, 29 March 1979, beating branches and foliage of *Juniperus* sp. on mountain side, 1 ♀, 2 nymphs, A. N. Garcia Aldrete and M. C. Herrera; Durango: 38.6 km west of Durango, Hwy. 40 (type locality) 16 July 1963, beating oaks and small ericaceous shrubs, 1 ♂ (holotype), 7 ♀ (allotype and paratypes), 12 nymphs, E. L. Mockford and F. Hill; 48 km west of Durango, el. 2438 m, 6 May 1961, 1 ♂, 3 ♀, 1 nymph, H. F. Howden and J. E. H. Martin; Mexico, 1.6 km west of Continental Divide, Hwy. 136, el. 3300 m, 3 July 1962, beating broad-leaved shrubs, 2 ♂, 8 ♀, 18 nymphs, E. L. Mockford and F. Hill; Nuevo Leon: 3 km north of San Roberto junction, Hwy. 57, el. 1800 m, 29 March 1979, beating foliage of *Larrea* sp., 4 ♀, A. N. Garcia Aldrete and M. C. Herrera; Oaxaca: 8 km south of Nochixtlan, Hwy. 190, 18 August 1968, sweeping grasses (*Aristida* sp.), 6 ♀, 11 nymphs, E. L. Mockford and A. N. Garcia Aldrete; San Luis Potosi: 30.5 km north of Huizache, Hwy. 57, 25 July 1963, beating desert shrubs, 1 nymph, E. L. Mockford and F. Hill. UNITED STATES: Colorado: Chaffee Co.: Agate Camp Ground in Gunnison National Forest, el. 2682 m, 21 July 1969, beating sagebrush (*Artemisia* sp.), 6 nymphs, E. L. Mockford; Gunnison Co.: Hwy 50, 9.7 km east of Blue Mesa Dam, el. 2316 m, 23 July 1969, beating oaks and small heath plants on hillside, 2 ♀, E. L. Mockford. Wyoming: *Teton* Co.: Grand Teton National Park, Hwy. 26, 22.5 km north of Jackson, 5 August 1966, beating Douglas firs (*Pseudotsuga taxifolia* Britton), 1 ♀, 1 nymph, E. L. Mockford; Sweetwater Co.: 14.5 km west of Point of Rocks, 26 July 1976, prey of robberfly, 1 ♀, R. J. Lavigne et al. The types are in my collection.

***Camelopsocus tucsonensis,* NEW SPECIES**

Diagnosis.—Similar to *C. hiemalis,* differing in following details: male epiproct (Fig. 26) with dorsal edge (uppermost in figure) somewhat narrower (compare to Fig. 15); median strap of hypandrium only approximately 1.3× as broad at its greatest breadth (near middle, Fig. 27) as at base, vs. approximately 2× in *C. hiemalis*; frame of phallosome (Fig. 28) decidedly wider distally than basally vs. nearly of same width in *C. hiemalis* (Fig. 17); pigmented arms of subgenital plate (Fig. 29) each approximately 1.2× as broad at greatest breadth as at base, vs. approximately 2.1× in *C. hiemalis.* Female ovipositor valvulae as in Figure 30.

Morphology and color otherwise as described for *C. hiemalis* except dorsal abdominal turret of male not darkly marked.

Holotype ♂, allotype, 9 ♂ and 7 ♀ paratypes, and 11 nymphs: Arizona: Pima Co.: 6.4 km west of Tucson on road to Desert Museum, 1 February 1979, beating jojoba, J. D. Pinto. The holotype, allotype, 7 male and 5 female paratypes will be deposited in the collection of the Entomology Department, University of California, Riverside. One pair of paratypes will be deposited in the Florida State Collection of Arthropods, Gainesville, Florida, and another pair of paratypes will be deposited in the collection of the author.

KEY TO THE SPECIES OF *CAMELOPSOCUS*

1. Macropterous, forewings at rest exceeding tip of abdomen (as in Fig. 4) . . . males 2

   Micropterous, wings reduced to minute scales, not reaching posterior end of thorax (as in Fig. 5) . . . females 6
2. Hypandrium with at least a few tubercle-based setae anterior to base of median strap (Fig. 16); distal process of phallosome flanked by two heavily pigmented lobes of low, rounded relief (Figs. 10, 17) 3

   Hypandrium lacking tubercle-based setae anterior to base of median strap; distal process of phallosome not flanked by pair of low, rounded lobes (Fig. 21) 5
3. Median strap of hypandrium approximately parallel-sided most of its length (Fig. 9); distal process of phallosome short, not appreciably longer than its basal width, truncated apically (Fig. 10); wing membrane, except along anterior veins of forewing and anterior margin of hindwing nearly clear, with only a trace of tawny wash (Figs. 6, 7) . . . . *C. bactrianus,* n. sp.

   Median strap of hypandrium widest in middle, tapering to each end (Figs. 16, 27); distal process of phallosome decidedly longer than its basal width, tapering to a blunt point apically (Figs. 17, 28); wing membranes with a decided tawny wash (Figs. 13, 14) 4

4. Median strap of hypandrium approximately 1.3× as wide at its greatest width as at base (Fig. 27); epiproct decidedly tapering from middle to anterior (upper in Fig. 26) end .... *C. tucsonensis,* n. sp.

   Median strap of hypandrium approximately 2× as wide at its greatest width as at base (Fig. 16); epiproct broadly truncated at anterior end, the truncated area much broader than in *C. tucsonensis* (Fig. 15 vs. Fig. 26) .... *C. hiemalis,* n. sp.

5. Hypandrium (Fig. 24) with median strap widest immediately beyond base, gradually narrowing to distal end; at distal end expanded as leftward-directed process. Edge of frame of phallosome broad to sides of distal process (Fig. 23) .... *C. similis* Mockford

   Hypandrium (Fig. 20) with median strap widest before middle, tapering from there toward base and toward distal end; at distal end expanded as bulbous region and leftward-directed process. Edge of frame of phallosome narrow to sides of distal process (Fig. 21) .... *C. monticolus* Mockford

6. Abdomen with a major turret on segment 5 and a minor one on segment 4 (lesser turrets visible on segments 3 and 2 in some specimens) 7

   Abdomen with a major turret on segment 5 and no other turrets........ 9

7. Pigmented arms of subgenital plate diverging from their bases; region between arms pointed or slightly truncated distally but never parallel-sided and never including a distinct pigmented band (Figs. 18, 29) ... 8

   Pigmented arms of subgenital plate parallel at bases, then diverging abruptly; region between arms parallel-sided where arms parallel, containing a distinct pigmented band (Fig. 11) .... *C. bactrianus,* n. sp.

8. Pigmented arms of subgenital plate relatively narrow (Fig. 29) with relatively broad bases; greatest width of an arm approximately 1.2× basal width .... *C. tucsonensis,* n. sp.

   Pigmented arms of subgenital plate relatively broad (Fig. 18) with relatively narrow bases; greatest width of an arm approximately 2.1× basal width .... *C. hiemalis,* n. sp.

9. Pigmented arms of subgenital plate with anterior ends tapering and curved backward; region between arms truncated posteriorly (Fig. 22) .... *C. monticolus* Mockford

   Pigmented arms of subgenital plate with anterior ends truncated and directed laterally; region between arms acuminate posteriorly (Fig. 25) .... *C. similis* Mockford

EGGS, POSTEMBRYONIC DEVELOPMENT, AND PHENOLOGY OF *CAMELOPSOCUS BACTRIANUS* AND *C. HIEMALIS*

Eggs.—On 14 March 1979, I visited the site near Sage, Riverside County, California (see records of *C. bactrianus* and *C. hiemalis*) and collected adults of *C. bactrianus* and *C. hiemalis.* Some gravid females were kept alive on twigs of chaparral shrubs in order to obtain eggs. It was not possible to distinguish the species in the field, nor was it possible to examine the live material with a dissecting microscope for several days after their capture. By that time, oviposition had already started, and because the live material included both species, the eggs of the two were not separated. The eggs appear quite uniform, and it is likely that those of the two species are closely similar.

Ovipositing females were held during their first four days of captivity in cotton-plugged shell vials 24 mm in diameter and 94 mm in height. The vials were held during that time in a plastic bag containing a small amount of moist paper towel to assure a higher than ambient relative humidity. After four days, the vials, then at my laboratory, were transferred to a desiccator jar at 75% relative humidity, 24°C daytime and 19°C nighttime temperature, and 17 hr light, 7 hr dark period.

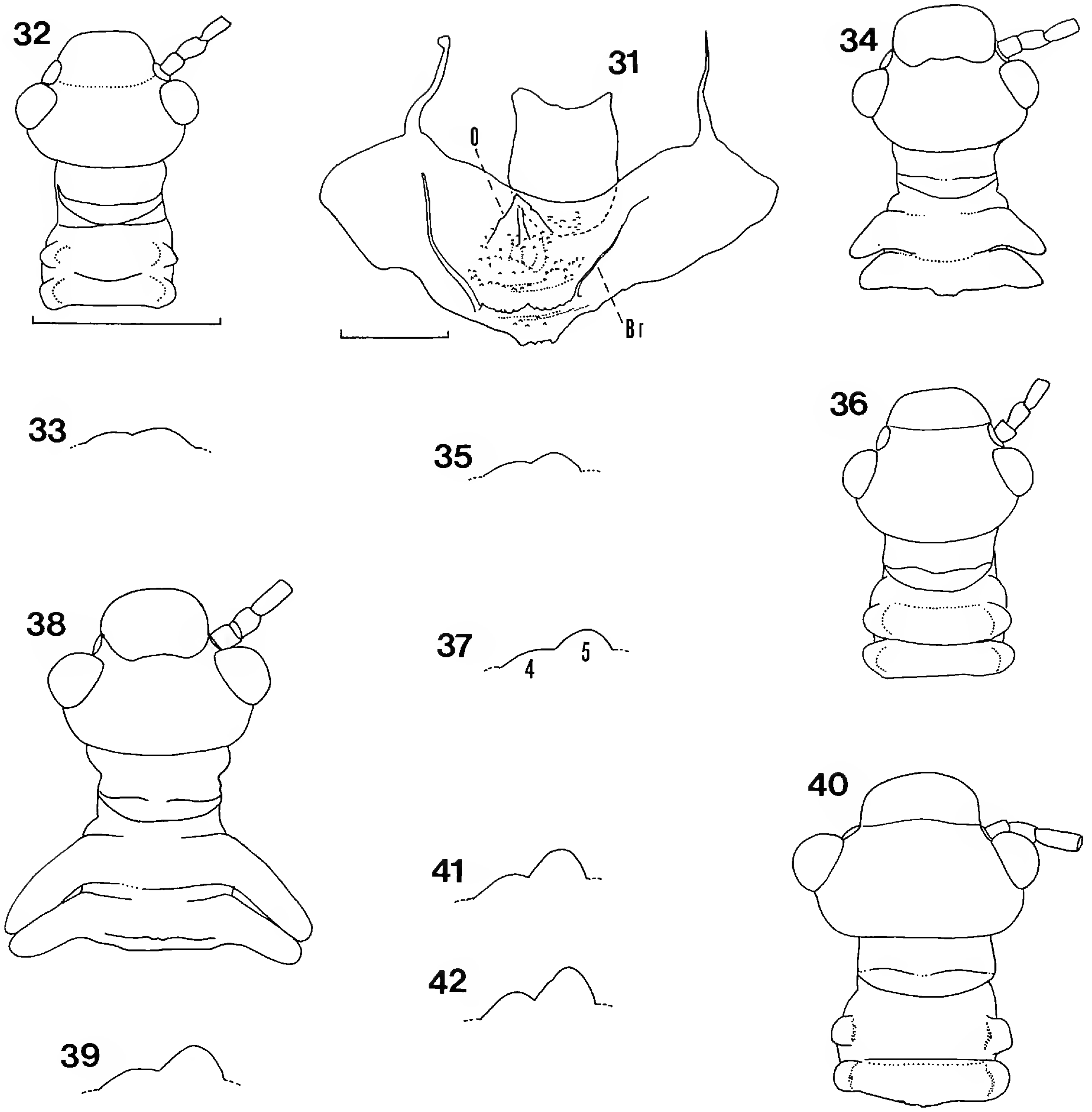
Eight separate ovipositions were found, one consisting of a single egg, one of three, one of four, two of eight, one of 11, one of 24, and one of 44 ($\bar{x} = 13$). All eggs are covered with crusty particles of debris of a color similar to that of the surrounding bark. The debris coating of the grouped eggs covers the entire group, so that they appear as a continuous clump. The larger clumps are oriented lengthwise of the rather small (ca. 2.5 mm in diameter) twigs on which they were placed. The one egg laid singly shows a ridge in the debris coating of its upper surface along each side in the anterior half (i.e., the half containing the hatching orifice). This egg measured 681 μ in length and 393 μ in greatest width. It tapers slightly toward the hatching end.

After oviposition had been completed, the eggs were stored at ambient relative humidity but otherwise under the conditions in which the females had been held. I intended to return them to high relative humidity in late October, shortly before the presumed eclosion time; however, I forgot about them until late November, at which time they had already started to eclose. Most of the nymphs were dead, probably of desiccation and/or starvation. The fact that some remained alive under conditions of ambient relative humidity and low food supply suggests that eclosion had not been occurring for much more than a week.

Embryonic exuviae.—These structures, extending from the openings of eclosed eggs, were mounted on a slide in Hoyer's medium for examination. The oviruptor (Fig. 31, O) is a pointed, toothlike structure arising from the slightly depressed middle of a platform-like region probably consisting of the entire anterior surface of the embryonic head. A fossa occupies the morphologically ventral surface of the oviruptor. Around and on the base of the oviruptor are numerous minute denticles. A pair of slender brachiae (Pearman, 1928) (Fig. 31, Br) arise below the oviruptor and diverge strongly. The platform to the sides of the depressed middle rises as a pair of lobes, each one surmounted by an anteriorly directed process. One of the processes is knobbed at the tip and the other acuminate. Immediately dorsal to the oviruptor lies a flap-like structure with its base posterior to the edge of the platform.

Nymphal instars.—At the Sage site, insects were sampled on jojoba shrubs at regular intervals throughout the year from February 1976 through April 1978 (Pinto, pers. comm.). The data for these two species of *Camelopsocus* are combined for phenological consideration for the years 1976, 1977, and 1978. Nymphs of *C. bactrianus* and *C. hiemalis* cannot yet be distinguished. Therefore, observations on the identification of instars and on their phenology presented below probably pertain to both species.

From the literature, it now seems safe to make two generalizations about developmental patterns of nymphs of suborder Psocomorpha. First, in general, there



Figures 31–42. *Camelopsocus bactrianus*, n. sp. or *C. hiemalis*, n. sp. 31. Anterior end of embryonic exuviae. O = oviruptor; Br = brachiae. Scale = 0.05 mm. 32. Second instar, sex unknown, dorsal view of head and thorax. Scale = 0.5 mm. 33. Second instar, outlines of turrets of abdominal segments 4 and 5, lateral view. Scale of Figure 32. 34. Third instar ♂, structure and scale as in Figure 32. 35. Third instar ♂, structure and scale as in Figure 33. 36. Third instar ♀, structure and scale as in Figure 32. 37. Third instar ♀, structure and scale as in Figure 33. 38. Fourth instar ♂, structure and scale as in Figure 32. 39. Fourth instar ♂, structure and scale as in Figure 33. 40. Fourth instar ♀, structure and scale as in Figure 32. 41 and 42. Fourth instar ♀ (two variants), structure and scale as in Figure 33.

are six nymphal instars. The only exceptions appear to be small, very neotenic males of some Archipsocids (Mockford, 1957). Secondly, first instars have six flagellomeres, while subsequent instars have eleven. The following literature citations serve to establish both generalizations: Weber, 1931; Sommerman, 1943a, 1943b, 1943c, 1944; Mockford, 1957; Eertmoed, 1966; Dunham, 1972; Fahy, 1972; Garcia Aldrete, 1973; Heilbronn, 1975. Nymphs of *Camelopsocus* appear to conform with both of these generalizations. Nymphs of six size classes, probably representing all instars, were found in material from the Sage site.

The smallest nymphs were taken in the earliest sample during the period of occurrence of these species. Because they have six flagellomeres, they are undoubtedly first instars. They have no trace of wing pads, and they lack abdominal turrets. These characters were also observed in nymphs newly emerged from eggs held in the laboratory.

The second instar (Figs. 32, 33), in addition to its larger size and possession of a minute turret of the fifth abdominal tergum, has eleven flagellomeres and small wing pads. The first flagellomere is about equal in length with the pedicel. Because only four specimens of this instar are present in the samples, it is not known if the sexes can be distinguished at this stage.

Third instars (Figs. 34–37), in addition to larger size, show a more prominent turret of the fifth abdominal tergum, a trace in some individuals of a turret of the fourth, relatively larger wing pads, and the first flagellomere very slightly longer than the pedicel. In this instar there is marked sexual dimorphism in size of wing pads, those of the male being slightly more than twice the length of those of the female.

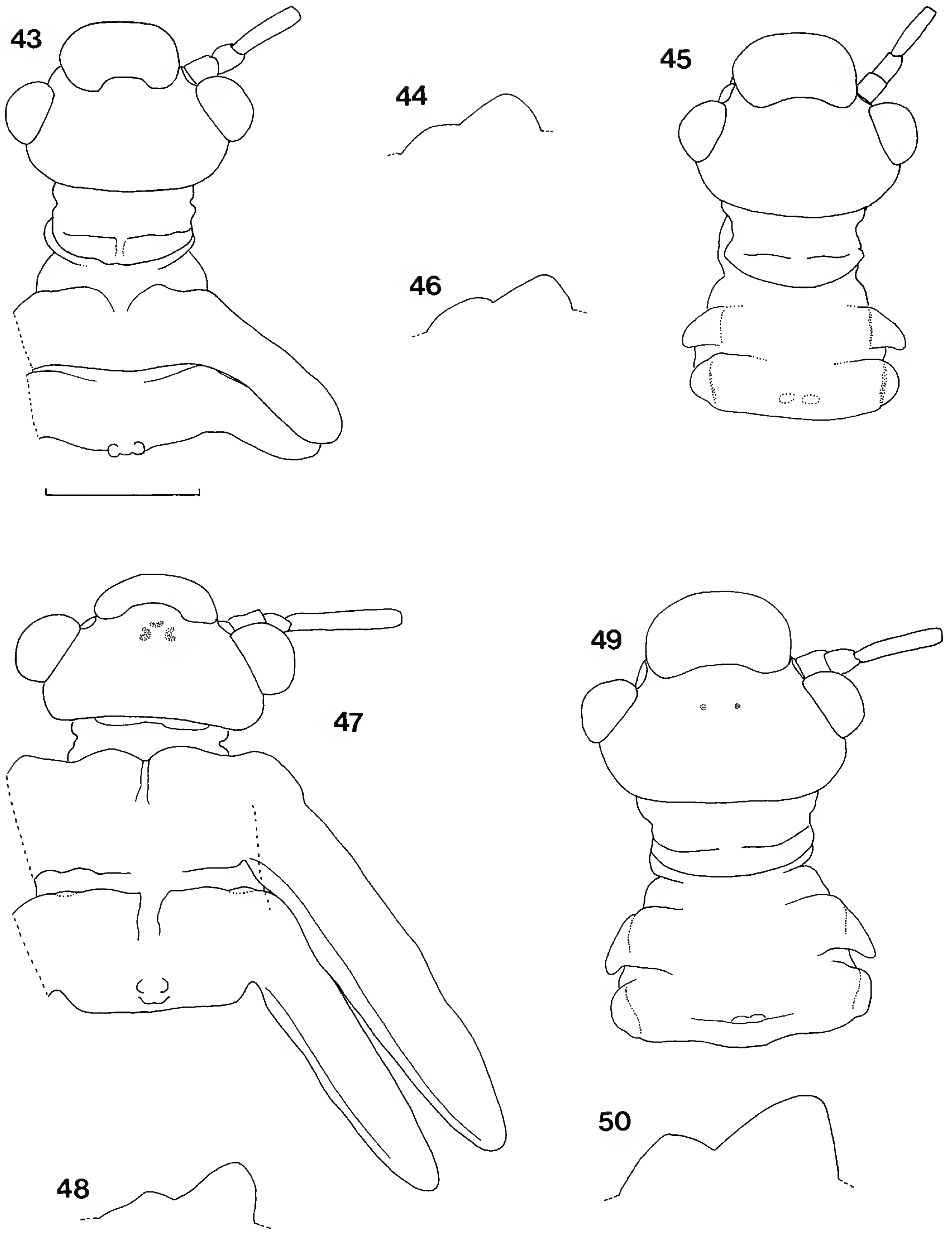
Fourth instars (Figs. 38–42), in addition to being larger, have the abdominal turrets more prominent, wing pads of the female very slightly larger but those of the male more than twice as long as in the previous instar. The relative length of the first flagellomere has increased to about 1.5× the length of the pedicel.

In the fifth instar (Figs. 43–46), the abdominal turrets have changed very little in prominence. Wing pads of both sexes have increased in relative size, the increase in the male being about 1.8×. The relative length of the first flagellomere has increased to about 2× that of the pedicel in the female and nearly 3× that of the pedicel in the male. Primordia of external genitalia have become visible in both sexes.

Sixth instars (Figs. 47, 48, 49, 50) show a marked increase in prominence of the abdominal turrets. Wing pads of the female have increased very little in relative size but have oriented somewhat more downward. Wing pads of the male have more than doubled in length. The relative length of the first flagellomere has increased to slightly less than 3× that of the pedicel in the female and slightly more than 4× that of the pedicel in the male. In the male, the mesonotal lobes have become more prominent, and ocellar primordia are visible. The latter are represented in the female by two small pigment spots which do not increase in size in the adult. Primordia of the external genitalia are more distinct in both sexes.

Phenology.—Table 2 shows seasonal occurrence of the nymphal instars and adults at the Sage site. It would appear that eclosion starts to occur in early November. Nymphal development is largely complete by mid-March. Adults, which started to appear in mid-December, persist in small numbers until late May.

There can be no doubt that these two species are univoltine. Most of the eggs have been deposited by mid-April, and apparently no eclosion occurs until late fall, after the return of cool weather. Such a regimen apparently permits the nymphs and adults of these species to exist under approximately the same climatic conditions as are experienced by those stages of *C. monticolus* and *C. similis*



Figures 43–50. *Camelopsocus bactrianus,* n. sp. or *C. hiemalis,* n. sp. 43. Fifth instar ♂, dorsal view of head and thorax. Scale = 0.5 mm. 44. Fifth instar ♂, outlines of turrets of abdominal segments 4 and 5, lateral view. Scale of Figure 43. 45. Fifth instar ♀, structure and scale as in Figure 43. 46. Fifth instar ♀, structure and scale as in Figure 44. 47. Sixth instar ♂, structure and scale as in Figure 43. 48. Sixth instar ♂, structure and scale as in Figure 44. 49. Sixth instar ♀, structure and scale as in Figure 43. 50. Sixth instar ♀, structure and scale as in Figure 44.

Table 2. Seasonal distribution of life history stages of *Camelopsocus bactrianus,* n. sp. and *C. hiemalis,* n. sp. at a site near Sage, Riverside County, California.

		Number of individuals					
Date	1st instar	2nd instar	3rd instar	4th instar	5th instar	6th instar	Adult (♂b, ♀b, ♂h, ♀h)
16 November	5	3			1 ♀		
10 December			1 ♂, 8 ♀	9 ♂, 1 ♀	2 ♂, 3 ♀		
16–20 December		1	1 ♂, 3 ♀	8 ♂, 10 ♀	7 ♂, 6 ♀	3 ♂	1 ♂b
25 January				3 ♀	5 ♂, 18 ♀	16 ♂, 9 ♀	3 ♂b, 1 ♀h
26 February						1 ♂, 1 ♀	3 ♂b, 6 ♀b
2 March						4 ♂, 2 ♀	1 ♂b, 3 ♀b
18 March						1 ♂, 2 ♀	2 ♂b, 33 ♀b
23–25 March						1 ♀	5 ♂b, 13 ♀b, 2 ♀h
29 March–1 April						1 ♂	3 ♂b, 32 ♀b, 3 ♀h
4 April							3 ♂b, 8 ♀b
9 April							1 ♂b, 13 ♀b
5 May							2 ♀b
21 May							2 ♀b

during the summer in the mountains of Wyoming, Colorado, New Mexico, and Arizona, and perhaps throughout much of the year in the mountains and high plateaus of Mexico. Only the eggs of the southern Californian species are exposed to the potentially desiccating conditions of summer and early fall.

TAXONOMIC RELATIONSHIPS OF *CAMELOPSOCUS*

This genus clearly belongs to Subfamily Psocinae (sensu Badonnel, 1951). Smithers (1972) made a cladistic analysis of subfamily Psocinae but based it only on certain hypandrial characters and one venational character. The information of other venational characters, the male epiproct, the phallosome, female genitalic features, and wing marking characters was not used. Furthermore, several genera could be interpreted as being out of place in Smithers' scheme. Thus, *Oreopsocus* and several species of *Trichadenotecnum* can be considered to have a median strap-like structure on the hypandrium. An intriguing partial review of the problems of relationships in the Psocinae is provided by Thornton (1961). It is evident from these works that we are still groping in the dark with problems of generic limits and general relationships within this subfamily.

The information-rich male epiproct in the Psocinae has not been adequately studied, and I hope to deal with it in a separate work. The chair-shaped male epiproct of *Camelopsocus* (Fig. 2) also occurs in *Loensia* (pers. observ.), *Oreopsocus* (Roesler, 1939, Fig. 10A), and several species of *Ptycta* (pers. observ.). In each case, it shows concordance with parameres converging basally. I am unable to assess the structure of the male epiproct in *Atlantopsocus* from the existing literature, although Meinander's figure (1973, Fig. 7C) suggests that it is not chair-shaped.

Other features suggest within the assemblage of genera *Oreopsocus–Loensia–Ptycta* (at least in part)–*Atlantopsocus–Camelopsocus* a closer proximity among

Oreopsocus, Atlantopsocus, and *Camelopsocus.* The forewing venation of *Atlantopsocus* and *Camelopsocus* shows in common a shallow pterostigma, a shallow, elongate stigmasaum, and shape of the areola postica with the distal segment of Cula directed distally. In *Oreopsocus* the pterostigma is not quite so shallow, the stigmasaum not quite so long, and the distal segment of Cula directed not quite so distally (Badonnel 1943, Fig. 93). The base of the phallosome in the form of an apodeme is common to *Camelopsocus* and *Atlantopsocus,* but not to *Oreopsocus.* All three genera share a relatively unpigmented distal end of the subgenital plate, a long, slender distal process of the second valvula, and a relatively large distal (or 'inner') lobe of the third valvula (Fig. 12, D). *Oreopsocus* and *Camelopsocus* share a markedly similar distal end of the phallosome: bilaterally symmetrical with a pointed median process and lateral shoulders. In both genera the median sclerotized strap of the hypandrium is bent abruptly to the left at its distal end.

ACKNOWLEDGMENTS

Most of the material of the new species described above was borrowed from the Research and Teaching collection of the Department of Entomology, University of California, Riverside. Mr. Saul Frommer, curator of the collection, arranged the loans. Mr. Frommer also very kindly aided me in numerous ways during my visit to Riverside, primarily to collect these insects, in March 1979. Dr. John D. Pinto, also of the Riverside institution, collected the type series of *C. tucsonensis* as well as some of the material of the other two new species. Dr. Pinto accompanied me in the field during part of my 1979 visit to Riverside. My collecting in Mexico in 1968 was supported by a National Science Foundation grant, NSF GB7729, to Illinois State University. Dr. Alfonso N. Garcia Aldrete, then a graduate student, accompanied me on the 1968 trip and did part of the collecting. Dr. Garcia Aldrete, now a member of the research staff of the Instituto de Biologia, UNAM, has collected additional Mexican material of *Camelopsocus* subsequent to my 1968 trip and very kindly put it all at my disposal during my visit to Mexico City in June 1979. The manuscript was reviewed by the publications committee, Division of Plant Industry, Florida Department of Agriculture and Consumer Services. To the above individuals and institutions I extend my sincere thanks.

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The Life History of *Paracantha cultaris* (Coquillett) on Wild Sunflower, *Helianthus annuus* L. ssp. *lenticularis* (Douglas) Cockerell, in Southern California (Diptera: Tephritidae)

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Paracantha cultaris is one of several phytophagous insect species infesting the flowerheads of wild sunflower, *Helianthus annuus* ssp. *lenticularis,* in southern California. Heretofore, little was known about the life history of this tephritid. The immatures and adults described herein were field-collected or reared in the insectary of the Division of Biological Control, University of California, Riverside, from flowerheads of wild sunflower collected in western Riverside and southwestern San Bernardino counties during 1979–1980. A few specimens were insectary reared from the capitula of commercial sunflower, *H. annuus* var. *macrocarpus* (deCandolle) Cockerell, collected in Riverside in 1980. Insectary conditions were 26 ± 1°C, 30–60% R.H., and a 12/12-hr (light/dark) photoperiod.

Distribution and host plants.—Foote and Blanc (1963) described the range of *P. cultaris* as Arizona, California, Idaho, Nebraska, Nevada, New Mexico, Oregon, Texas, Washington, and Mexico, south to Costa Rica. Table 1 records rearings of *P. cultaris* from flowerheads of wild and cultivated sunflowers from different locations in Riverside and San Bernardino counties in southern California, counties from which this tephritid was unreported in Foote and Blanc (1963). Wasbauer (1972) listed *Borrichia frutescens* (L.) Decandolle, *Cirsium occidentale* (Nuttal) Jepson, and "*Helianthus* spp." as other host plants of *P. cultaris* besides *H. annus.* The second author (RDG) and D. W. Ricker have reared many *P. gentilis* Hering from *C. occidentale* capitula collected in southern California in recent years (unpubl. data), but never *P. cultaris.* Therefore, this rearing record for *P. cultaris* from *C. occidentale* in southern California, first published in Foote and Blanc (1963), is suspect.

Biology.—*Egg.* Newly laid eggs (Fig. 1a) were smooth, shiny-white, elongate-ellipsoidal, and had a long thread-like pedicel bearing the micropyle at its apex. Measurements of 7 eggs yielded the following means (±SE): body length = 0.93 ± 0.02 mm, body greatest width = 0.29 ± 0.007 mm, pedicel length = 1.41 ± 0.03 mm, pedicel width near middle = 0.043 ± 0.002 mm, pedicel width at the distal end = 0.068 ± 0.002 mm. The total lengths of the eggs including their pedicels averaged 2.30 ± 0.02 mm. The egg of *Aciurina ferruginea* (Doane) pictured by Tauber and Tauber (1967) is very similar to *P. cultaris,* as is the egg of *P. culta* (Wiedemann) described by Benjamin (1934).

Only very small (2–4 mm in diameter), immature capitula were chosen for oviposition by *P. cultaris* in the field. When ovipositing, the females pierced the phyllaries. The body of the egg was inserted between the developing disk florets

Table 1. Field collections of *P. cultaris* in southern California during 1979 and 1980.

County	Locality	Host plant[a]	Months collected	Stage(s) collected[b]
Riverside	Moreno	l	II	a
Riverside	Riverside	m	II	p
Riverside	nr. Highgrove	l	III	p
Riverside	Moreno	l	III	a
Riverside	Riverside	m	III	p
Riverside	Riverside	l	III	p
San Bernardino	Colton	l	IV	p
Riverside	Moreno	l	IV	p
Riverside	Riverside	l	IV	p
Riverside	Rubidoux	l	IV	p
Riverside	Moreno	l	V	p
Riverside	Riverside	l	V	l
Riverside	Rubidoux	l	V	p
Riverside	Moreno	l	VI	p
Riverside	Riverside	l	VI	a
Riverside	Beaumont	l	VII	p
San Bernardino	Chino	l	VII	l, p
San Bernardino	Colton	l	VII	l, p
San Bernardino	nr. Fontana	l	VII	p
Riverside	Moreno	l	VII	p
Riverside	nr. Murrieta	l	VII	l, p
Riverside	Perris	l	VII	p
Riverside	Riverside	l	VII	p
Riverside	Rubidoux	l	VII	l, p
Riverside	Temecula	l	VII	p
San Bernardino	Colton	l	VIII	l, p
Riverside	Riverside	l	VIII	l
Riverside	Temecula	l	VIII	l, p
Riverside	Riverside	l	IX	p
Riverside	Riverside	l	X	l
Riverside	Moreno	l	XII	a

[a] l = *H. annuus* ssp. *lenticularis,* m = *H. annuus* var. *macrocarpus.*

[b] l = larvae, p = puparia, a = adults.

with the long axis of the egg perpendicular to the long axes of the florets. The egg stalk projected from the oviposition scar in an outer phyllary (Fig. 2a). In mature, infested heads, oviposition by *P. cultaris* usually was evidenced by long, narrow, slitlike scars through the involucral bracts. The scars always ran lengthwise along the bracts. The empty white chorions usually were found within the scars, with their stalks projecting from the outermost or middle phyllaries (Fig. 2a). The lengths of the oviposition scars in the inner surfaces of the phyllaries of 20, mature, wild sunflower heads averaged 0.95 ± 0.04 mm, 1.60 ± 0.14 mm, 1.91 ± 0.16 mm, in the outermost, middle, and inner bracts, respectively.

Females rarely oviposted in caged flowerheads in the insectary, and when they did, oviposition was not observed. *Paracantha cultaris* females deposited an average of 1.2 ± 0.11 (range: 1–3) eggs in 23 small, immature capitula collected in the field. Although up to 3 eggs were deposited in a single capitulum, dissected field-collected flowerheads rarely yielded more than 1 larva or puparium.

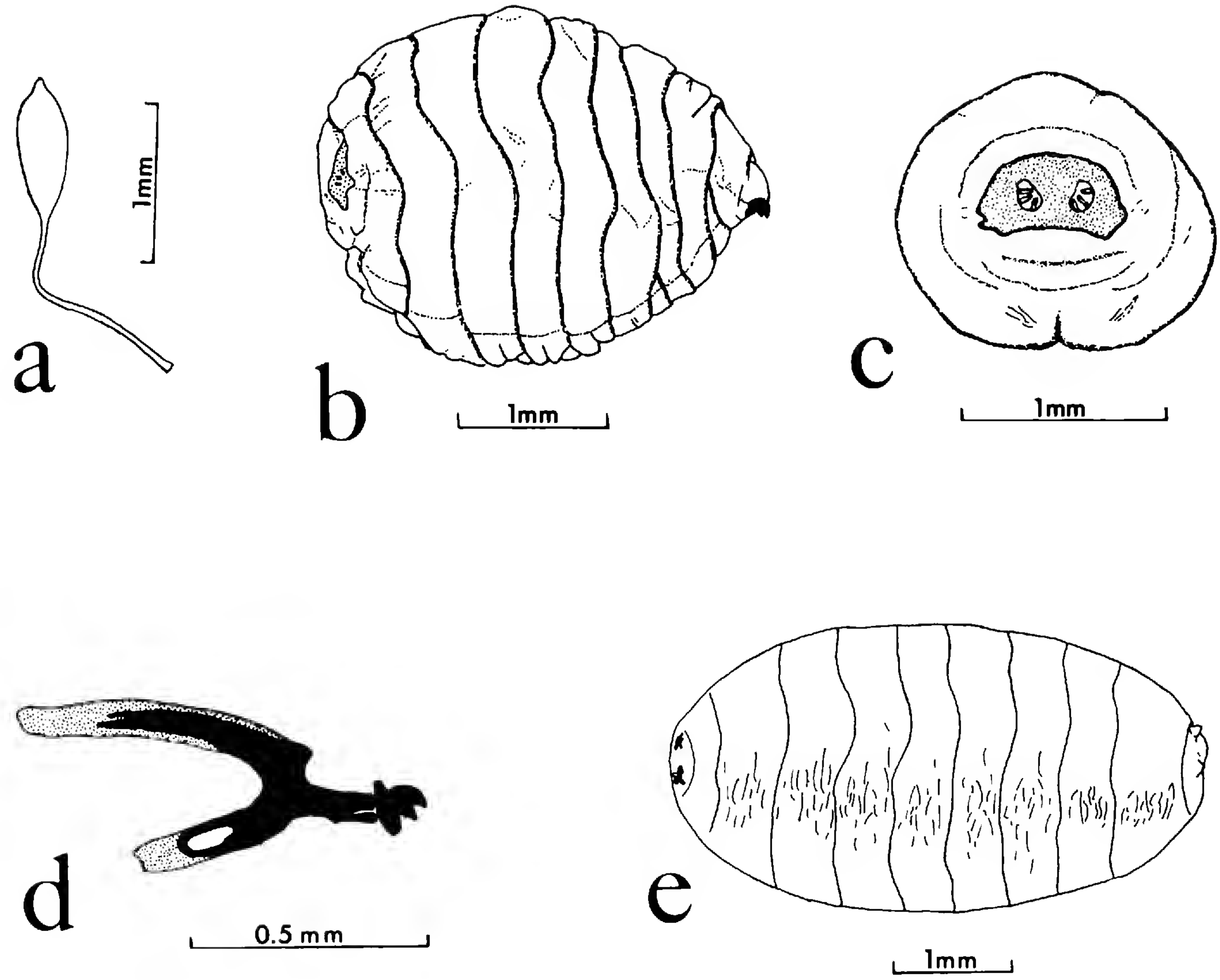

Figure 1. *Paracantha cultaris*: (a) egg, (b) 3rd instar, (c) 3rd instar posterior spiracles, (d) 3rd instar cephalopharyngeal skeleton, (e) puparium.

Larva.—There were 3 instars, but the first 2 rarely were collected. The 3rd instar (Figs. 1b, 2b) is glossy, cream-colored, barrel-shaped, anteriorly conical, and posteriorly truncate. Five 3rd instars averaged 3.47 ± 0.33 mm in length and 2.30 ± 0.12 mm in greatest width. The posterior spiracles (Fig. 1c) of the 3rd instars have 3 pairs of well-developed stigmatic slits. The stigmatic area was depressed. Eighteen stigmatic slits from 3 fully developed 3rd instars averaged 0.077 ± 0.001 mm in length and 0.022 ± 0.0005 mm in width. The cephalopharyngeal skeleton (Fig. 1d) of the 3rd instar was heavily sclerotized and darkened. The cephalopharyngeal skeletons of 3, 3rd instars yielded the following average measurements: total length from tip of mouth-hook to end of dorsal wing plate = 0.71 ± 0.13 mm, width between the dorsal wing plate and pharyngeal plate = 0.32 ± 0.02 mm, length of neck region between dorsal bridge and the mouth-hook = 0.15 ± 0.007 mm, width of neck region = 0.07 ± 0.005 mm, length of mouth-hook = 0.11 ± 0.002 mm, length of elliptical holes in pharyngeal plates = 0.13 ± 0.006 mm, and width of holes = 0.06 ± 0.004 mm.

The young larva tunneled across the top of the receptacle through the bases of numerous immature disk florets within an immature capitulum. The damaged areas soon darkened. Mature capitula of wild sunflower infested with *P. cultaris* usually were deformed, asymmetrical, and stunted and occasionally had clorotic bracts and lighter yellow petals.

The older larva continued mining the upper part of the receptacle. In mature

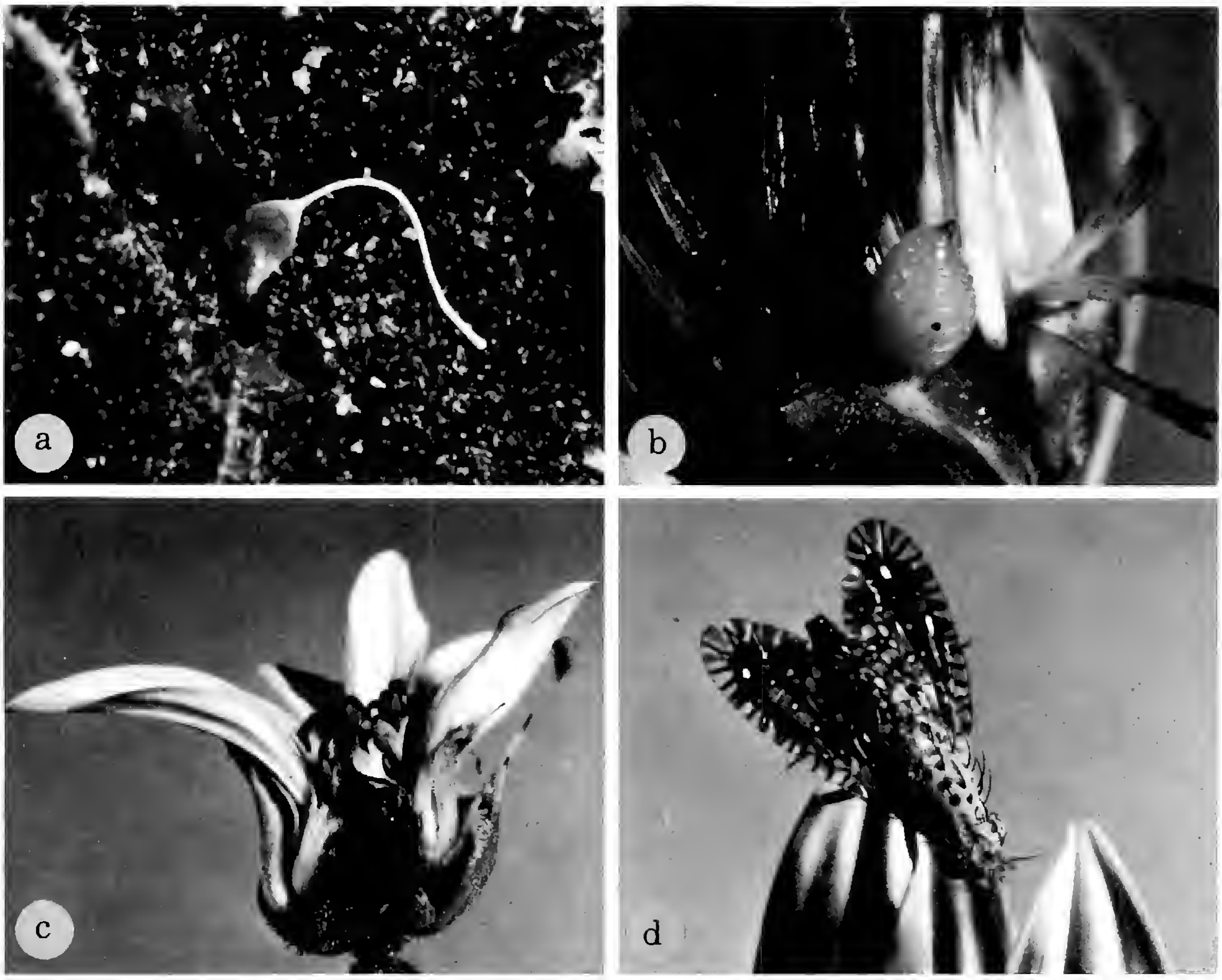

Figure 2. Life stages of *Paracantha cultaris* on wild sunflower: (a) egg chorion projecting from an oviposition scar in a phyllary, 20×, (b) larva-infested head, 5×, (c) puparium inside a malformed head, 2×, (d) adult female on flower petal, 6×.

flowerheads, larval damage was evidenced as a premature browning of the normally whitish, disk florets. The larvae produced much frass, which darkened and usually was mixed with a sticky sap or resin. Cavities were excavated among the ovaries by the last instars (Fig. 2b). The larvae pupated in these cells surrounded by tightly packed frass. The disk florets became darkened and matted just above the feeding areas.

Both *P. cultaris* and *Trupanea bisetosa* (Coquillett) commonly attack wild sunflowers in southern California. Infestations of these 2 tephritids could be distinguished in the field by the size of the infested heads, the deformity of *P. cultaris*-infested capitula, and by the numbers of larvae or puparia in each flowerhead. *Trupanea bisetosa* 3rd instars and puparia were found in wild sunflower heads with disks averaging 21.8 ± 0.47 (range 11–29) mm in diameter ($n = 47$). Puparia and 3rd instars of *P. cultaris* were found in wild sunflower heads with disks averaging 18.0 ± 0.57 (range: 11–30) mm in diameter ($n = 56$). These means were highly significantly different ($P < 0.001$, t-test). *Trupanea bisetosa* larvae did not deform the flowerheads like *P. cultaris*. *Paracantha cultaris*-infested flowerheads contained only 1.02 ± 0.01 (range: 1–2) larvae or puparia per flowerhead ($n = 96$); whereas, *T. bisetosa* averaged 4.6 ± 0.33 (range: 1–15) larvae or puparia per infested head ($n = 83$). These larval means also were significantly different. *Trupanea bisetosa* and *P. cultaris* commonly were reared from flowerheads collected from the same stand of host plants, but only rarely were found together in the same capitulum.

Pupa.—The puparia (Figs. 1e, 2c) are barrel-shaped, black, and shiny. The cephalic end of the puparium is narrower than the rounded posterior end. Twenty *P. cultaris* puparia dissected from sunflower heads averaged 4.65 ± 0.08 mm in length and 2.44 ± 0.05 mm in width. Field-collected puparia were held in the insectary for 11 to 13 days before the adults emerged. Emergence of the adults from puparia usually occurred between 5 (lights-on) and 8 a.m. in the insectary.

Adult.—The adult (Fig. 2d) has a characteristic wing pattern that easily separates it from other tephritid genera in California (Foote and Blanc, 1963). The longevities of 18 adult males fed a yeast hydrolyzate (2 parts) + honey (5 parts) mixture averaged 51.1 ± 6.39 (range: 20–115) days; whereas, 16 females lived 57.3 ± 8.09 (range: 19–126) days. These means were not significantly different (t-test).

Paracantha cultaris presumably is multivoltine, as adults and puparia were collected in southern California during most months of the year (Table 1 and Foote and Blanc, 1963). This species probably mainly overwinters as adults but also as immature stages in flowerheads on the occasional host-plant individuals that escape killing frosts and continue to bloom during mild winters in southern California.

Plant damage.—Tephritid infestations of wild sunflower heads can influence the seed set and number of viable seeds per head. Twenty capitula infested with *P. cultaris* had significantly lower numbers of seeds than 31 uninfested capitula (106.3 ± 11.47 vs. 226.0 ± 6.83, respectively) as well as significantly smaller diameters (19.8 ± 1.23 mm vs. 28.7 ± 0.92 mm, respectively). Twenty larvae each destroyed an average of 34.14 ± 2.85 (range: 14–58) disk florets during their development. About half the number of florets normally contained in uninfested flowerheads from healthy plants were directly and indirectly lost to each *P. cultaris* larva.

Adult behavior.—When caged singly, *P. cultaris* adults mostly remained motionless except for their sponging mouthparts, which constantly moved in a pumping manner. The wings usually were held motionless slightly overlapped above and near the abdomen. Occasionally, a female alternately arched each wing forward, twisting it when nearly perpendicular such that its ventral surface faced anteriorly.

A behavioral pattern involving both males and females repeatedly was observed in insectary cagings. When a male approached within ca. 3 cm of a female, he began to sway back and forth and inch forward. With his mouthparts fully extended towards the female, the male leaned his body and sidestepped as he zigzagged towards the female. With each forward movement, he thrust both wings forward in unison, so that they formed a straight line with their ventral surfaces facing anteriorly. The male stopped when he neared the female. The female largely remained motionless during this time with her rostrum pulsating. The male folded his wings along his dorsum and kept his mouthparts fully extended. Sometimes the female would turn and walk away, or turn away, then back again, just before they next joined mouthparts. Occasionally, a female touched the extended mouthparts of the male with her prolegs before extending her proboscis and joining his.

The ventral surfaces of their labella were placed flat together in close contact. Both flies stood motionless for a few minutes with their mouthparts in contact. The wings of the female were overlapped and at rest; those of the male, only slightly outstretched. One pair of flies stood with their mouthparts joined for 6 minutes and 47 seconds. They then broke apart and shortly rejoined for an additional 6 minutes and 50 seconds.

Some tephritids are aggressive and use wing displays and other means to ward off intruders (Bateman, 1972). Pritchard (1967) observed that aggressive behavior had to be subdued in *Rioxa pornia* (Walker) in order for mating to take place. He suggested that an elaborate courtship behavior was necessary to overcome the female's normal tendency to fight or take flight. Male *R. pornia* produced a mound of foam on which the females fed during copulation. Perhaps the *P. cultaris* male similarly transfers a pacifying substance or recognition token to the female when their mouthparts are joined. This "kissing" behavior often was observed in insectary cagings but mating never was observed to follow. Batra (1979) reported "kissing" between *Euaresta festiva* (Loew) adults during courtship as well as territorial behavior.

Mortality factors.—Pteromalus (*Habrocytus*) sp. (Hymenoptera: Pteromalidae) was reared from *P. cultaris* puparia. *Bracon nuperus* Cresson (Hymenoptera: Braconidae) was reared from *P. cultaris* larvae.

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Predation upon Velvet Ants of the Genus *Dasymutilla* in California (Hymenoptera: Mutillidae)

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Abstract.—Most diurnal velvet ants appear to be warningly colored, though some appear to be cryptically colored. Field observations failed to implicate any likely predators upon these organisms. In the laboratory, velvet ants of the genus *Dasymutilla* Ashmead were exposed to predation by grasshopper mice, two species of lizards, a mantid, and a scorpion. Results indicated that lizards may provide one source of predation upon diurnal velvet ants.

Insects make up a large part of the diet of many animals, both vertebrates and invertebrates. Since most velvet ants are brightly colored, conspicuous creatures, many of which can be found running around on the ground in daylight, it seems unlikely that they could exist without a means of defense. Furthermore, since velvet ants are parasitic on other wasps and bees, they frequently are exposed to the bites and stings of the latter. But the velvet ants are well adapted to their ecological niche, as noted by Schmidt and Blum (1977) in their account of the defensive adaptations of the velvet ant *Dasymutilla occidentalis* (Linnaeus).

As a first line of defense, these wingless wasps have a very heavy, deeply pitted integument. The integument functions as a suit of armor, and can be penetrated by the stings and bites of other insects only with great difficulty, if at all (Evans and Eberhard, 1970).

The most significant defense mechanism exhibited by velvet ants is their sting. The stinger is a modified ovipositor, and may be half as long as the entire body. The sting of the velvet ant is very painful (Kirkpatrick, 1957). And, while the sting is rarely used in an offensive role, it is used with remarkable effectiveness as a defensive weapon.

Since most velvet ants are brightly colored, presumably they would draw the attention of potential predators. However, since the females are such vicious stingers, it is supposed that the bright coloration assumes the role of a warning signal to prospective enemies. Due to warning coloration, it is assumed that natural enemies learn more quickly to avoid these painful stingers (Metcalf and Flint, 1932).

The velvet ants exhibit another defensive characteristic, a file on the base of the third visible abdominal tergite. When rubbed against a scraper (a sharp ridge on the underside of the second visible abdominal tergite), a squeaking sound is produced (Hinton et al., 1969). There has been speculation that this sound serves both as a sexual signal and in a defensive role. Kirkpatrick (1957) stated that it is reasonably certain that this sound increases the effectiveness of the warning coloration.

Evans and Eberhard (1970:221) sum up this combination of defense mechanisms with the statement that ". . . an animal that discovers that the mutillid is hard-bodied and a powerful stinger is likely to remember its brilliant and unusual color pattern and to avoid it in the future."

It is interesting to note that while the males of the family do not possess any means of stinging, they too have the warning coloration. Through the use of pseudoaposematic coloration, the males are receiving benefits from the females' ability to sting (Hinton et al., 1969).

Another defensive measure apparently used in at least one species is protective coloration, or mimicry. *D. gloriosa* (Saussure), a species which inhabits the deserts of New Mexico, Arizona, and southern California, is covered with long, white hairs which make it appear remarkably like thistle down. Unless moving, velvet ants of this species are easily overlooked. Since most related forms are brightly colored, and are not known to be heavily preyed upon by any other organism, the reason for this mimicry is not known (Cockerell, 1895).

While *D. gloriosa* provides the most obvious example of mimicry within the genus, there are other species that also may exhibit this defensive mechanism. It seems odd that some species would exhibit protective coloration if there were no predators to produce a selective pressure for this phenomenon. This study was conducted to determine what organisms might be applying a selective pressure for the protective coloration exhibited by a few velvet ants of the genus *Dasymutilla.*

MATERIALS AND METHODS

After location of specimens in numbers suitable for study (Manley, 1975), velvet ants were observed under natural conditions. Field observations were made throughout the summer of 1974. Due to their greater mobility, males were more difficult to observe. Most observations of males were made in conjunction with observations of females, the latter frequently luring males into the open. Once females were located, individual specimens were followed and their activities observed. Care was taken to remain at distances sufficient to insure that normal behavior would not be altered.

A primary concern in this project was to subject the velvet ants to predation by various animals which might prey upon them under natural conditions. In order to do this, specimens were collected and kept alive in the laboratory. After specimens were transported to the laboratory, they were transferred to plastic aquariums approximately 10 cm by 18 cm at the bottom. Fine mesh screen was placed over the containers to prevent escape. Sand was placed in the bottom and water was administered through glass vials plugged with cotton. Specimens were kept in the containers at room temperature (ca. 22°C) until used in the experiments.

Five potential predator species were utilized: two southern grasshopper mice (*Onychomys torridus* (Coues)); a scorpion (*Hadrurus arizonensis* (Ewing)); two lizards (*Sceloperus magister* Hallowell and *Dipsosaurus dorsalis* (Baird and Girard)); and a mantid of undetermined species.

All experiments were conducted by introducing the velvet ants to containers with the "predator." In the first experiment, the container was a glass jar and the predator was a desert mantid. In the remaining experiments the container was a 20 cm by 30 cm glass aquarium covered by a coarse mesh wire screen. In each experiment the predator was presented with a velvet ant. In all but the trials with the lizards, the predators then were presented with other arthropods to determine if a predatory drive existed.

The first laboratory experiment was undertaken on August 23, 1974. A female *D. clytemnestra* (Fox) was placed in a glass jar with a desert mantid captured at light the previous night. Following removal of the velvet ant, two moths and a fly were introduced into the jar (one at a time) to test the predatory response of the mantid.

The second experiment was undertaken on September 6, 1974, using two laboratory-born southern grasshopper mice. Since the mice had been fed only standard commercial rat pellets, they were conditioned to live food for one week prior to the experiment. They were fed two live crickets daily. After one week their predatory response to live food seemed well-developed.

The mouse that had shown the keenest predatory response was transferred to the glass aquarium and allowed to become acclimated to the new surroundings for one hour. A female *D. magnifica* Mickel then was introduced into the aquarium. In order to test the mouse's predatory drive, a bumblebee then was placed in the aquarium with the mouse. The first mouse then was removed and the second mouse was placed in the aquarium with the velvet ant. A milkweed bug (*Oncopeltus fasciatus* (Dallas)) was later introduced into the aquarium in order to test predatory response. About an hour later, the first mouse again was introduced into the aquarium and confronted by a female *D. magnifica,* followed by a female *D. satanas* Mickel.

The third experiment was conducted December 13–20, 1974. On December 13, a female *D. magnifica* was placed in the aquarium with a scorpion (*H. arizonensis*) that had been captured in August 1974. Observations were made, periodically, from December 13 through December 20. Cockroaches and mealworms subsequently were placed in the aquarium with the scorpion in order to test predatory response.

The final experiment took place May 14–19, 1975. In that experiment, two lizards were used which had been caught May 11, 1975 and which had not been fed since capture. On May 14 the first lizard (*D. dorsalis*) was placed in the aquarium and allowed one hour to acclimate to its new surroundings. At that time a thread was tied around a female of *D. nocturna* Mickel in such a way that its movements were not restricted. It was then lowered in front of the lizard. The second lizard (*S. magister*) was subsequently placed in the aquarium and the procedure was repeated.

On May 16, the procedures were repeated, again using both lizards. This time each lizard was presented first with a female of *D. nocturna,* then with a female of *D. clytemnestra.* A final test was conducted on May 19 by lowering another *D. nocturna* on a thread in front of the *Sceloperus* lizard.

RESULTS

While most taxa of terrestrial animals include at least some insectivorous members, at no time was an attempted capture of a velvet ant observed under natural conditions. The opportunity for predation by rodents or reptiles existed frequently.

It was not uncommon to see female velvet ants enter a rodent or reptile burrow during the course of their explorations. On a number of occasions in which a velvet ant was seen entering a small burrow, a lizard was seen exiting the burrow after the velvet ant's entry. Thus, it would seem that the lizards had no great desire to confront the velvet ants under natural conditions. Lizards involved in those observations were not identified.

There were instances in which velvet ants became entangled in spider webs that guarded the entrance to burrows. On those occasions, the velvet ants quickly and easily freed themselves without any interference from the occupants of the webs (which appeared to be recent and presumably occupied).

Possible enemies of the velvet ants under field conditions appeared to be true ants. Columns of ants going to or from their nest were frequently encountered by the velvet ants. On every occasion, they would cross the column with great haste. On one occasion a female *D. gloriosa* was dropped near the entrance to one of these ant nests and was quickly killed by the ants. It seems ironic that the velvet ant, whose integument is impenetrable to the stings of other wasps and bees, was so easily overcome by ants.

When placed with the mantid, the *D. clytemnestra* was not attacked. Soon after introduction of the velvet ant into the jar, the mantid appeared ready to strike, but then backed off and showed no further interest in the mutillid. The mantid eagerly devoured two moths and a fly that were then placed in the jar.

When the velvet ant was placed in the aquarium with the first mouse, the latter immediately attacked the velvet ant. It picked the velvet ant up with its front feet and attempted to decapitate its prey in the manner characteristic of this species (Cyr, 1970). For its efforts, the mouse received a sting in the mouth. Instinct to attack movement caused the mouse to repeatedly attack the velvet ant. Each time the attack was terminated as the mouse was stung in the mouth. This lasted for approximately five minutes with the mouse becoming increasingly hesitant to attack. Pain apparently overcame instinct and attacks ceased. At that time the mouse appeared groggy and glassy-eyed. The struggle between instinct and pain resulted in considerable displacement behavior on the part of the mouse, including rolling and digging in the sand. When the bumblebee was confined with the mouse, the bee was captured, decapitated, and eaten.

When the second mouse was placed in the aquarium, it immediately attacked the velvet ant that was again placed in the aquarium. It, too, was stung in the mouth. The predatory drive was apparently not as strong in the second mouse and, after being stung once, it ceased to attack. Again, displacement behavior was observed. Females of *D. satanas* and *D. gloriosa* were subsequently introduced into the aquarium. Though different colors from *D. magnifica,* these two latter species apparently looked similar enough to *D. magnifica* that no attacks upon them were observed. When a milkweed bug was introduced into the aquarium, it was quickly captured, decapitated, and eaten.

When the first mouse again was placed in the aquarium, it seemed to have regained its original vigor and predatory drive. Again, it was stung repeatedly in the mouth. The mouse finally assumed what appeared to be a "do or die" attitude and, in spite of numerous stings, kept the velvet ant in its mouth long enough to cause injury. Once the velvet ant had been injured, it was decapitated, after which the mouse attempted to eat its prey. For whatever reason, the mouse was not successful in consuming its subdued victim. The dead velvet ant was left with the mouse for a period of one week following the experiment and was not consumed during that time.

After the mouse had attempted, and failed, to eat the velvet ant, the dead specimen was replaced by another live velvet ant, a female *D. satanas.* The mouse again attacked repeatedly and was stung repeatedly. The mouse soon appeared groggy and all predatory activity ceased. Displacement behavior was again observed, but no further advances were made toward the velvet ant during the next fifteen minutes.

While the velvet ant was confined with the scorpion, whenever it passed nearby, the scorpion would attempt to grab it. Whenever captured, the velvet ant was released almost immediately. It appeared that the scorpion was stung upon the pedipalp in order to cause release. The scorpion, however, showed no reaction other than release of the velvet ant. This sequence of events occurred repeatedly throughout the day.

When next observed, on December 16, the velvet ant was still alive. Similar displays continued to take place through December 20, after which time the velvet ant had spent one week with the scorpion. From observation, it appeared that a key to the scorpion's inability to capture the velvet ant was that pressure applied by the pedipalp of the scorpion seemed unable to injure the velvet ant. Cockroaches and mealworms placed in the aquarium with the scorpion were quickly killed and consumed.

When the velvet ant was lowered in front of the first lizard (*D. dorsalis*), the lizard made no movement toward the velvet ant until it had been annoyed (by the presence of the velvet ant on and in front of its face) for about five minutes. After apparently being stung, the lizard made two or three snaps at the velvet ant, but did no apparent damage. When the procedure was repeated with the second lizard (*S. magister*), it did not attack the velvet ant even after five minutes of annoyance. When repeated on May 16, the results were the same. The *D. dorsalis* finally snapped at the velvet ant, but did no damage. The *S. magister* did not attack the velvet ant.

On the final trial, the *Sceloperus* first showed no inclination to attack the *D. nocturna,* even after considerable annoyance. Finally, however, it snapped at the *D. clytemnestra,* nearly severing the velvet ant between the head and thorax. The velvet ant was not eaten by the lizard, but died shortly thereafter from injuries that it had sustained. The *D. nocturna* was left in the aquarium with the *Dipsosaurus* until May 19 and was not injured. Later that day, another *D. nocturna* was lowered on a thread in front of the *Sceloperus.* After only a few seconds the lizard crushed and consumed the velvet ant in one quick movement. The lizard exhibited no difficulty in consuming the velvet ant, and the sounds of crushing of the tough integument were easily heard.

DISCUSSION

This study was stimulated by the apparent fact that a few velvet ants are cryptically colored while the majority are brightly colored. The most striking example of this is *D. gloriosa,* which Cockerell (1895) described as resembling thistle down. Cockerell related that, unless moving, these velvet ants were easily overlooked.

In this study, it was noted that all specimens of *D. gloriosa* that were observed were found in the vicinity of creosote (*Larrea divaricata* Cav.), and that these velvet ants showed a remarkable resemblance to the fruit of the creosote. While this made the velvet ants easy to overlook when at rest, it was discovered that their movements made them equally difficult to observe. These velvet ants moved in a jerky manner which resembled a creosote fruit being blown in the wind. More than once a blowing creosote fruit was mistaken for one of these velvet ants. It is not known how many velvet ants were overlooked as they sat motionless.

Another example of this cryptic coloration is seen in *D. clytemnestra.* This small, pale yellow velvet ant was found most frequently in the vicinity of dry, pale yellow grass. Unless moving, it was most difficult to see. On one occasion, a specimen that was being observed stopped in the grass. Though the position of this individual was known, it was almost impossible to distinguish the velvet ant from its surroundings at a distance of more than a few centimeters.

Still another example is *D. nocturna,* a predominately pale species that is found upon sand dunes. This species is very inconspicuous upon the light-colored sand and, like *D. gloriosa,* is very likely to be overlooked unless moving.

Since cryptic coloration apparently exists in some velvet ants, the obvious question is why it exists. In order for cryptic coloration to be an advantage, the potential predator must possess color vision. Using this as a criterion, it may be possible to reduce the number of potential predators. For example, most mammals do not have the ability to see color. This is particularly true of nocturnal mammals for which the light necessary for color vision is usually not available. And, since most desert mammals are nocturnal, it seems unlikely that they would provide the predatory pressure necessary to favor cryptic coloration by velvet ants.

Grasshopper mice were chosen as an example of mammalian predators because they are small, voracious, and highly insectivorous predators (Cyr, 1970). Like most desert mammals, grasshopper mice are nocturnal. Therefore, it is quite possible that they would rarely, if ever, encounter these diurnal velvet ants. And even though they may dig in the sand for prey, the habits of the velvet ants are not well enough known to establish whether they might be encountered by this potential predator.

The laboratory experiment with the two grasshopper mice was repeated four times. On three trials the mice were subdued by stings of the velvet ants. On one trial the velvet ant was killed. It seemed very doubtful, however, that under natural conditions, the grasshopper mice would have taken as much punishment as they did before retreating. Under conditions other than the confined laboratory situation, the grasshopper mice probably would seek an easier meal.

One observation that remains unexplained at this point is that the grasshopper mouse failed to eat the velvet ant even after it had been killed and decapitated. Velvet ants have a very tough integument. Grasshopper mice, however, are accustomed to eating beetles of the family Tenebrionidae (including *Eleodes* sp.), and these beetles also have very tough integuments. It is possible that the dense pubescence may have made the velvet ant unpalatable to the mouse.

Perhaps other arthropods prey upon the velvet ants. It is known that many arthropods have color vision. Their vision, however, is presumably quite different from our own. Therefore, it is not known if cryptic coloration (as we see it) is cryptic to potential arthropod predators. The fact that many of the potential predators are nocturnal (including scorpions and solpugids) raises further doubts as to their predatory potential upon diurnal velvet ants.

The fact that the mantid started to move toward the velvet ant and then stopped is a very interesting point. It seems very unlikely that this nocturnal predator had ever before seen a velvet ant. Yet it seemed to recognize it as a source of danger. Perhaps stridulation by the velvet ant served to warn this potential predator that persistence would result in a sting. At any rate, the mantid seems an unlikely predator of velvet ants under natural conditions.

The scorpion, too, had little success preying upon the velvet ant, even under the confining laboratory conditions. And it, too, is nocturnal.

It would have been interesting to have placed a velvet ant in confined conditions with a large solpugid (had one been available). Whether it would have been any more successful than the scorpion is not known. But the solpugid is also nocturnal, and even if it had been successful, it would not have explained cryptic coloration.

An untested possibility of predation upon the velvet ants comes from birds. The fact that so many birds are diurnal, that they possess color vision, and that some are insectivorous all make them suspect of such predatory activity. Discussions with Dr. Charles T. Collins and Dr. Stuart L. Warter (ornithologists at California State University, Long Beach) have led to the opinion that likely candidates for predation upon the velvet ants might be some members of the family Mimidae, the thrashers. These birds are diurnal, insectivorous and occupy much of the same habitat as the velvet ants. However, no birds were seen harassing velvet ants in the field, even after many hours of observation of velvet ants under natural conditions.

A possible source of predation of velvet ants that emerged from this study is insectivorous lizards. While no predatory activity was observed in the field, laboratory experiments showed that lizards have the capability of eating velvet ants. This, like all of the laboratory experiments, occurred under confined conditions, and with hungry potential predators. The fact that lizards can eat a velvet ant does not establish that they ordinarily do so.

At this point it seems that the only two potential predators that might pursue velvet ants would be certain birds and lizards. And, based upon observations which have been made to this point, it seems unlikely that even these organisms would encounter or pursue velvet ants on any regular basis.

If the color exhibited by some of the velvet ants is, indeed, cryptic coloration, then it seems most likely that some selective pressure exists, whether it be by one of the organisms already mentioned, or by something entirely different.

Another possibility is that the colors are not designed to be cryptic at all, and that it is only to our eyes that they appear so. The lighter colors may be thermoregulatory in function. But both of these possibilities present irregularities. Most importantly, why are other velvet ants, both larger and smaller, brightly colored? Whether the colors are defensive in nature, or physiological, there should be some consistency. The brightly colored and cryptically colored individuals occupy the same areas.

In conclusion, it seems that the colors exhibited by some velvet ants probably are cryptic in function. What selection pressure exists is not known. Why other velvet ants are not also cryptically colored but are, instead, warningly colored is also not known. Whatever the answers, it seems probable that velvet ants do not make up a large part of the diet of any other animal. It seems that there must be an easier meal than the hard-bodied, powerfully stinging, velvet ant.

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Five New Species of the Band-winged Grasshopper Genus *Trimerotropis* Stål (Orthoptera: Oedipodinae)

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Abstract.—Five new species of *Trimerotropis* grasshoppers from the western United States are described. Four species are known only from California. *T. leucophaea* is described from several localities east of the Sierra Nevada Mountains. The other three Californian species are restricted: *T. bernardi* to the San Bernardino Mountains; *T. infantilis* to the Santa Cruz Mountains; and *T. inyo* to the Whitney Portal area. *T. whitei* is known only from pink sandy substrate areas of southwestern Utah.

In this paper we describe five new species of *Trimerotropis* Stål. Four species are restricted to California and the fifth is found in southwestern Utah.

The genus presently includes 56 species (Rentz and Weissman, 1980, 1981; Weissman, 1984), and is one of the most common orthopteran components of insect communities in North America. Species occur, often sympatrically, in habitats ranging from below sea level in desert areas, to coastal sand dunes, to rocky slopes at or above timberline. White (1973) and Weissman and Rentz (1980) divided the genus into two sections, A and B, based entirely on karyotypic parameters. Section A included those species in which the entire chromosomal complement was telocentric. Section B species possess metacentric chromosomes, either fixed or polymorphic.

Species' descriptions within the paper refer to the whole series. All specimens examined except holotypes are paratypes. Holotypes and main series of the new species are in the California Academy of Sciences (CAS), San Francisco. Paratypes will be deposited in the Academy of Natural Sciences of Philadelphia (ANSP), University of Michigan Museum of Zoology (UMMZ), and the Australian National Insect Collection, Canberra (ANIC).

Trimerotropis bernardi, NEW SPECIES
(Figs. 1, 2)

Recognition characters.—Species with blue hind tibia, yellow wings, and metacentric chromosomes. See Table 2 for comparison with other *Trimerotropis* species with blue hind tibia and yellow wings. Most similar to *T. fratercula* McNeill (which occurs only in the Rocky Mountains) but differs in having a broader tegmen, generally less deeply sulcate frontal costa, and blue instead of yellow hind tibia. The former resembles *Circotettix splendidus* Rehn and Hebard from which it may be distinguished morphologically by its smaller size and reduced thickness

Table 1. Measurements (in mm) for new species of *Trimerotropis.*

	Length body	Length pronotum	Length hind femur	Length tegmen
T. bernardi				
Holotype ♂	24.9	5.1	13.1	26.3
Paratypes				
Males (6)	23.7–24.4	4.3–4.9	11.4–12.3	23.0–25.6
Females (8)	28.1–32.5	6.0–6.6	14.5–16.2	30.0–31.4
T. infantilis				
Holotype ♂	15.7	3.2	10.0	16.0
Paratypes				
Males (17)	13.7–17.2	2.4–3.9	8.6–11.2	14.7–19.6
Females (7)	19.7–21.6	3.8–4.4	10.8–13.1	18.7–23.5
T. inyo				
Holotype ♂	23.0	4.5	11.7	23.3
Paratypes				
Males (15)	19.8–21.0	3.8–4.3	10.9–12.3	21.8–23.0
Females (3)	27.7–31.2	5.7–6.0	14.3–15.0	28.1–28.8
T. leucophaea				
Holotype ♂	21.9	4.2	11.4	22.5
Paratypes				
Males (51)	18.2–22.6	3.7–4.5	10.2–11.7	20.3–25.1
Females (36)	25.0–30.4	4.7–5.7	12.9–14.4	26.2–30.5
T. whitei				
Holotype ♂	17.3	3.7	10.4	20.9
Paratypes				
Males (37)	12.1–13.6	3.4–3.9	9.6–10.9	19.3–22.2
Females (19)	22.0–23.7	4.6–4.7	12.3–12.5	24.5–25.7

of the anal veins of the hind wing, including the posterior axillary vein, and by the typically low crepitational flights characteristic of *Trimerotropis* as opposed to the very high flights accompanied by loud snapping characteristic of *Circotettix.*

Geographic distribution (Fig. 1).—Known only from the San Bernardino Mountains, California.

Holotype male.—"USA: California: San Bernardino Co., San Bernardino Mts., Mill Creek Camping area, 6000 ft. elev., #81-24, 25 July 1981. Cal. Acad. Sci. Access. David Weissman Coll." Holotype in California Academy of Sciences, No. 12787.

Description.—See Table 1 for measurements. Head with frontal carinae heavy, parallel nearly their entire length, not extending to fronto-clypeal suture; fastigium of vertex broad, shallow, lateral carinae moderately heavy, extending to about middle of eye, median carina absent. Pronotum without lateral carinae, prozona and mesozona deeply sulcate (Fig. 2), metazona smooth, not tuberculate; median carina moderately high, prozona convex; lateral lobe without tooth (Fig. 2). Meso- and metasternal interspace relatively broad. Tegmina wide, extending for a distance of ⅓ its length beyond hind tibia. Ventral and lateral surfaces of thorax and legs setose. Body and tegmina coloration speckled dark brown and greyish white. Antenna annulate. Pronotum with median portion of disk dark brown, lateral

Table 2. Characters for distinguishing *Trimerotropis* species with blue hind tibia and yellow or yellow-green wings. Most species are only distinguished by a combination of characters. See Weissman and Rentz (1980) for crepitation terminology.

Species	Chromosomal section[1]	Pronotal tooth[2]: present +, absent −	Lateral prozonal carinae[2]: present +, absent −	Crepitation: crackle (C), buzz (B), pulse buzz (PB)	Other significant characters
albescens McNeill	A	−	−, +	C, B	greyish white color
arenacea Rehn	A	−, +	−	B	probably not in California
bernardi, n. sp.	B	−	−	C	San Bernardino Mts. only
bifasciata Bruner	A	−	+	B	
bilobata Rehn and Hebard	A	−, +	−	B	distinctive median carina
cincta (Thomas)	A	−	+	PB	not in California
fontana Thomas	A	−, +	+	B, C	tegminal bands distinct
inconspicua Bruner	A	−	−	B	blue hind tibia unusual
infantilis, n. sp.	A	+, −	+	B	band through eye, small size, northern California
inyo, n. sp.	B	−	+	PB	blue tinge in wing disk
koebelei (Bruner)	A	−, +	−	B	band through eye
occidentaloides Rentz and Weissman	A	−, +	+	B	Santa Monica Mts.
suffusa Scudder	B	−	+	C	no tegminal bands
thalassica Bruner	B	−, +	+	B	
topanga Rentz and Weissman	A	+, −	+	B	southern California

[1] Data from Weissman and Rentz (1980), Weissman (1984).

[2] Usual condition listed first.

areas greyish white. Tegmina with 2 indistinct bands formed by coalescence of speckles, absent in some specimens; wing disk opaque yellow at base becoming semitranslucent near band; band narrow and smoky, apex clear with a few speckles. Outer pagina of hind femur with 2 distinct, oblique dark brown bands; inner pagina black, dorsal margin with 3 black bands separated by yellow areas; apex with a yellow band; hind tibia blue.

Karyotype.—2N ♂ = 23; Section B, subsection 2; 3 large, 6 medium, 2 small autosomes. X metacentric, all 3 large autosomes homomorphic metacentrics, floating inversion series in the two specimens examined involving 2 and 3 medium autosomes respectively. Individuals examined: type locality, 2 ♂.

Specimens examined.—California, San Bernardino Co., San Bernardino Mts., Mill Creek Camping area, 1829 m, 25.vii.1981, D. Weissman, 2 ♂, 2 ♀, including holotype (CAS); 5.x.1947, P. Timberlake, 2 ♂, 1 ♀ (CAS). San Bernardino Mts., Vivian Creek, 2190 m, heavy forest, 29.viii.1919, Rehn and Hebard, 3 ♂, 6 ♀ (ANSP). San Bernardino Mts., High Creek, 2740 m, 29.viii.1919, Rehn and Hebard, 2 ♂ (ANSP).

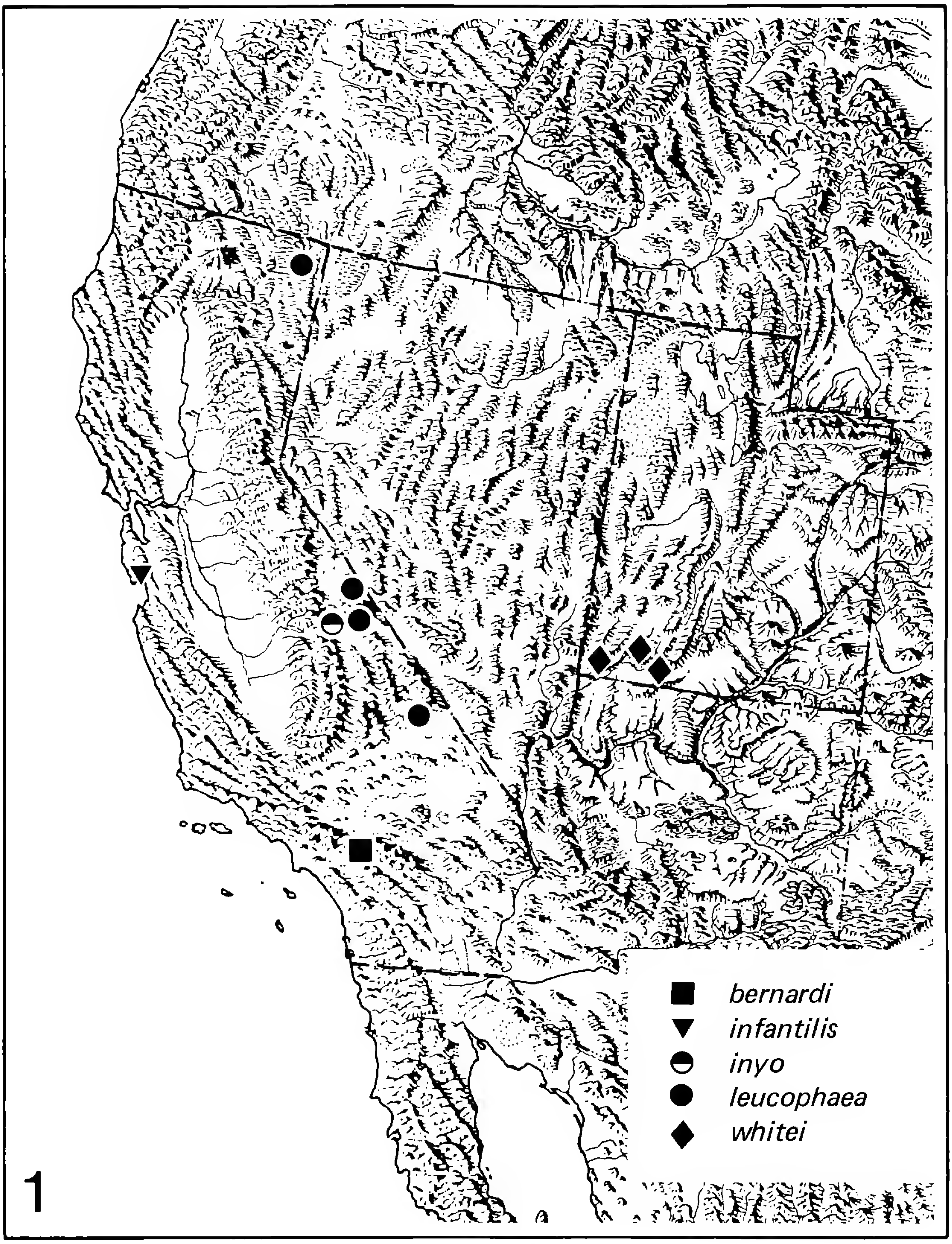
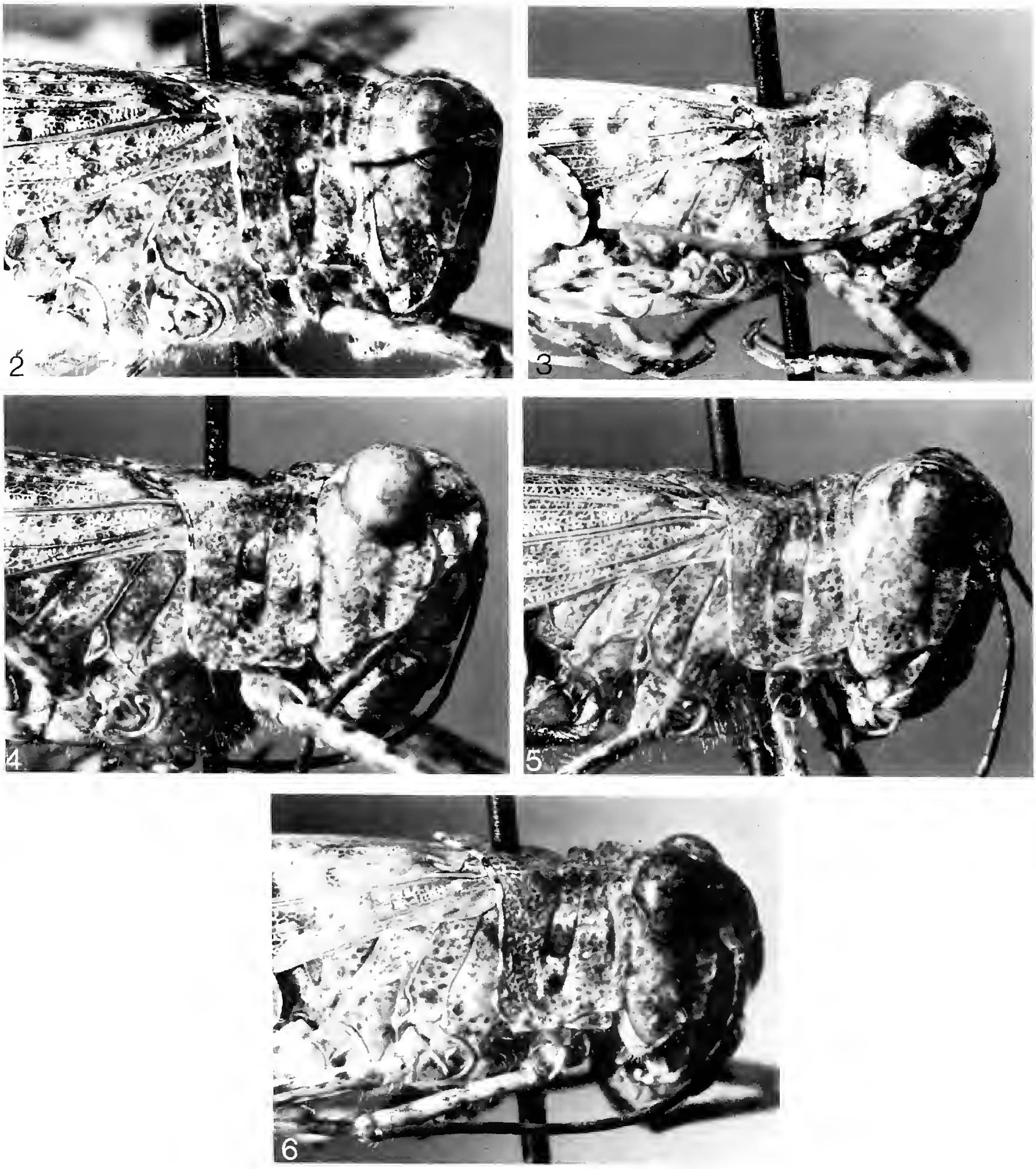


Figure 1. Known distribution of five new species of *Trimerotropis*.

Remarks.—*T. bernardi* is an inhabitant of the Ponderosa pine community from 1820 to 2743 meters elevation. The 1981 type series was found at the intersection of Valley of the Falls and Quercus Roads on gravelly substrate with pine needle cover. All 4 of these specimens flew 2–4 m; male crepitation was a crackle, similar to that of *T. p. pallidipennis* (Burmeister) (see Otte, 1970:123). Both females



Figures 2–6. Lateral view, paratopotype males of *Trimerotropis*. 2. *T. bernardi*. 3. *T. infantilis*. 4. *T. inyo*. 5. *T. leucophaea*. 6. *T. whitei*.

contained nearly mature eggs. The adjacent sandy, dry Mill Creek stream bed and pine-oak woodland-grass banks were searched but only *T. fontana* Thomas was found. The series shows variation primarily in the intensity of the color of the hind wing; a single male has the entire apical portion of the wing smoky black. This species is named with a dual purpose; we honor our friend Prof. Bernard John and christen it after the San Bernardino Mountains.

Trimerotropis infantilis, NEW SPECIES
(Figs. 1, 3)

Recognition characters.—Small species with blue hind tibia, yellow wings, a band through the eye, and only telocentric chromosomes. See Table 2 for comparison with other *Trimerotropis* species with blue hind tibia and yellow wings. Most similar to *T. koebelei* Bruner but differs in its smaller size, narrower and more deeply sulcate frontal costa, higher pronotal crest, and less distinct lateral pronotal carinae. This species can be confused with *Conozoa* species: in the latter genus tegminal bands cover only half of the tegmen; in *Trimerotropis* the bands are absent all together or continuous across the entire tegmen, although odd individuals in the type series of *T. infantilis* resemble *Conozoa* in this character.

D. Otte (pers. comm.) is describing a small species from coastal California near Lompoc which might be confused with *T. infantilis.* This former species is slightly larger, more robust, and has a more poorly defined median pronotal carina. Its color is pale, almost whitish, and the bands on the hind femur are more sharply indicated. It lacks any trace of a band through the bottom of the eye.

Geographic distribution (Fig. 1).—Known only from the Santa Cruz Mountains, California.

Holotype male.—"USA: California: Santa Cruz Co., Santa Cruz Mountains, Felton, E. Zyante Rd., 1 mi E intersection of E. Zyante Rd. and Graham Hill Road, 16 July 1977, leg. D. B. Weissman & D. C. Rentz, Calif. Acad. Sci. Coll." Holotype in California Academy of Sciences, No. 14100.

Description.—See Table 1 for measurements. Head with frontal carinae heavy, constricted at median ocellus, carinae continuing almost to fronto-clypeal suture; fastigium of vertex relatively narrow, lateral carinae heavy, extending beyond middle of eye, convergent; occiput with a pair of impressions. Pronotum with lateral carinae represented as tubercles; median carina heavy, prozona and mesozona raised; lateral lobe (Fig. 3) with a minute tooth; surface of disk minutely rugose, lateral lobe smooth but not shining. Tegmina relatively short, extending for about ¼ to ⅕ its length beyond hind tibia. Legs and thorax very sparsely setose. Body and tegmina coloration greyish to light brown; head with ventral half of eye and adjacent intra-antennal area blackish, remainder of frons greyish white; antenna faintly annulate in basal half. Tegmina with 2 bands varying from indistinct to distinct; wing light yellow, highly transparent, band narrow, relatively faint, remainder of wing uniformly colorless except for cross veins. Outer pagina of hind femur with 2 faint, oblique stripes; inner pagina dark brown in proximal half, then with 2 yellow bands separated by a narrow dark brown band that continues onto dorsal margin; hind tibia light blue grey.

Karyotype.—2N ♂ = 23; Section A; all telocentric; 3 large, 6 medium, 2 small autosomes; of 8 ♂ examined from the type locality, 5 had a supernumerary segment heterozygous in one of the small autosomes, 1 had the segment homozygous, and the remaining 2 had no segments.

Specimens examined.—California, Santa Cruz Co., Santa Cruz Mts., Felton, E. Zyante Road, 1.6 km E intersection of E. Zyante and Graham Hill Roads, 16.vii.1977, D. B. Weissman, D. C. Rentz, 12 ♂, 5 ♀ including holotype (CAS). Santa Cruz Mts., no date, A. Koebele Collection, 1 ♂, 2 ♀ (CAS); 13.viii.1938, J. Russell, 1 ♂ (ANSP); Alma, 16.viii.1928, E. G. Linsley, 2 ♂ (CAS); Felton, 13.viii.1959, D. C. Rentz, C. Wemmer, 1 ♂ (ANIC); Santa Cruz, 28.ix.1941, K. E. Frick, 1 ♂ (CAS).

Remarks.—At the type locality *T. infantilis* was found on sandy substrate sparsely covered with *Lotus* and grasses at the base of pines above a rock quarry (Lone Star Industries, Olympia Plant #125). Individual flights were from 1 to 2 meters with male crepitation a rapid buzz. Approximately 25% of the population was fourth and fifth instar on 16 July 1977; females bore nearly mature eggs. No other *Trimerotropis* was microsympatric although *T. p. pallidipennis* and *T. thalassica* Bruner were caught nearby. This species is named with reference to its small size; it is only slightly larger than *T. pogonata* Strohecker, the smallest known species in the genus.

***Trimerotropis inyo*, New Species**
(Figs. 1, 4)

Recognition characters.—Species with blue hind tibia, greenish yellow wing with a blue tinge, and metacentric chromosomes. May be distinguished from other *Trimerotropis* species with blue in the wing by the combination of the short lateral pronotal carinae, distinct tegminal banding, greenish yellow (fades in some museum specimens) wing with a blue tinge, narrow dark band, and high pronotal crest. Morphologically most similar to *T. pseudofasciata* Scudder but differs in lacking a lateral lobe tooth and always having the wing disk predominantly green, in addition to the characters listed previously. Also similar to *T. cyaneipennis* Bruner but differs in smaller size and narrower wing band. Also the flight in *T. inyo* is shorter and the crepitation is a series of rapid buzzes (pulse buzz—see Weissman and Rentz, 1980, Fig. 1), as opposed to the crackle of *T. cyaneipennis* (Weissman, 1984).

Geographic distribution (Fig. 1).—Known from the eastern slopes of the Sierra Nevada Mountains above the Owens Valley, California.

Holotype male.—"USA: California: Inyo County, 12.8 km W. Lone Pine on Whitney Portal Road, 1920 m, 6.viii.1978, D. B. Weissman, D. Lightfoot Stop 120, Calif. Acad. Sci. Coll." Holotype in California Academy of Sciences, No. 14101.

Description.—See Table 1 for measurements. Head with frontal carinae heavy, nearly parallel two-thirds their entire length, persistent to fronto-clypeal suture; fastigium of vertex broad, shallow, carinae heavy, continuing well past middle of eye; occiput with a pair of inverted comma-like impressions. Pronotum with minute lateral carinae, prozona and mesozona deeply sulcate, the former raised; median carina well indicated; lateral lobe punctate, usually without a tooth, but ventral margin (Fig. 4) sometimes with faint indication of tooth. Tegmina slender, extending for a distance of about ⅓ its length beyond hind tibia. Ventral surface of legs and thorax sparsely setose. Body and tegmina coloration brown or grey brown, speckled. Antenna intensely annulate. Tegmina with 2 distinct bands, a third band indicated by a coalescence of speckles; wing mostly transparent, disk greenish yellow with a blue tinge basally, band variable, from half as wide as tegmina and broken, to almost as broad as tegmina and uninterrupted, dark brown, apex colorless. Outer pagina of hind femur with 2 distinct, dark brown bands, a fainter band present at base; inner pagina brown, with a single yellowish area and 2 dark brown or black bands continuous to dorsal margin; hind tibia blue.

Karyotype.—2N ♂ = 23; Section B, subsection 1; 3 large, 6 medium, 2 small autosomes. X metacentric, L_1, L_2, L_3, M_5 and M_6 homomorphic metacentric, rest telocentric; no inversion polymorphism noted in the 4 males examined from the type locality.

Specimens examined.—California, Inyo Co., 12.8 km W Lone Pine on Whitney

Table 3. Characters to distinguish *T. leucophaea* from *T. cyaneipennis*.

	T. cyaneipennis	*T. leucophaea*
Chromosome number	2N ♂ = 21 (23 in central New Mexico)	2N ♂ = 23
Tegmina	usually with distinct bands, slate grey-brown	without distinct bands, brown
Wing disk	rich blue, translucent (difficult to read label through disk near center)	light blue, transparent (easy to read label through disk near center)
Wing band	wide, complete	narrow, sometimes interrupted
Behavior	loud crackle, difficult to collect	soft crackle, easy to collect
Distribution	Oregon, Arizona, Utah, Nevada, Idaho, New Mexico, ? California	California, ? Nevada

Portal Road, 1920 m, 6.viii.1978, D. B. Weissman, D. Lightfoot. 13 ♂, 3 ♀, including holotype (CAS). 17.6 km W Lone Pine on Whitney Portal Road, 2530 m, 19.vii.1961, D. C. Rentz, 2 ♂ (CAS). 9.6 km W Big Pine, 1.ix.1964, M. R. Gardner, 1 ♂ (U.C. Davis).

Remarks.—This species is found on bare, gravelly substrate in the Pinyon-Sage community on the eastern slopes of the Sierra Nevada Mountains. It occurs sympatrically with *T. albescens* McNeill with the latter being much more common. Flights in *T. inyo* range from 3–7 m; male crepitation is a pulse-rapid buzz. At the time of collection of the holotype, only two males crepitated of the 13 seen. Females at the time bore nearly mature eggs; one last instar female was seen.

***Trimerotropis leucophaea*, NEW SPECIES**

(Figs. 1, 5)

Recognition characters.—Species with blue hind tibia and wings, and metacentric chromosomes. Most similar to *T. cyaneipennis* but distinguishable by a combination of characters—see Table 3. Differs from *T. pseudofasciata* in having a low metazonal carina and lacking a lateral lobe tooth. Also similar to *T. sparsa* (Thomas) but differs in having blue rather than brown or yellowish-brown hind tibia and having a distinctly blue wing disk. Differs from *T. arizonensis* Tinkham (known only from holotype) in lacking green in the wing disk (always light blue in *leucophaea*), having uniform blue hind tibia, and less distinct tegminal bands. The latter species was collected along the hot, barren Colorado River.

Geographic distribution (Fig. 1).—California; specimens at ANSP from Reno, Nevada, may be this species.

Holotype male.—"California: Inyo County, Westgard Pass, 7200 feet elevation, 26 July 1962. D. C. Rentz, C. D. MacNeill, collectors." Holotype in California Academy of Sciences, No. 12774.

Description.—See Table 1 for measurements. Head with frontal carinae feeble, weakly constricted and ending below median ocellus; fastigium of vertex (Fig. 5) broad, shallow, lateral carinae weak, extending slightly beyond middle of eye, median carina absent. Pronotum without lateral carinae; prozona and mesozona relatively deeply sulcate; median carina low, absent in mesozona, lateral lobe (Fig. 5) without tooth; surface of disk relatively smooth, minutely, evenly punctate. Tegmina elongate, extending for a distance of about ⅓ of its length beyond hind tibia. Ventral surface of thorax and legs sparsely setose. Body and tegmina coloration uniformly medium grey brown. Antenna faintly annulate in proximal half, less so distad. Tegmina speckled without bands; wing light blue, transparent, crossveins along anterior margin light brown, remainder blue, brown band faintly indicated. Outer pagina of hind femur uniform color; internal pagina with 2 yellow blotches, dorsal surface entirely yellow; hind tibia blue.

Karyotype.—2N ♂ = 23; Section B, subsection 2; 3 large, 6 medium, 2 small autosomes. X metacentric, 2 largest autosomes fixed metacentrics; four other autosomes from L_3 to S_{10} were polymorphic for inversions. One Silver Canyon male had 1 small B chromosome. Individuals examined: 1.6 km E type locality, 1 ♂; Silver Canyon, 5 ♂.

Specimens examined.—California, Inyo Co.: Westgard Pass, 2100 m, 26.vii.1962, D. C. Rentz, C. D. MacNeill, 10 ♂, 14 ♀ (CAS); 21.vii.1964, D. C. and K. A. Rentz, J. D. Birchim, 4 ♂, 3 ♀ (CAS); 1.6 km E Westgard Pass summit, 2102 m, 6.viii.1978, D. B. Weissman, D. Lightfoot, 1 ♂, 1 ♀ (CAS); 1.6 km W summit, 24.vii.1965, D. C. Rentz, 1 ♂; White Mountains, Silver Canyon, 2010 m, 10.ix.1919, Rehn and Hebard, 13 ♂, 6 ♀ (ANSP); 2012 m, 19.viii.1982, D. B. Weissman, #82-73, 5 ♂, 2 ♀ (CAS); Angus Range, 780 m, 9.ix.1922, Rehn and Hebard, 1 ♂ (ANSP); Amargosa Range, Boundry Canyon, Hole in the Rock Spring, 790 m, 17.viii.1919, Rehn and Hebard, 1 ♂ (ANSP); Panamint Range, Wild Rose Canyon Spring, 1102 m, 6 and 8.ix.1922, Rehn and Hebard, 3 ♂, 4 ♀ (ANSP). Modoc Co., Warner Mts., Cedar Peak, 1920–2190 m, 22.viii.1922, Rehn and Hebard, 3 ♂, 4 ♀ (ANSP); Cedar Peak, Stowe Reservoir Camp, 2130–2440 m, 18.vii.1968, D. C. Rentz, 2 ♂ (CAS); near Cedar Pass, 1830 m, 25.vii.1962, D. C. Rentz, C. D. MacNeill, 1 ♂ (CAS); Cedar Pass Camp, 28.viii.1965, D. C. Rentz, Stop 32, 2 ♂, 1 ♀ (CAS); San Bernardino Co., Trona, 500–550 m, 5 and 9.ix.1922, Rehn and Hebard, 4 ♂, 1 ♀ (ANSP).

Remarks.—At Silver Canyon, *T. leucophaea* was found on the valley floor and on gentle talus slopes covered with scattered vegetation. Individuals flew 2 to 10 m close to the ground and were easy to catch. Male crepitation was a crackle, softer than that of *T. cyaneipennis* (DBW, personal observation, Zion National Park, Utah; Hebard, 1935; Strohecker et al., 1968). Individuals from Westgard Pass and Cedar Peak were found in dry arroyos and on rocky slopes. Two specimens collected on 6 August 1978 from the Westgard Pass area were both teneral. In August of both 1978 and 1982, DBW was unable to find adults on the west side of Westgard Pass, although the 1982 Silver Canyon adults were not teneral.

T. leucophaea occurs with *Circotettix undulatus* (Thomas) at both Westgard Pass and Silver Canyon, although the latter is usually on steeper slopes. At Silver Canyon, *T. p. pallidipennis* was intermingled with *T. leucophaea.*

T. leucophaea is presently known only from the mountains of eastern California. Most California specimens considered previously (Strohecker et al., 1968) to be *T. cyaneipennis* are *T. leucophaea.* The occurrence of *T. cyaneipennis* in California is now uncertain. Strohecker et al. (1968) listed the Westgard Pass records of this species under *T. sparsa.*

Only material from the White Mountains has been examined cytologically—they all have 2N ♂ = 23 with inversion heterozygosity similar to that reported for *T. cyaneipennis,* also a member of Section B. The latter species, though, has 2N ♂ = 23 only in central New Mexico (White, 1951) whereas farther west it has 2N ♂ = 21: western New Mexico (White, 1951), Arizona (King, 1923), Nevada (White, 1949—one population only some 100 km from Westgard Pass), and southeastern Oregon (Weissman and Rentz, 1980).

The name is derived from leucophaeus, meaning grey or ash-colored.

***Trimerotropis whitei,* NEW SPECIES**

(Figs. 1, 6)

Recognition characters.—Species rusty brown in overall coloration with yellow hind tibia and wings, and telocentric chromosomes. Similar to *T. arenacea* Rehn but differs in having a brighter yellow disk and yellow instead of blue hind tibia. Also similar to *T. citrina* Scudder and *T. agrestis* McNeill but smaller and without red hind tibia.

Geographic distribution (Fig. 1).—Known only from pink sandy substrate areas of Kane County, Utah.

Holotype male.—"Utah, Kane Co., Zion National Park, 2.6 km W. of Park's E boundary on road through Park. 1646 m, 21.viii.82. D. B. Weissman #82-82, Cal. Acad. Sci. Coll." Holotype in California Academy of Sciences, No. 14160.

Description.—See Table 1 for measurements. Head narrow, frontal carinae heavy, extending to fronto-clypeal suture; sulcus deep; fastigium of vertex narrow, lateral carinae strong, extending beyond middle of eye; median carina indicated solely by color; occiput with a pair of shallow indentations. Pronotum with lateral carinae very feebly indicated on prozona, distinct on metazona; transverse sulci continuous, deep; median carina distinct, higher on prozona than mesozona, low on metazona; surface evenly punctate; ventral margin of lateral lobe without a tooth (Fig. 6). Tegmina elongate, narrow, extending for a distance of about ⅓ its length beyond apex of hind tibia. Ventral surface of thorax not setose, legs sparsely setose. Thorax and tegmina rusty brown with whitish blotches on sides; head speckled whitish brown; antenna reddish brown with distinct whitish annuli. Tegmina lightly banded, the distal band not much more than a coalescence of speckles; wing yellow, not highly opaque; black band narrow, continuous. Outer pagina of hind femur with 2 very faint brown bands; internal pagina with 3 yellowish blotches separated by 2 narrow, brown bands; hind tibia uniformly pale lemon yellow.

Karyotype.—2N ♂ = 23; Section A; all telocentric, 4 large, 5 medium, 2 small autosomes. Individuals examined: type locality, 6 ♂.

Specimens examined.—Utah, Kane Co.: Zion National Park, 2.6 km W of Park's E boundary on road through Park, 1646 m, 21.viii.1982, D. B. Weissman, 12 ♂, 3 ♀, including holotype (CAS): 16 km NW Kanab on Hywy 89, 1737 m, 21.viii.1982, D. B. Weissman, 1 ♀ (CAS); Sand Dunes 16 km NW Kanab, 2.viii.1951, M. J. D. White, 7 ♂, 2 ♀ (ANSP); Kanab, 5.viii.1949, G. F. Knowlton, 1 ♂, 1 ♀ (ANSP); Pink Sandhills 40 km SE Mt. Carmel Junction, 1950 m, 22.viii.1956, no collector, 1 ♀ (ANSP); Pink Sandhills, road between Virgin River and Three Lakes, 1752 m, 1.ix.1926, Rehn and Hebard, 18 ♂, 11 ♀ (ANSP).

Remarks.—Vegetation at the type locality included *Manzanita,* pines, and other shrubs. Although known only from pinkish sands, and despite having a pink hued body, alighted specimens were conspicuous at the type locality. Flights by both sexes were low, usually less than 2 m but occasionally to 5 m. Crepitation by both sexes was a loud buzz made during most of flight. Individuals were easy to catch. One individual at each 1982 locality was teneral. Sympatric oedipods included *T. cyaneipennis, Circotettix rabula* Rehn and Hebard, and *T. texana* (Bruner).

This species is named in honor of Prof. M. J. D. White who has been interested in the cytological characteristics of *Trimerotropis* for over 35 years, and who recognized this as an undescribed species when he collected it.

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V. F. Lee and C. Mullinex helped at the California Academy of Sciences; D. C. Lightfoot and S. I. Weissman assisted in fieldwork; and T. J. Cohn and D. Otte provided useful discussion. Financial assistance was provided to DBW by American Philosophical Society, Explorers Club, and Sigma Xi. The California Academy of Sciences is thanked for their usual generous use of facilities.

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Contributions to Nearctic Psychodidae (Diptera, Nematocera)

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Since Quate's comprehensive work on Nearctic Psychodidae was published in 1955, only a few other publications have dealt with this interesting group of Diptera (Quate, 1957, 1960a, 1960b, 1960c; Vaillant, 1959, 1963, 1968, 1973; Wagner, 1980). Quate's drawings simplify very often the complicated structure of the male genitalia, which has lead to unnecessary synonymies by subsequent authors.

In the present paper, I recognize a new synonymy, describe two new species and one new subgenus of Nearctic Psychodidae.

Threticus bicolor (Banks)
(Figs. 1–4)

Psychoda bicolor Banks, 1894, Can. Ent., 26:333.

Psychoda nigra Dyar (nec Banks), 1928, Proc. Ent. Soc. Wash., 30:87. (Synonymy after del Rosario, 1936:116.)

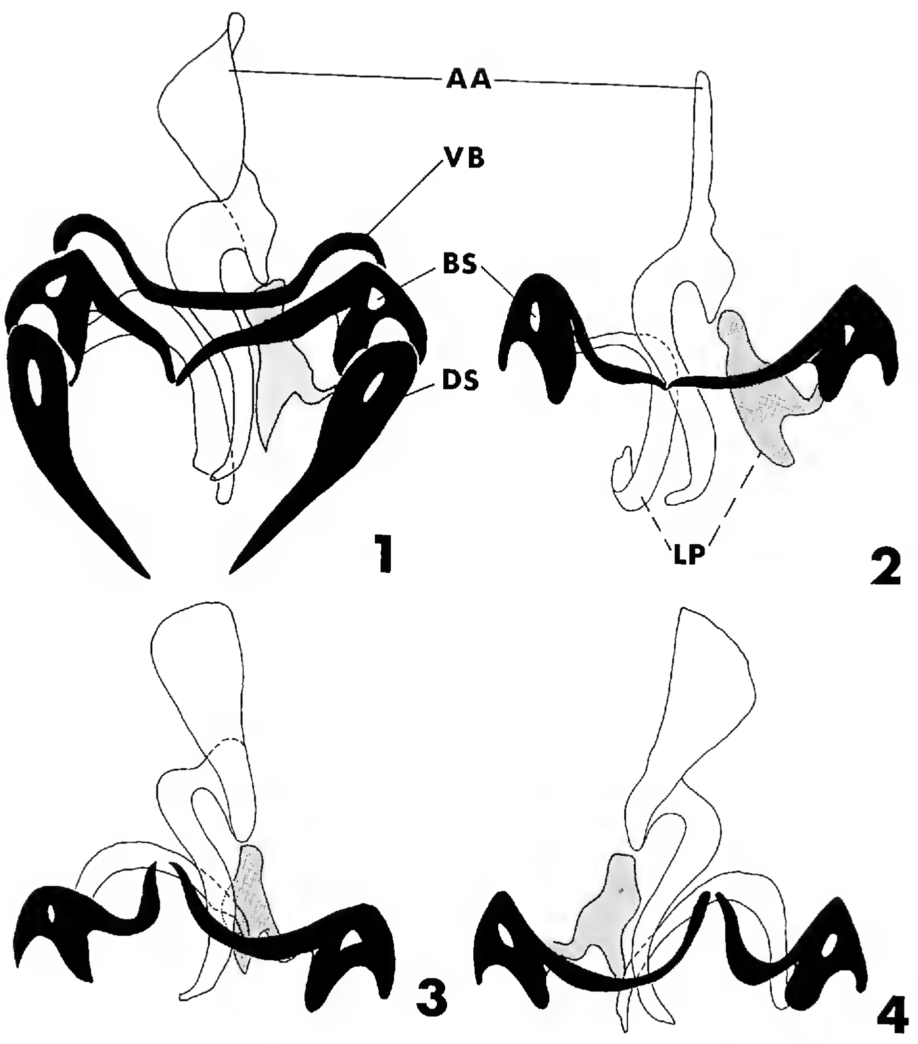
Threticus appalachicus Vaillant, 1973, Ann. Soc. Ent. Fr. (N.S.), 9(1):355. **New synonymy.**

Material.—1 ♂, U.S.N.M. type no. 4308, New York; 1 ♂, Erie County, Travis Run, 4-VI-1980; 1 ♂, Erie County, 4-mile Ck., 25-VIII-1980; 1 ♂, Erie County, 4-mile Ck., 4-IX-1980, and 8 further specimens from Erie County, 6-mile Ck., 4-mile Ck., from June–August 1981, all leg. E. Masteller.

This species is easy to distinguish from other Nearctic Psychodidae by the extremely long inner prolongations of the basistyles, and the strong laterally compressed basal part of the aedeagus. Quate (1955), and Vaillant (1973) both have presented drawings of the male genitalia, but only the latter is adequate. Quate simplified the very complicated build especially of the aedeagus, which is shown very well by Vaillant (1973:353, 356).

This species has an asymmetric aedeagus, and as mentioned by Wagner (1979) in species with asymmetric genitalia two sorts of males appear to be equally abundant, whose genitalia are mirror symmetric. This happens also in *Threticus bicolor* (Banks) (compare especially Figs. 3 and 4).

Quate (1957) placed *Psychoda bicolor* Banks in the genus *Threticus* Eaton, but the genitalia show some specialized features, which are not found in the European species. The basistyles have long flexible inner appendages. Their positions differ according to a more or less extruded condition of the aedeagus (Figs. 1–4). The two lateral parts (right one rastered) are laterally joined with the basistyles and are also movable. Figure 1 shows the most everted, Figure 2 an intermedial, and Figure 3 the most inverted position of the aedeagus.



Figures 1–4. *Threticus bicolor* (Banks), structure and function of genitalia. 1. Extruded position. 2. Intermedial position. 3. Inverted position of the aedeagus. 4. Mirror symmetric genitalia. AA = aedeagus apodeme. BS = basistyle. DS = dististyle. LP = lateral parts of aedeagus. VB and DS omitted in Figures 2–4.

Genus *Stupkaiella* Vaillant

Stupkaiella Vaillant, 1973, Ann. Soc. Ent. France (N.S.), 9(1):367.

Type-species.—*S. furcata* Vaillant, by original designation.

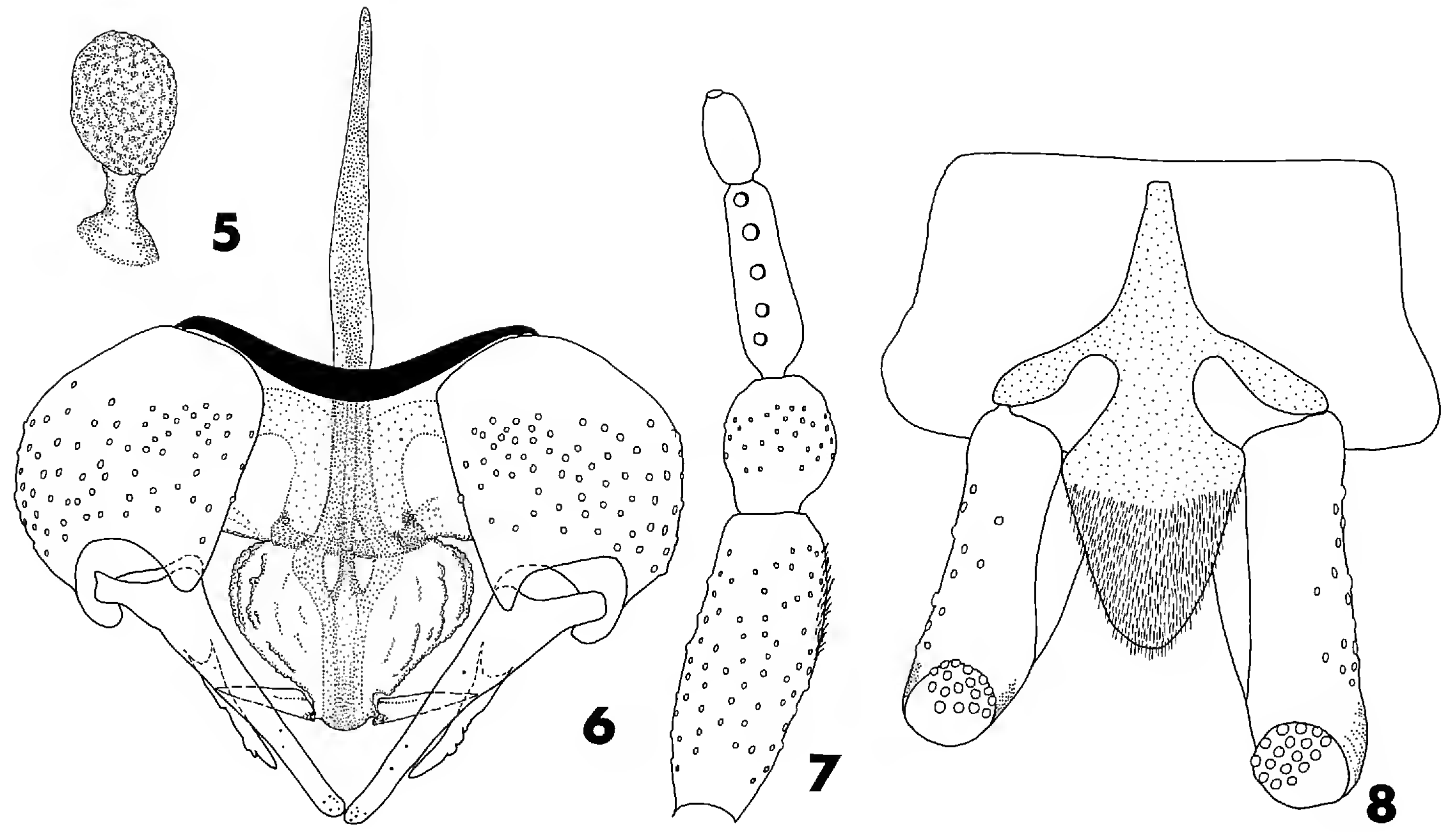
The generic description given by Vaillant (l.c.) lists the absence of sensory organs on the thorax (patagiae, tegulae). I can confirm Quate's observations (1955) that at least *S. kincaidi* (Quate), *S. bessophila* (Quate), and *S. mastelleri,* n. sp. have small patagiae.

Stupkaiella masterelli, New Species

(Figs. 5–8)

Material.—Holotype, ♂, Erie County, 4-mile-Ck., Behrend Campus, 2-V-1980 (located in C.A.S.); paratype, ♂, Erie County, 6-mile-Ck., 12-V-1980 (in my collection); further material, about 20 males, 4-mile-Ck. and 6-mile-Ck., May–June 1980, all leg. E. Masteller, to whom the species is dedicated.

Description.—Head: Eye bridge consists of 4 rows of facets, distance between the eyes 3 facet diameters, interocular suture U-shaped; 6 postocular bristles behind each eye. Antennae 16-segmented; scape elongate cylindric, 2.5 times longer than wide and 2.5 times longer than the spherical pedicel; post-pedicel



Figures 5–8. *Stupkaiella mastelleri,* n. sp. 5. Patagium. 6. Ventral bridge, styles, and aedeagus ventral view. 7. Antennal segments 1–4. 8. 9th tergite and cercopodia ventral view.

elongate, bearing 5–6 strong bristles; 16th segment with a thin eccentric tip; segments 7–14 with a pair of short simple ascoids. Length ratio of the basal antennal segments: 62–23–38–15. Length ratio of palpal segments: 40–62–64–82.

Prothorax with a pair of small spherical patagia. Wing length 2.8–3.0 mm. M_2 with a basal peduncle. Medial angle: 145°.

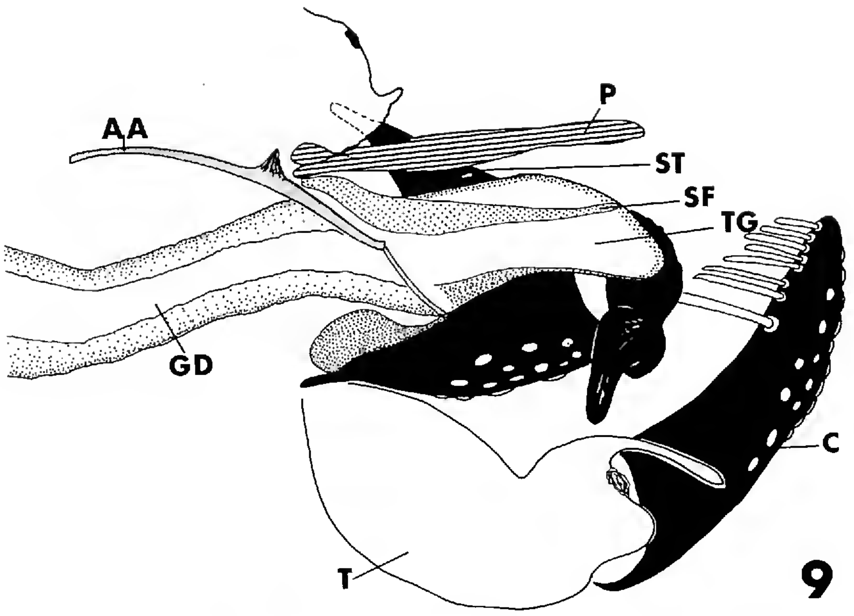
Sternal bridge regularly curved, of equal width throughout. Basistyles with straight medial and semicircular lateral margins. Diststyles forked. In ventral view the dorsal branch is much shorter than the ventral one. Cercopodia strongly bent with 15 slightly frazzeled tenacula. Ninth tergite 2 times wider than long. Aedeagus with a long narrow spatula distally with two triangular spines, which are homologous to the inner lamellae of Palaearctic Pericomini.

Relations.—*S. mastelleri,* n. sp. is a close relative of *S. recurrens* Vaillant, from Great Smoky Mountains National Park. The shape of the aedeagus and of the diststyles readily distinguish the two species.

***Parapanimerus,* New Subgenus**

A number of Nearctic species presently included in *Telmatoscopus* Eaton are in fact not members of that genus, but of *Panimerus* Eaton, in which species of the group of *Telmatoscopus basalis* form a distinct subgenus, *Parapanimerus* new subgenus.

Description.—Imago ♂: Eyes separated by a distance of 1–2 facet diameters. Eye bridge consists of 4 rows of facets. Antennae of 16 segments. Scape elongate cylindric, 1.5–2 times longer than the spherical pedicel. Flagellar segments flask-shaped, the 16th segment is always the longest. About 35–40 simple short ascoids on each flagellar segment. Head with a pair of flatspread sensory organs (cornicula),



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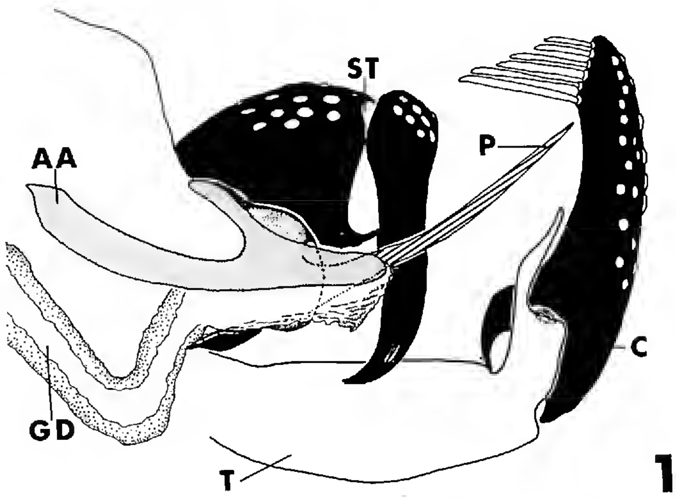

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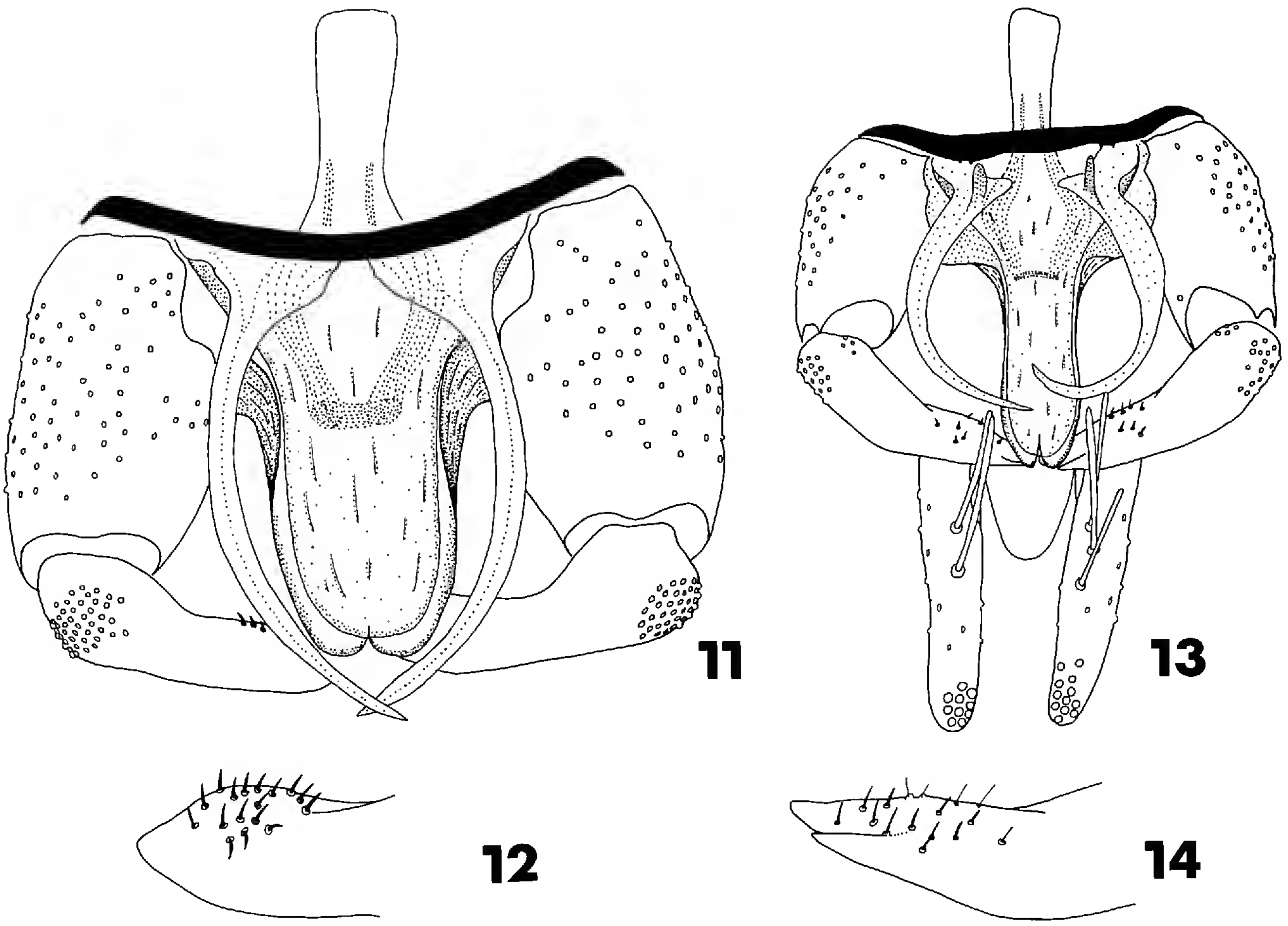
Figures 9, 10. 9. Sagittal sections of genitalia of *Panimerus* (*Parapanimerus*) *basalis*. 10. *Panimerus* (s. str.) *goetghebueri*. AA = aedeagus apodeme. GD = gonoduct. T = 9th tergite. ST = styles. C = cercopodia. P = parameres. TG = tub-shaped tegmen. SF = slightly sclerotized flap.

which are normally carried between head and prothorax, and are everted only during premating ceremonies.

Thorax: Front femora with a double row of 10–20 large bristles on the posterior face. Wing of normal size and shape, radial fork closer to wing base than medial fork. Head (without cornicula and antennae), thorax, and a more or less extended area of the wing base are covered with black setae (androconia).

Genitalia have often been compared with those of Palaearctic *Panimerus* (sensu stricto), (Figs. 9, 10), but their structure is different. The aedeagus apodem is Y-shaped with two short distal parts, which surround the distal part of the gonoduct. The bases of the parameres are close together and are medially linked with the apodeme. They are placed very much towards the ventral side of the basistyles. In contrast, in Palaearctic *Panimerus* they are laterally linked with the tips of the apodeme, and they are placed near the dorsal side of the basistyles. The distal part of the aedeagus (tegmen) is tubshaped, and covered by a thin slightly sclerotized flap (possibly a distal closing mechanism of the gonoduct). Styles simple, 9th tergite rectangular, wider than long, cercopodia slightly curved or straight with at least 10 tenacula, which often are distributed over the distal half of the



Figures 11–14. 11, 12. *Panimerus* (*Parapanimerus*) *basalis* (Banks). 11. Ventral bridge, styles, and aedeagus, ventral view. 12. Tip of dististyle. 13, 14. *P. (Parapanimerus) arnaudi,* n. sp. 13. Genitalia, ventral view. 14. Tip of dististyle.

cercopodia. In contrast, Palaearctic *Panimerus* do not have a tub-shaped tegmen, and they have no slightly sclerotized flap.

♀.—Similar to the males. They do not have androconia, cornicula, and spines on femore I. The antennal segments each bear a pair of ascoids, which are either simple or have 2 or 3 short branches, differing in single specimens from segment to segment.

No larvae and pupae of this genus have been described yet. The larva of "*Panimerus*" *lucens* Vaillant (1973:352), belongs to a species close to *Telmatoscopus quadripunctatus* (Banks), and may possibly be closer related to Palaearctic *Mormia* species (Vaillant, pers. comm.).

Type-species.—Psychoda basalis Banks, 1907, Proc. Ent. Soc. Wash., 8:150 (by present designation). Aedeagus and styles in Figures 11, 12.

Further species included in *Panimerus* subgenus *Parapanimerus*: *Panimerus scalus* (Haseman), **New Combination**; *Panimerus dysmica* (Quate), **New Combination**; *Panimerus cio* (Quate), **New Combination**; *Panimerus sierra* (Quate), **New Combination**; *Panimerus arnaudi,* **New Species**.

***Panimerus (Parapanimerus) arnaudi,* New Species**

(Figs. 13, 14)

Material.—Holotype, ♂, North Carolina, Cumberland County, Fort Bragg, 14-V-1967, leg. Jim D. Birchim.

Etymology.—Dedicated to Dr. P. H. Arnaud, San Francisco, who made the CAS collection available to me.

Description.—Head: Eye bridge consists of 4 rows of facets. Distance between the eyes, 1.5 facet diameters. Scape twice as long as broad, and twice as long as the spherical pedicel. Flagellar segments flask-shaped, each with about 40 simple short ascoids. A pair of cornicula present. Length ratio of palpus segments: 28–54–55–60.

Thorax: Femora I with double row of 5–7 spines. Wing length 1.5 mm, basally with black anoconia. Medial angle 195°.

Genitalia: 9th tergite wider than long. Cercopodia straight, with 12 tenacula distally, and 3 single tenacula in the middle of the cercopodia. Ventral bridge slightly sclerotized with two pairs of tiny tips laterally, near the bases of the parameres. Basistyles two times longer than wide. Dististyles slightly bent, with two short tips (Fig. 14). Parameres strongly bent medially. Tegmen (tub-shaped structure) slender with parallel sides and a distal incision. Aedeagus apodeme small, short, and slender.

Relations.—*P. arnaudi,* n. sp. is the closest relative of *P. basalis* (Banks). However, both species differ from the western Nearctic species with converging lateral margins of the tegmen, in having a tegmen with parallel sides. *P. arnaudi* is separated from *P. basalis* by the parameres, which are much more curved in *P. arnaudi,* and by the dististyles, which have an entire tip in *P. basalis.*

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Scientific Note

Wasps on *Agave* Flowers in Mexico

Although bats are the principal pollinators of *Agave* (Agavaceae) in the American Southwest and Mexico (e.g., Howell and Roth, 1981, Ecology, 62:1–7), a variety of insects, including bees and wasps also visit the flowers for pollen and nectar (Schaffer and Schaffer, 1979, Ecology, 60:1051–1069; Schaffer et al., 1979, Ecology, 60:976–987). Peak periods of visits to *Agave* flowers coincide with periods of peak nectar and pollen availability (Schaffer et al., 1979, Ecology, 60: 976–987). In this note I report some observations on wasp associations with *Agave* flowers at Mazatlan, State of Sinaloa, Mexico, 12–14 November 1979.

A single inflorescence, about 2 meters tall, bearing several panicles with flowers in various stages of development, formed the basis of these observations. I noticed that the vivid yellow flowers were visited heavily at various hours of the day by at least three different kinds of large-bodied wasps. Very few other kinds of insects were seen. I checked the flowers usually at 800, 1200, and 1600 hours on each of three days, and made a small reference collection of wasps seen. For each of the time periods, I saw from 0 to 7 wasps on the flowers, with the most commonly observed species being *Polistes* (*Onerarius*) *carnifex* (F.) (Hymenoptera: Vespidae). I saw from 1 to 4 individuals of this large wasp at various places in the flower, including head-downward at the base. Another, less abundant visitor was *Polistes* (*Aphanilopterus*) *instabilis* de Saussere (also Vespidae). An unidentified sphecid, probably subfamily Sphecinae, tribe Sceliphronini, was also seen at the flowers. Typically these wasps positioned themselves in various ways on the flower, but generally did not come into contact with the anthers. They were feeding primarily on the viscous nectar at the base of each flower.

The frequent occurrence of wasps on flowers in various stages of development suggests that these insects may be nectar thieves, contributing to a reduction in the amount of potential reward for pollinators. Such an effect could be additive if flowers are not pollinated the night before such thieving by wasps takes place. Daytime thieving may also deprive other kinds of pollinators of nectar. Very likely the wasps, being eusocial in the sense of Wilson (The Insect Societies, Harvard, 1971), make repeated visits to an *Agave* inflorescence once it is discovered. Such behavior increases the impact of these insects, as nectar thieves, on the plant-pollinator interaction.

I thank the Milwaukee Public Museum for support, and Dr. Robert L. Jeanne for the determinations of the wasps.

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A New Classification of the Subfamily Ephemerellinae and the Description of a New Genus

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A single female nymph collected in central Idaho represents an undescribed genus and species.

Caurinella Allen, NEW GENUS

Nymph.—Head without tubercles, and without frontal or occipital projections; head with long setae around lateral and ventral margins of head, above mouthparts; maxillary palpi two-segmented. Thoracic nota without tubercles or protuberances. Abdominal terga without paired dorsal abdominal tubercles; postero-lateral projections on segment nine 50% longer than length of segment at midline, and postero-lateral projections upturned at apices.

Type species.—*Caurinella idahoensis* Allen, **New Species**.

Remarks.—The nymph of this new taxon is not similar morphologically, to any of the other known genera in the subfamily, but it does have some characters in common with the genus *Serratella.* The nymphs of both are without tubercles or projections on the head and thorax, they both possess well developed spines on the femora, and they both have a reduced maxillary palpus and long spines on the caudal filaments. The long postero-lateral projection on segment nine is not unique as some or all species of *Torleya, Acerella* and *Cincticostella* have long abdominal projections. The upturned apices of the postero-lateral projections of segment nine and the row of long setae around the head are characters which are unique to *Caurinella.*

Caurinella idahoensis Allen, NEW SPECIES

Nymph.—Length: body 4.0 mm; caudal filaments 3.0 mm. General color light brown. Head light brown; maxillary palpi 2-segmented. Thoracic nota light brown with irregular brown markings; legs light brown; femora with dorsal spines and ventral setae; dorsal spines set in elevated sockets; claws with 3–4 small denticles. Abdomen light brown, median area terga 5–7 brown; imbricated gills terga 3–7 unusually small; postero-lateral projections segments 4–9, small on 4 and increasing in length posteriorly; postero-lateral projection segment 9 more than 50% longer than segment length at midline and postero-lateral projections turned upward at apices. Caudal filaments light brown with spines and sparse setae.

Holotype.—Female nymph, Bushy Creek, trib. Lochsa River (between Lolo Pass and Powell Ranger Sta.), Idaho Co., Idaho, 26-VI-80, Bill Platt et al., in collection California Academy of Sciences, San Francisco.

Classification.—In 1980, Allen divided the subfamily Ephemerellinae into 2 tribes, 14 genera and 10 subgenera, and he placed the genus *Vietnamella* Tshernova as a subgenus of *Cincticostella* Allen. This synonymy is incorrect. *Vietnamella* is known only from the nymphal stage and the nymphs differ from those of *Cincticostella,* and all other Ephemerellinae, in the number and placement of the dorsal abdominal gills. The nymphs of *Vietnamella* have six pairs of lamellate gills on segments 2–7, eleven other genera, including *Cincticostella,* have five pairs of lamellate gills on segments 3–7, and four genera have four pairs of lamellate gills on segments 4–7.

I apply the philosophy used in the separation of subgenera in the Ephemerellinae, and herein erect subtribes in the tribe Ephemerellini which will eliminate the necessity of referring to these nymphs as "those with gills on segments 3–7" or "those with gills on segments 4–7". I propose the name EPHEMERELLAE for those genera with nymphal gills on abdominal segments 3–7, the name TIMPANOGAE for those genera with nymphal gills on segments 4–7, and the name VIETNAMELLAE for the genus *Vietnamella* with nymphal gills on segments 2–7.

The subfamily Ephemerellinae is now divided into 2 tribes, 3 subtribes, 17 genera, and 9 subgenera as follows:

Tribe Ephemerellini Lameere, 1917
  Subtribe EPHEMERELLAE Allen, **New Subtribe**
    Type Genus. Ephemerella Walsh, 1862
    Nymph. Abdominal terga with five pairs of lamellate gills on segments 3–7.
    Genera and Subgenera

1. *Ephemerella* (=*Chitonophora* Bengtsson, 1908)
2. *Serratella* Edmunds, 1959
3. *Caurinella* Allen, **New Genus**
4. *Uracanthella* Belov, 1979
5. *Torleya* Lestage, 1917
6. *Teloganopsis* Ulmer, 1939
7. *Caudatella* Edmunds, 1959
8. *Drunella* Needham, 1909
    a. *Drunella* s.s.
    b. *Tribrochella* Allen, 1980
    c. *Unirhachella* Allen, 1980
    d. *Myllonella* Allen, 1980
    e. *Eatonella* Needham, 1927
9. *Crinitella* Allen and Edmunds, 1963
10. *Acerella* Allen, 1971
11. *Cincticostella* Allen, 1971
    a. *Cincticostella* s.s.
    b. *Rhionella* Allen, 1980

  Subtribe TIMPANOGAE Allen, **New Subtribe**
    Type Genus. Timpanoga Needham, 1927
    Nymph. Abdominal terga with four pairs of lamellate gills on segments 4–7.
    Genera and subgenera

1. *Attenella* Edmunds 1971 (=*Attenuatella* Edmunds, 1959 *nec* Stehli, 1954)
2. *Eurylophella* Tiensuu, 1935

  - 3. *Dannella* Edmunds, 1959
    - a. *Dannella* s.s.
    - b. *Dentatella* Allen, 1980
  - 4. *Timpanoga*

Subtribe VIETNAMELLAE Allen, **New Subtribe**

Type Genus. Vietnamella Tshernova, 1972

Nymph. Abdominal terga with six pairs of lamellate gills on segments 2–7.

Vietnamella only known genus.

Tribe Hyrtanellini Allen, 1980

Hyrtanella Allen and Edmunds, 1976, only known genus.

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Allen, R. K. 1980. Geographic distribution and reclassification of the subfamily Ephemerellinae (Ephemeroptera: Ephemerellidae). pp. 71–91 *in* J. F. Flannagan and K. E. Marshall (eds.), Advances in Ephemeroptera Biology, Plenum Publ. Corp., N.Y., 552 pp.

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Bionomics of Nearctic Species of *Aclypea* Reitter: Phytophagous "Carrion" Beetles (Coleoptera: Silphidae)

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Abstract.—Diagnoses, distributions, notes on bionomics, and a key for identification are presented for the two Nearctic phytophagous "carrion" beetles *Aclypea opaca* (L.) and *A. bituberosa* (LeC.). A brief discussion of the possible evolutionary history of the genus in the Nearctic region is given.

Recent studies on the biology, distribution and systematics of the Silphidae of Canada and Alaska (Anderson, 1981) have revealed problems concerning the identity and distribution of two Nearctic species of the genus *Aclypea.* The latest reviews (Hatch, 1957; Miller and Peck, 1979) have indicated that two species live in North America; the primarily Palearctic *A. opaca* (L.), 1758, and the Nearctic *A. bituberosa* (LeConte), 1859. Adults of the two species are morphologically very similar. We have found the characters in keys that attempt to separate the species (Arnett, 1944; Hatch, 1927; Horn, 1880; Portevin, 1926) to be vague or imprecise. Thus, there has been a problem in distinguishing them and in accurately documenting their distributions and habits in North America.

Adult *Aclypea* can be recognized by the following generic characters: labrum deeply emarginate, with the inner faces of the emargination swollen; eyes relatively small, and not bounded posteriorly by a row of erect setae. The genus is represented by approximately 27 species, distributed throughout the Holarctic region, some members of which have been previously assigned to the genera *Blitophaga* Reitter and *Silpha* L. (Portevin, 1926; Hatch, 1927, 1928; and others). We use *Aclypea* rather than *Blitophaga* following Seidlitz (1883:311) as first reviser in accordance with article 24 (a) (i) in the International Code of Zoological Nomenclature.

The vast majority of the species are found in the Palearctic region, and no attempt is made here to treat them. We have found that the two Nearctic forms can be distinguished as follows:

1a. Genitalia of both sexes thinly sclerotized (light brown in color); pronotum often with impunctate area on anterior third behind eye; elytra with punctures shallow, the distance behind punctures rarely less than the width of a puncture (Fig. 3); isodiametric microsculpture of pronotum and elytra distinct (Fig. 3); generally smaller in size (12–15 mm). Distribution in Nearctic restricted to Alaska and extreme northwest N.W.T. . . . . *A. opaca* (Linn.)

1b. Genitalia of both sexes thickly sclerotized (dark brown in color); pronotum never with impunctate area behind eye, although other impunctate areas may be present; elytra with punctures deep, the distance between the punctures often less than the width of a puncture (Fig. 4); isodiametric microsculpture usually indistinct (Fig. 4); larger in size (14–17 mm). Widespread in western North America . . . *A. bituberosa* (LeConte)

Aclypea opaca **(Linnaeus), the Beet Carrion Beetle**
(Figs. 1, 3, 5)

Silpha opaca Linnaeus, 1758:361.

Diagnosis.—Color blackish to brown, usually clothed with yellow hairs dorsally. Pronotum with anterior margin usually narrow (Fig. 1), lateral margins not distinctly raised; with occasional impunctate areas present behind eyes. Elytra with punctures shallow, distance between them rarely less than their width (Fig. 3). Isodiametric microsculpture of pronotum and elytra distinct. Genitalia in both sexes thinly sclerotized, light brown in color. Smaller in size, 12–15 mm in length. Synonymies are in Portevin (1926) and Hatch (1928).

Variation.—Variation in this species appears to occur primarily in the pattern of the impunctate areas on the pronotum. Some specimens of *A. opaca* possess impunctate areas on the pronotum in the anterior third directly behind the eyes in addition to other impunctate areas which may be present near the midline. These impunctate areas behind the eyes are not found in *A. bituberosa,* although other impunctate areas may be present.

There is little structural variation in other characters in the material that we have examined.

Distribution.—The species is known to us to occur in North America through very few specimens from Alaska and the Northwest Territories (Fig. 5). It has previously been recorded from various localities in the United States (Horn, 1880; Hatch, 1927), but these appear (based on our re-examination of available specimens) to be misidentifications of *A. bituberosa. Aclypea opaca* also occurs throughout the northern areas of the Palearctic region (Hatch, 1928).

Material examined.—(24 specimens with the following data; abbreviations of collections in Arnett and Samuelson, 1969).

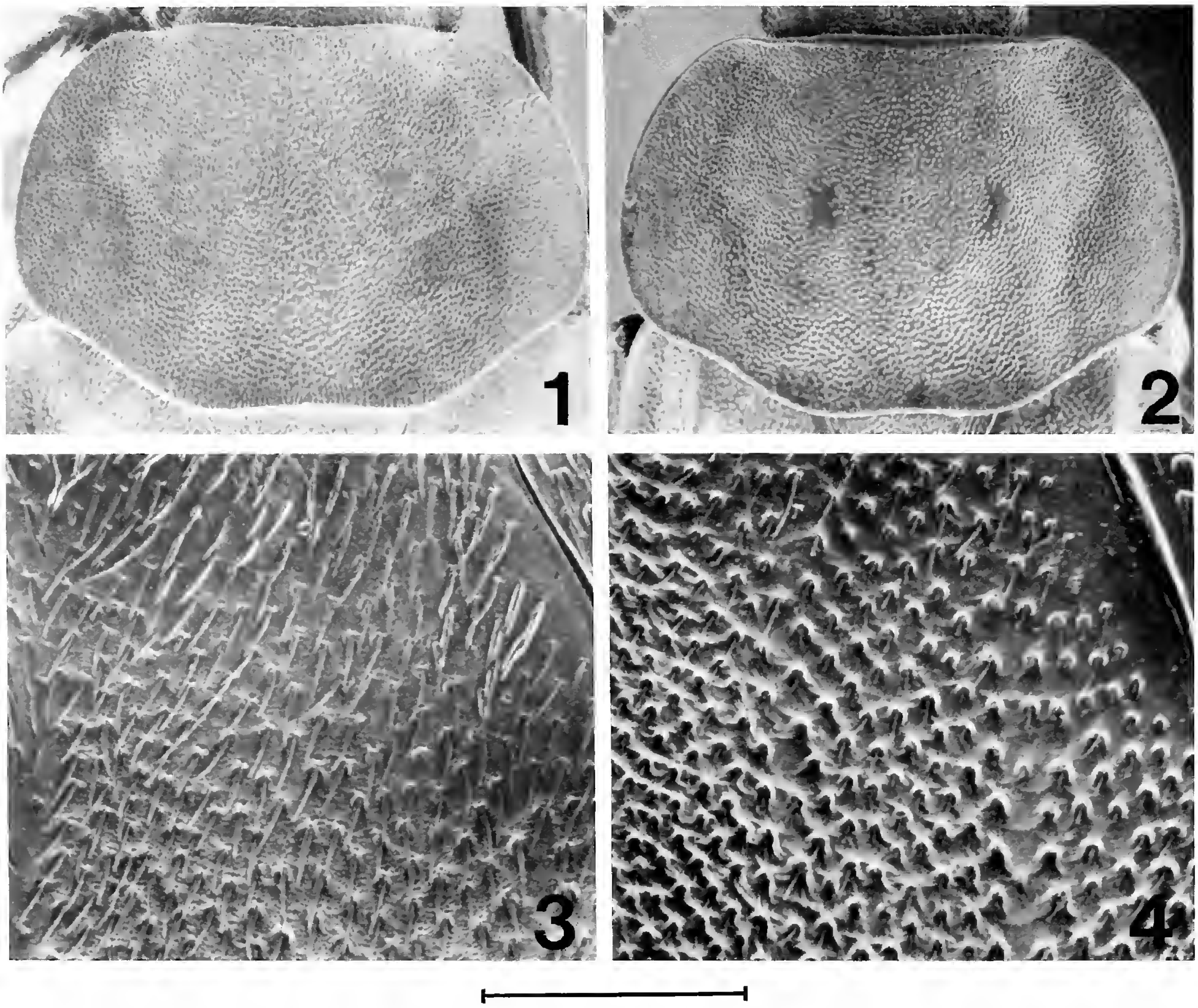
CANADA. *Northwest Territories.* Aklavik, 10.VIII.31, O. Bryant, 1 (CASC).

UNITED STATES. *Alaska.* Circle, 3.VII.58, G. E. Ball, dry field, 1 (UASM); Fairbanks, 26.VI–1.VII.79, B. Wright, 1 (NSMC); Fort Yukon, 17.VI.16, Harrington, 2 under logs (USNM); 11.VI.16, Evans, 1 (USNM); Kussiloff (Kasilof), VII.98, Evans, 1 (USNM); Palmer, 15.VII.79, 1.VI.80, 25.VII.80, 1.VIII.80, 13.VIII.82, 3.IX.82, D. P. Bleicher, baited cone traps 8 (University of Alaska).

OTHER COUNTRIES. 8 specimens from Northern and Central Europe.

Bionomics.—Like other *Aclypea,* the species in Europe is phytophagous on various Chenopodiaceae, and has also been recorded as a pest of sugar beets (Martin, 1945; Heymons et al., 1929).

The natural history has been well documented by Heymons et al. (1929) and Martin (1945) in Europe. According to these authors, adults overwinter and emerge in the spring when the sugar beets are germinating. Larvae appear about two weeks later and feed externally on the young shoots and leaves. When mature, the larvae



Figures 1–4. 1. Dorsal view of pronotum of *Aclypea opaca* (Northwest Territories: Aklavik); scale line = 2.3 mm. 2. Dorsal view of pronotum of *Aclypea bituberosa* (Saskatchewan: Kenosee); scale line = 2.7 mm. 3. Dorsal view of base of left elytron of *Aclypea opaca* (Northwest Territories: Aklavik); scale line = 0.7 mm. 4. Dorsal view of base of left elytron of *Aclypea bituberosa* (Alberta: Calgary); scale line = 0.9 mm.

move into the soil to pupate. Adults emerge 10–15 days later and also feed on the plants, but not as extensively as the larvae.

Although recorded as a pest of sugar beets in North America (Cooley, 1906, 1917; Forbes and Hart, 1900), data presented here make it very likely that these records were misidentifications of *A. bituberosa.* There appears to be no indication that *A. opaca* is a pest of any cultivated crops within the extent of its known distribution in North America. In fact, we know of no reliable data on native host plant relationships in North America.

Our Nearctic records indicate that adults are active from June through August.

Aclypea bituberosa **(LeConte), the Spinach Carrion Beetle**

(Figs. 2, 4, 5)

Silpha bituberosa LeConte, 1859:6.

Diagnosis.—Color blackish to brown, usually clothed with yellow hairs dorsally, although these are often abraded. Pronotum with anterior margin thicker than in

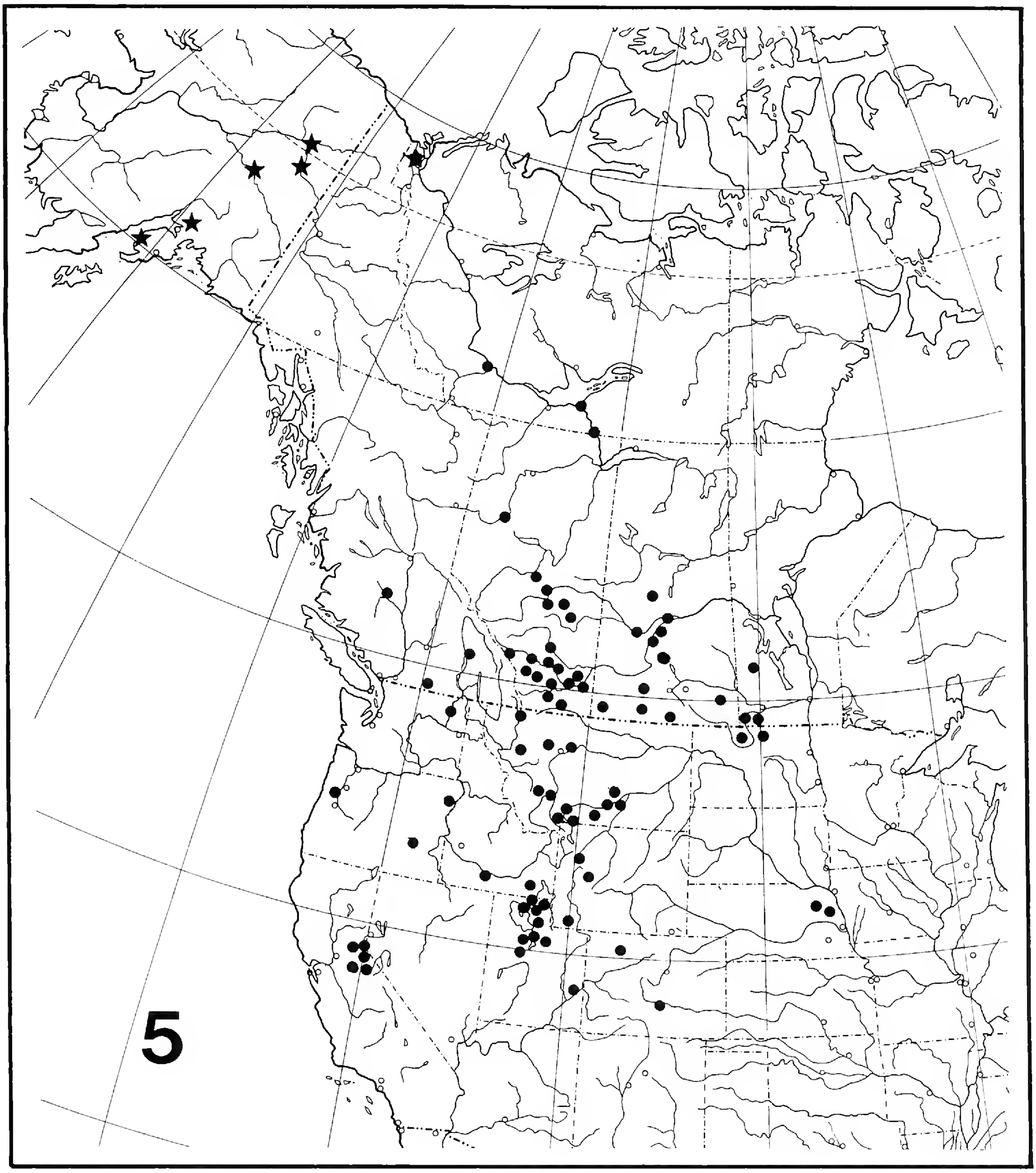


Figure 5. Known distribution of *Aclypea opaca* (stars) and *Aclypea bituberosa* (dots) in North America.

A. opaca (Fig. 2), lateral margins distinctly elevated; with occasional impunctate areas, but not with any behind eyes. Elytra with punctures deep, often confluent, especially towards base (Fig. 4). Microsculpture of pronotum and elytra not distinct. Genitalia in both sexes thickly, darkly sclerotized. Larger in size, 14–17 mm in length.

Variation.—Although all prairie specimens of *A. bituberosa* are structurally similar, examination of the few available specimens of *A. bituberosa* from montane localities indicates a smaller overall size and a much less convex elytra than those from the lowland prairie areas. In these montane forms, the genitalia tend to be as heavily sclerotized as in all other *A. bituberosa.* However, the punctures of the elytra tend to become smaller and shallower, thus approaching the state in *A. opaca.* The punctures at the base of the elytra, although still large and deep, are rarely confluent.

These patterns of morphological variation appear correlated with a change to montane-alpine habitats and may have an ecogenotypic or ecophenotypic basis. Possibly there is a continuous morphocline between the northern *A. opaca* and the southern *A. bituberosa* through these intermediate montane populations. This would indicate probable conspecificity but our collection data presently indicate the existence of a geographic zone where neither species occurs. However, until more representatives of this genus become available from this area (i.e., provided the known distribution is a collecting artifact) we think it best to continue to recognize the two forms as distinct species.

Distribution.—In Canada, the species is found throughout the provinces of Alberta, Saskatchewan and Manitoba, extending northward into the southern Northwest Territories (Fig. 5). It appears to be found primarily in open grassland or prairie habitats, although some specimens have been collected in interior valleys and alpine habitats in British Columbia. In the United States it occurs throughout the northern midwest into the western coastal and Rocky Mountain states.

Material examined.—(278 specimens examined and other literature records.) Only generalized locality and seasonality data (when available) are given here. Full data are available from the authors. Specimen numbers are given only if the record is based on more than one. Material is in the following collections: AMNH, CASC, CDFA, CNCI, DZEC, FMNH, LACM, MCZC, SBPC, UASM, UBCZ, UICM, USNM (abbreviations follow Arnett and Samuelson, 1969); the collections of the Canadian Department of Agriculture at Lethbridge, Saskatoon, and Winnipeg; the Saskatchewan Provincial Museum; the Universities of Manitoba and Saskatchewan; and J. L. Carr collection, Calgary.

CANADA. *Alberta.* Brooks, August, 3. Calahoo, July. Calgary, May, 20; June, 2; July. Diamond City (Farstad, 1949). Drumheller, June. Gorge Creek (50 mi W Calgary), June, 29; July, 23. Grand Prairie, July. High River, April. Holden, May, 3. Hussar, May, 2. Leduc, June. Lethbridge, April, 3; May, 2; June, 2. Medicine Hat, April; May, 6; June, 5. Millarville, May. Ralston, May, 2. Raymond, July, 2. Sherwood Park (suburb of Edmonton), April, 4; May, 5; September. Tilley, June, 3. Viking (MacNay, 1954). *British Columbia.* Chilcotin, April, October. Manning Prov. Park (Nicomen Ridge, 6600′), July. Vernon, May, 2. *Manitoba.* Grandview, May, 3. Lauder, May. *Northwest Territories.* Fort Resolution, June, 2; July. Fort Smith, May, 9; June, 11; July, 21; August, October. Fort Simpson, June, July, August. *Saskatchewan.* Big River, July. Chaplin, July. Dundurn, April. Fort Walsh, July. Gravelbourg, July. Kenosee, June. Moosomin, July. Norbery, May. Prince Albert (MacNay, 1954). Rockglen, July. Rosthern, June, 2. Saskatoon, March, April, May, July, October, November.

UNITED STATES. *California.* Alpine Co., Ebbetts Pass, July; Sonora Pass, June, 2. Eldorado Co., Echo Lake, 7400′; July. Tallac, July. Mono Lake (1880 Horn record, in MCZ). Tuolumne Co., no other data; Yosemite National Park, Mt. Lyell, August (see Miller and Peck, 1979, for full data). *Colorado.* Craig, May, 6200′. Custer Co., no other data. *Idaho.* Buhl, no other data. Downey, June. *Kansas.* No locality, Forbes and Hart (1900); this could be an error resulting from the type collection which was made in Wyoming, then in "Kansas Territory."

Montana. Billings (Cooley, 1912, 1916); April, May. Bozeman, March, 2; April, 2; May, June. Butte, no date. Cartersville, July. Edgar, May, 2. Gallatin Co., April, 4800′; May, 4; June. Glacier Park, no date. Huntley, April, May. Jefferson Co., April, May, 18. Rapelje, October. Ravalli (Pepper, 1951). Teton Co., no date. Yellowstone Park, June. *Nebraska.* Norfolk and West Point (Cooley, 1917). *North Dakota.* Bottineau, June, 3; July. Maxbass, July. *Oregon.* Malheur Lake and Snake River (Hatch, 1957); Alpine, June. *Utah.* Benson, March. Davis Co., May. Hooper, June. Logan, April. Logan Canyon, June. Moab, May. Orme, June. Ogden, May. Petersboro, June. Provo, April, May. Salt Lake City, May. Trenton, June. Vernon, May (most records from McComb and Knowlton, 1950). *Washington.* Okanogan, Slate Peak, 6500′, August. *Wyoming.* Fort Bridger (Holotype 8952 in MCZ). Pinedale (20 mi NE), 10,400′, August, 4. Togwotee Pass, 9600′, August.

Bionomics.—The habits of this species have been well documented by Cooley (1917). Adults and larvae are phytophagous, eating *Chenopodium album* (lamb's quarters, introduced), *Monolepis nuttalliana* (povertyweed) and other native Chenopodiaceae, as well as *Solanum triflorum* (nightshade) (Solanaceae) (Hatch, 1957; Cooley, 1917). They have also been recorded from squash, pumpkin, spinach, beet, wheat, radish, rhubarb, potato, lettuce, cabbage, rapeseed, and turnip (Cooley, 1906, 1916, 1917; MacNay, 1954, 1955; Forbes and Hart, 1900; Farstad, 1949, 1951) and are considered a pest of these crops in some areas. The species is in some North American texts on agricultural entomology (sometimes under the name *Silpha opaca*). We have found adults in montane meadows, where they were crawling along the ground and not in direct association with any single plant species. Adults could probably be collected in meadows and grassland areas by using large pans as unbaited pit traps.

Cooley (1917) has reported on the life cycle of the species in Montana, summarized as follows: Adults emerge very early in the spring, and lay eggs in the soil which hatch about 5 days later. Larvae eat leaves and young shoots of the young plants during the day, hiding in the soil during the night. The first larval instar lasts 5 days, the second also 5 days, and the third about 15 days. Pupation takes place in the soil and the adults emerge about three weeks later. These new adults feed, but do not lay eggs, returning to the soil to overwinter. Other rearing (Forbes and Hart, 1900) found larvae in June and July, with adults emerging in July. The above records show the adults to be active from March through November, with later dates usually being more northerly or at higher elevations.

IMMATURE STAGES

Aclypea larvae are easily distinguished from all other silphine larvae by the presence of a ventral as well as mesal serrate edge on the mandibles (Newton, pers. comm.). The side margins of the tergites, noted as pale by Hatch (1927) and used to distinguish *Aclypea* larvae from other silphine larvae, are black in some of the material that we have seen and hence this character is unreliable.

Third instar larvae of Nearctic *Aclypea* will key to *Heterosilpha ramosa* in Dorsey (1940) but can be distinguished from the latter by the aforementioned mandibular structure and by the following key:

1a. Maxillary apical palpomere approximately three times as long as wide; labial palp with the basal segment 1.5 × the length of the apical segment .... *H. ramosa*

1b. Maxillary apical palpomere approximately 2 × as long as wide; labial palp with the basal and apical segments equal in length . . . . *Aclypea*

We are not presently able to distinguish the larvae of *A. opaca* from *A. bituberosa.* Although larvae and other immature stages of these two have been treated by Cooley (1917), Martin (1945), and Heymons et al. (1928), the descriptions in these papers and the key in Hatch (1927) are insufficient to provide reliable species identifications based on material that we have available.

EVOLUTIONARY CONSIDERATIONS

It has been long thought that *A. opaca* was introduced from Europe, probably with shipments of plants (Hatch, 1927, 1957; Forbes and Hart, 1900) and hence was not a regular member of our fauna. However, the apparent confinement of the species to the extreme northwestern corner of North America, and its widespread distribution in the northern Palearctic region would suggest recent dispersal via a Beringian land bridge connection. The direction of dispersal was probably from the Palearctic to the Nearctic, as it was for many large mammals and some other insects during the Quaternary, and as would be expected of a group whose highest diversity is centered in the Palearctic.

The marked similarity of the two species suggests that they are sister species, descended from a single common ancestor. However, we cannot now demonstrate this by synapomorphies. We suggest that this ancestor originated in the Palearctic and dispersed to the Nearctic across the Bering bridge in the Tertiary or Pleistocene. During a Pleistocene glacial some populations of the ancestor were isolated in localities south of the ice margin, and differentiated into *A. bituberosa.* North and west of the ice margin, in unglaciated refugia in Alaska and the Yukon, *A. opaca* retained intermittent contact with Palearctic conspecifics, or became extinct and has reoccupied the Nearctic in the Recent. The lack of far northern specimens of *A. bituberosa* indicates that it did not survive glaciation in the northern refugia, but only in areas south of the ice sheets. Subsequent reinvasion of previously glaciated land has therefore been from the south, resulting in the present distribution pattern.

Unfortunately, no fossil specimens of *Aclypea* have been recorded in North America which can test these evolutionary hypotheses.[1]

ACKNOWLEDGMENTS

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[1] After this paper had gone to press, a single record of a fossil specimen of *Aclypea* was sent to us by Dr. R. E. Nelson, Colby College, Maine. The specimen was collected from deposits of age 16,640 years BP at Seattle, Washington, and is assignable to *A. bituberosa* based on elytral sculpture and punctation characteristic of that species. This discovery indicates that isolation and structural divergence of *A. bituberosa* did not occur in the glacial advance of the Late Wisconsinan.

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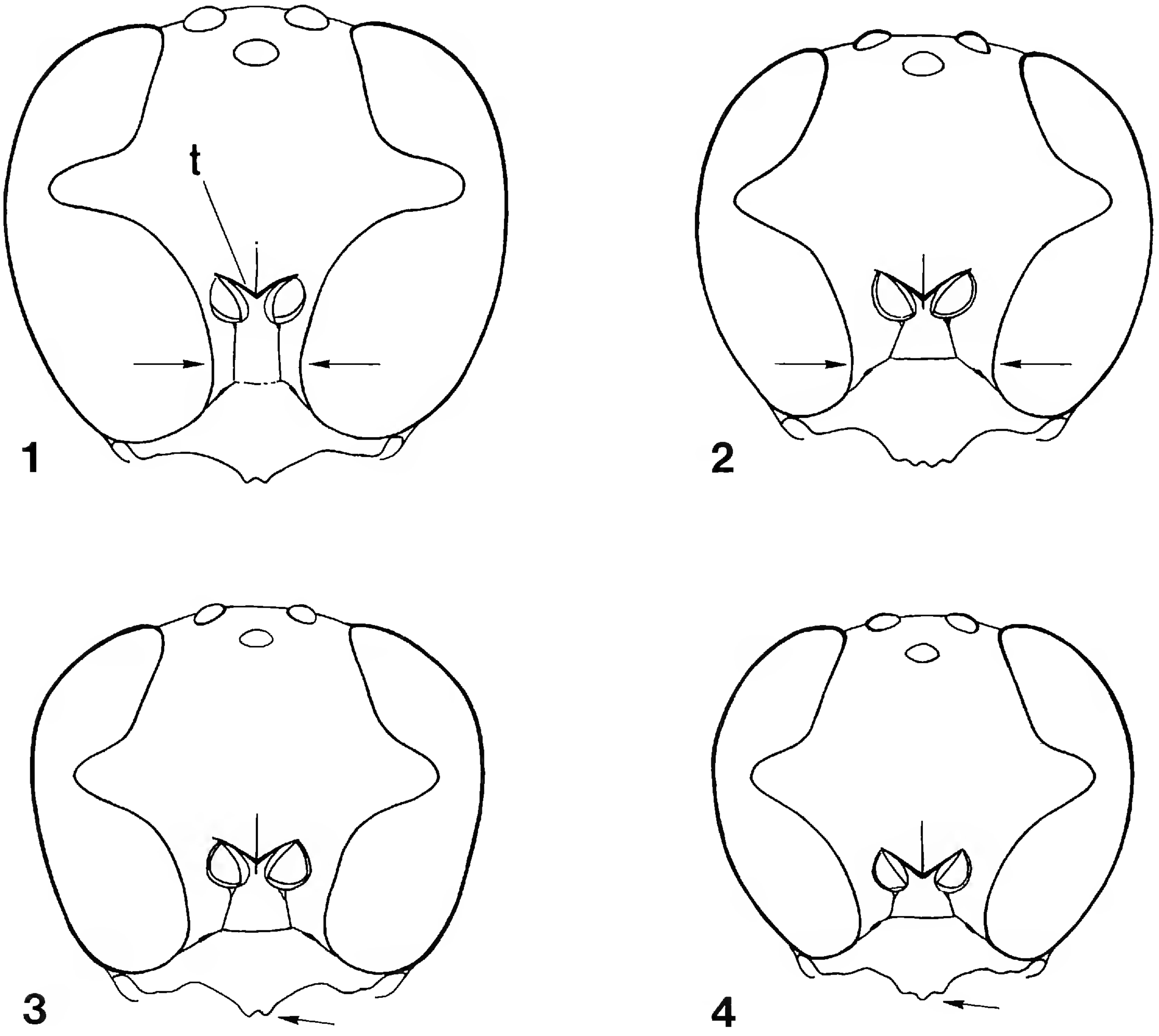
Scientific Note

The Occurrence of *Trypoxylon clavicerum* in North America (Hymenoptera: Sphecidae)

Trypoxylon (*Trypoxylon*) *clavicerum* Lepeletier and Serville is a widespread Palearctic wasp, occurring from Northern Europe to Japan (Bohart and Menke, 1976, Sphecid wasps of the world, University of California Press, 695 pp.). In the course of a systematic study of *Trypoxylon* wasps in North America, I discovered that *T. clavicerum* now occurs in the Great Lakes Region of the United States and Canada. North American specimens were compared with examples of *clavicerum* in the collections of the British Museum of Natural History (London), Oxford University, and the Zoologisk Museum (Copenhagen). No differences between the North American and European specimens were found.



Figures 1–4. 1. Head of female *Trypoxylon clavicerum* showing the width of the face (arrows) below the transverse interantennal carina (t). 2. Head of female *T. kolazyi* showing width of face (arrows). 3. Head of male *T. clavicerum* showing the two minute medial teeth (arrow) on the clypeal apex. 4. Head of male *T. kolazyi* showing the single medial tooth (arrow) on the clypeal apex.

Trypoxylon clavicerum is probably a recent introduction into North America. The oldest record is a female specimen from Van Buren Co., Michigan, taken on 11 June 1949. Specimens had been collected in Indiana, Ontario, Pennsylvania, and several counties in Michigan by 1962.

In the most recent key to the Nearctic species in the subgenus *Trypoxylon* (Sandhouse, 1940, Am. Midl. Nat., 24:133–174) *T. clavicerum* keys out to *T. backi* Sandhouse, a junior synonym of *T. kolazyi* Kohl (see Krombein, 1979, *in* Krombein et al., Cat. Hymen. Am. N. Mex., Vol. 2, Apocrita (Aculeata), p. 1644). *Trypoxylon clavicerum* is easily confused with *T. kolazyi.* In females the face below the transverse interantennal carina is much more narrow in *T. clavicerum* (Fig. 1) than in *T. kolazyi* (Fig. 2). In males the clypeal apex of *T. clavicerum* has two minute medial teeth (Fig. 3), whereas the clypeal apex of *T. kolazyi* has a small medial tooth with an even smaller tooth or angulation on each side (Fig. 4).

Specimens of T. clavicerum *examined.*—CANADA. *Ontario.* 1 ♂ London, VI-1957, N. R. Couling (Canadian National Collection, Ottawa = CNC); 2 ♀ Guild (?), 6 and 14-VII-1962 (CNC). UNITED STATES. *Indiana.* Hamilton Co.: 1 ♀ Cicero, 10-VII-1954, J. M. Kingsolver (Illinois State Natural History Survey). *Michigan.* Branch Co.: 1 ♂ 4-VII-1972, T. A. Bowling (Michigan State University = MSU). Calhoun Co.: 12 ♂ Tekonsha, 2-VII-1972, T. A. Bowling (MSU). Clare Co.: 1 ♀ 23/28-VII-1959, R. R. Dreisbach (MSU). Gladwin Co.: 1 ♀ 28/30-VII-1959, R. R. Dreisbach (MSU). Ingham Co.: 1 ♂ East Lansing, 30-VIII-1960, G. Eickwort (MSU). Iosco Co.: 24 ♂, 7 ♀ Tawas City, 8-VII-1973, I. J. Cantrall (University of Michigan). Kalamazoo Co.: Gull Lake Biol. Sta., 1 ♀ 2-VII-1956, 1 ♂ 2-VII-1957, 6 ♂, 5 ♀ 1-VII/27-VIII-1958, 23 ♂, 2 ♀ 28-VI-1961, 1 ♂ 1 ♀ 26-VI/11-VII-1965, 1 ♀ 9-VII-1970, R. L. Fischer (MSU). Midland Co.: 1 ♀ 17-IX-1958, 1 ♀ 12/16-VII-1960, R. R. Dreisbach (MSU). Saginaw Co.: 7 ♂, 16 ♀ St. Charles, 28-V/16-VIII-1969, rotary trap at ground level-12 ft height, J. G. Truchan (MSU). Van Buren Co.: 1 ♀ 11-VI-1949, Royji Namda (MSU). *Pennsylvania.* Erie Co.: 1 ♂ 2 ♀ Presque Isle St. Pk., 15/20-VII-1961, F. E. Kurczewski (Museum of Comparative Zoology, Harvard).

Rollin E. Coville, *Division of Entomology and Parasitology, 201 Wellman Hall, University of California, Berkeley, California 94720.*

PAN-PACIFIC ENTOMOLOGIST
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Neosminthurus bellingeri, a New Species from California (Collembola: Sminthuridae)[1]

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Abstract.—A new species, *Neosminthurus bellingeri* Muzzio, is described from a survey of Collembola taken at Grover Gulch, near Bates Creek in Santa Cruz County, California. This was the first time a member of this genus has been collected on the West Coast. Some characteristics which separate it from other members of the genus are the presence of ventral dental setae, absence of posterior finger-like process on meso- and metafemora, weak subsegmentation on fourth antennal segment and six cylindrical setae on the posterior margin of head.

A systematic and ecological study of Collembola was taken from April 1980 through April 1981. The study area was located approximately three miles north-northeast from Soquel, in Grover Gulch near Bates Creek, in the Santa Cruz Mountains, California. Sampled areas were fairly remote from human habitation. During the survey a new and undescribed species of *Neosminthurus* was discovered. The purpose of this paper is to describe that new species.

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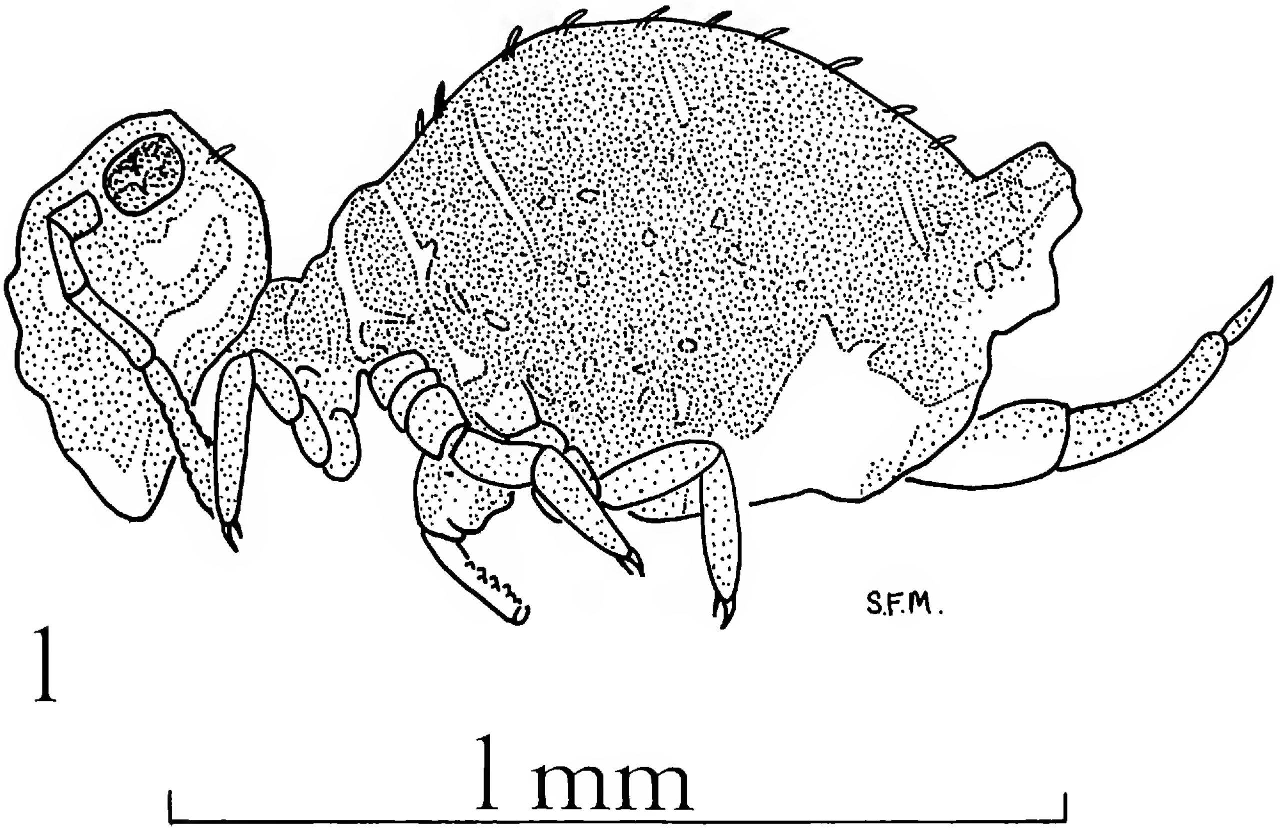

Figure 1. *Neosminthurus bellingeri*, n. sp. lateral view, habitus.

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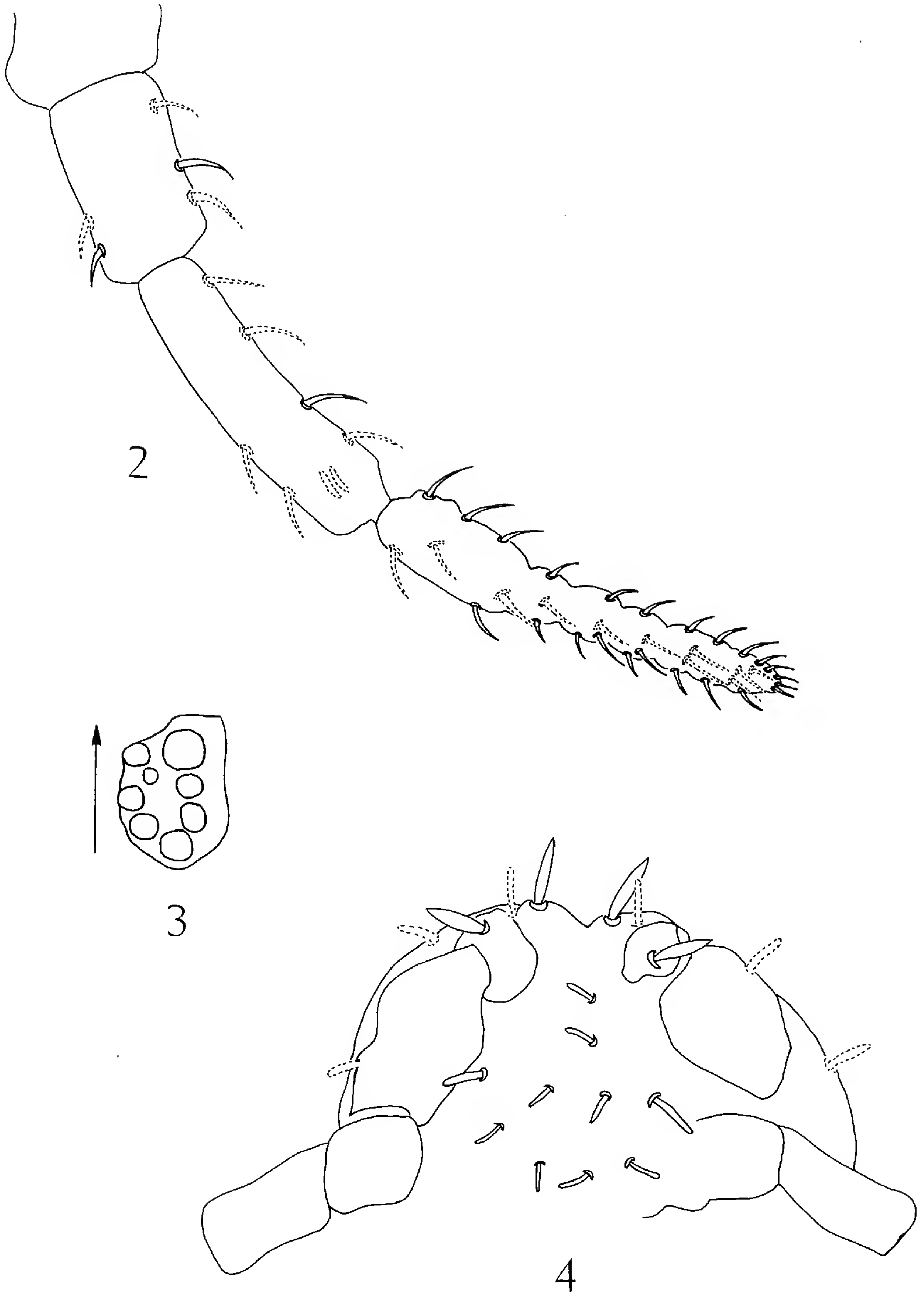
[1] Partial fulfillment of Master's Thesis at San Jose State University.



Figures 2–15. *Neosminthurus bellingeri,* n. sp. 2. Antenna, holotype. 3. Left eyepatch, paratype. 4. Cylindrical setae on posterior margin of head and interocular setae, holotype. 5. Metatrochanter and femur, paratype. 6. Profemur, paratype. 7. Metatibia, paratype. 8. Fore foot, paratype. 9. Hind foot (slightly damaged), paratype. 10. Abdominal setae, paratype. 11. Body setae, holotype. 12. Neosminthuroid seta, paratype. 13. Furcula (=manubrium, dens, mucro), dorsal view, paratype. 14. Female subanal appendage, lateral view, paratype. 15. Tenaculum, holotype.

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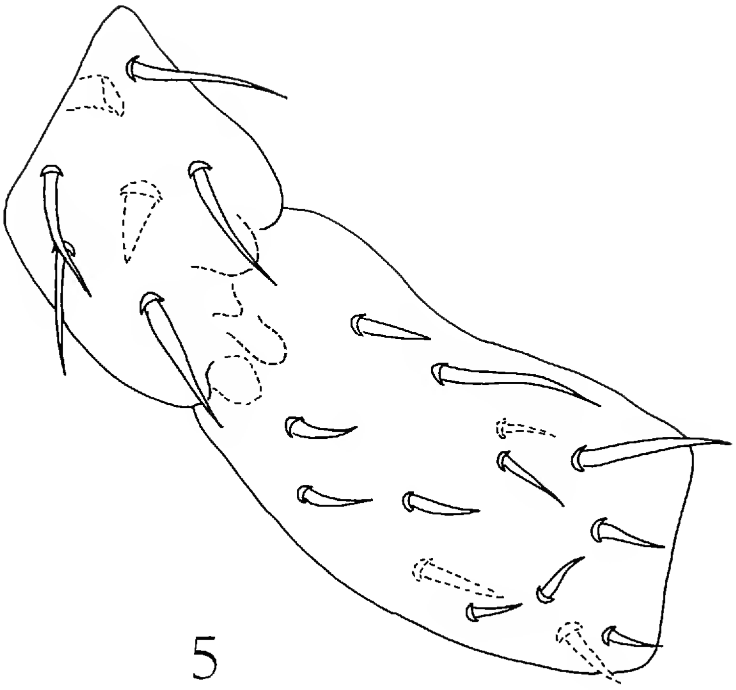

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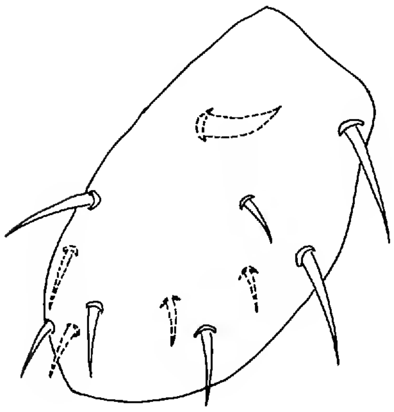

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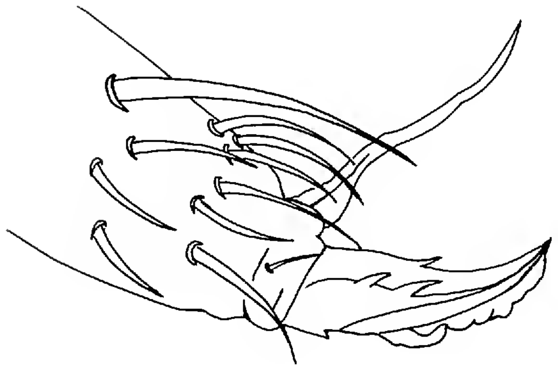

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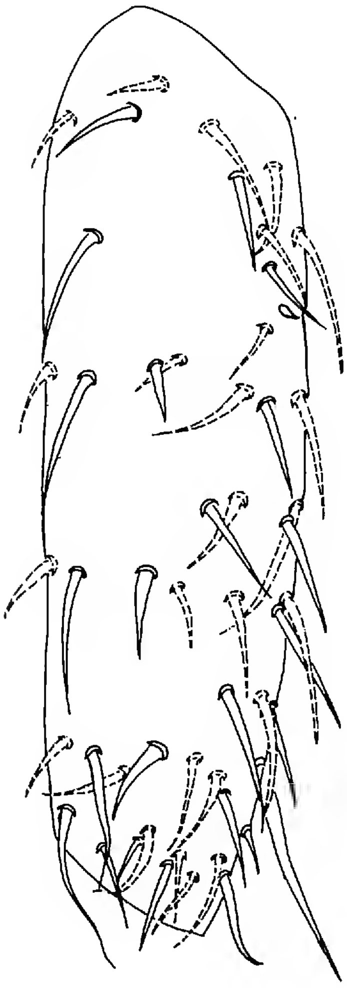

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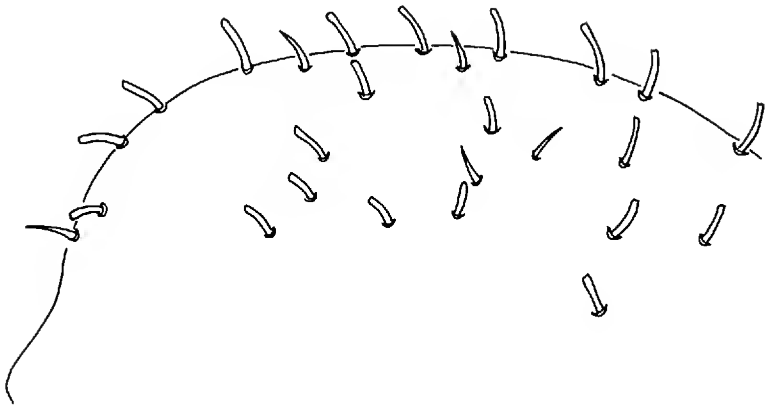

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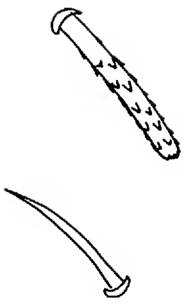

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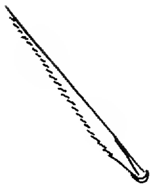

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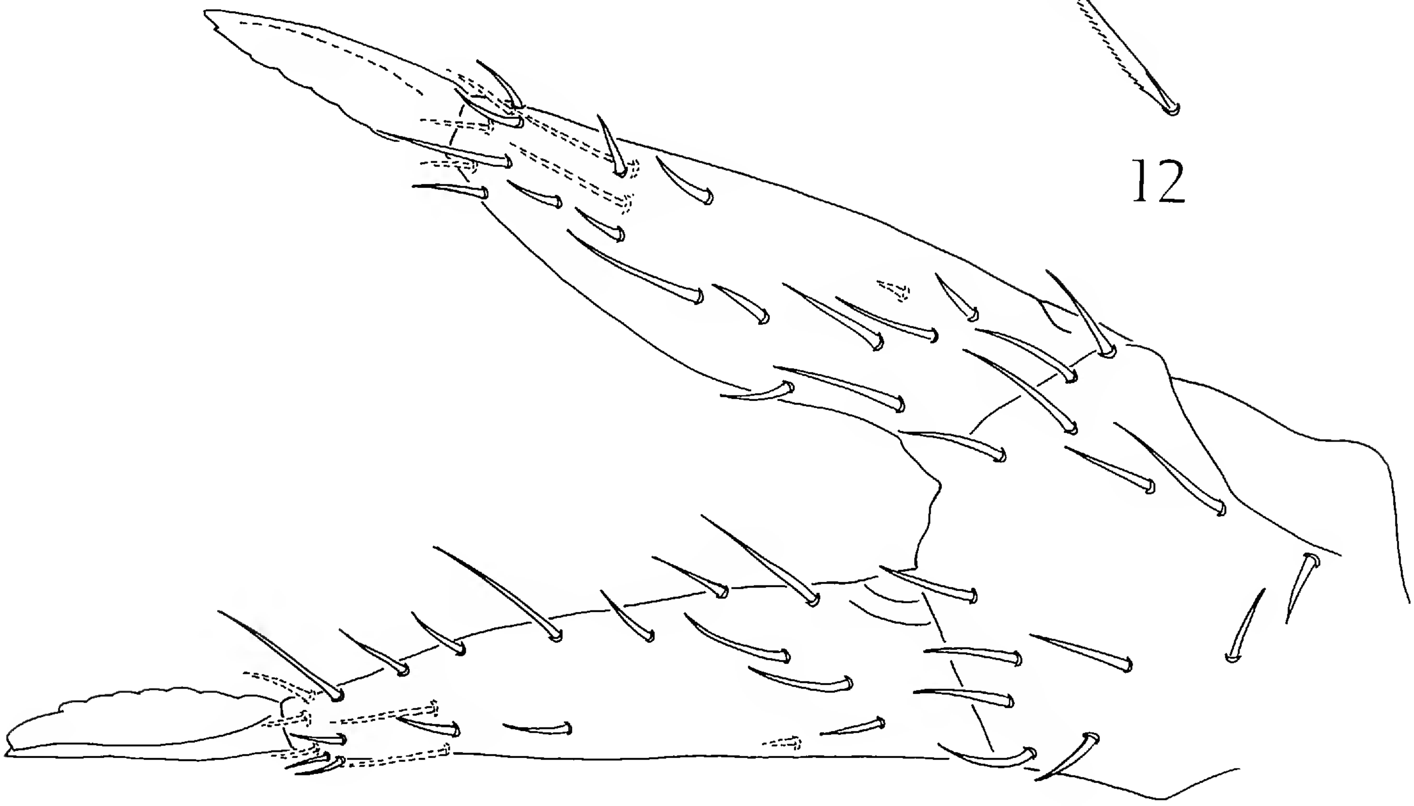

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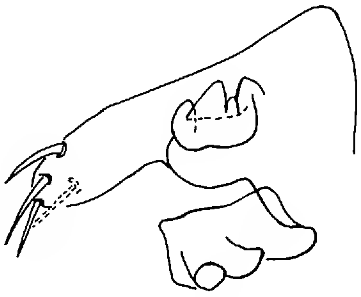

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Neosminthurus bellingeri, NEW SPECIES

Antenna uniformly dark blue. Head mottled dark blue. Body dorsally mottled dark blue to black, paler ventrally with fine intersegmental lines separating thoracic segments. Legs, collophore and furcula speckled blue (Fig. 1).

Antenna IV with six to seven weak subsegments, without subapical bulb and 1.3–1.5 times as long as Ant. III. Ant. III with two subapical sense rods lying in deep depressions (Fig. 2). Eyes 8 + 8 with ocellus A one-half the diameter of B; D at least one-third diameter of B (Fig. 3). Head with six cylindrical setae located on posterior margin of head; interocular setae short and blunt (Fig. 4). Metatrochanter with posterior spine, five anterior setae and oval organ (Fig. 5). Profemora with one appressed posterior spine (Fig. 6). Meso- and metafemora without posterior finger-like process. Metatibia with an oval organ located two-thirds distance from apex on inner edge, five long setae on inner edge, four to five short setae on outer edges and four setae on posterior surface (Fig. 7). Tarsus with anterior and posterior setulae. Tenent hair acuminate. Unguis with inner tooth, tunica and pseudonychium (=lateral serrations) present (Fig. 8). Unguiculus lamellate with apical filament lanceolate (Fig. 9). Body with cylindrical scaled setae and smooth setae (Figs. 10, 11). Neosminthuroid setae present and located between bothriotrix C and base of furcula (Fig. 12). Manubrium with 14 dorsal setae. Dens with seven inner dorsal setae, five external setae, two lateral internal setae, and one dorsal seta; ventrally with one pair of subapical ventral setae, Ve_3 seta short, and located one-third the distance from base of dens (Fig. 13). Mucro with inner lamella serrate and outer lamella entire. Female subanal appendage curved and acuminate with bilateral apical ciliations (Fig. 14). Sacs of ventral tube tuberculate. Tenaculum with four distal setae and 3 + 3 teeth (Fig. 15). Maximum length 1.2 mm.

DIAGNOSIS

Neosminthurus bellingeri keys out closest to *N. bakeri* in Christiansen and Bellinger (1980–81). It can be separated from other members of the group by the following characteristics:

N. bellingeri	*N. bakeri*	*N. richardsi*	*N. clavatus*
ventral setae present on dens	ventral setae absent on dens	ventral setae absent on dens	ventral setae absent on dens
dens with 5E, 7Id, 2L, & 1D setae	dens with 5E, 8Id, 3L, & 1D setae	dens with 4E, 7Id, & 3L setae	dens with 4E, 8Id, & 3L setae
ant. IV weakly subsegmented	ant. IV not subsegmented	ant. IV not subsegmented	ant. IV not subsegmented

Features which commonly associate *N. bellingeri* with the Neosminthuroid group are presence of the Neosminthuroid seta, the well-developed trochanteral spine, the peculiar modification of head and body setae, and the slight bifid appearance at the apex of the mucro.

It seems appropriate to extend the diagnosis for this genus to include the following characteristics which may be present: Ant. IV weakly subsegmented, and ventral setae on dens. In appreciation for his support and encouragement this species was named after Dr. P. F. Bellinger, Professor of Biology, Northridge University.

ECOLOGICAL NOTES

N. bellingeri was discovered during the wettest months of the year. Subadults were collected in January, February, and April; adults were taken in March. Specimens were extracted from Tanbark-oak *Lithocarpus densiflora* (H. & A.) Rehd. and Pacific madrone *Arbutus menziesii* Pursh. leaf litter. Specimens were found as far down as five centimeters in the soil.

The upper soil layer at the study site has a fine sandy clay loam composition. The litter layer pH ranged from 4.45 to 4.80. Normal precipitation for the area averages 1219 mm (48 inches), however, rainfall was below normal when the survey was being conducted and amounted to only 482 mm (19 inches).

Species commonly found with *N. bellingeri* were *Tomocerus reductus* (Mills), 1949; *Sinella sexoculata* (Schött), 1896; *Hypogastrura* (*Ceratophysella*) spp.; *Tafallia robusta* (Scott), 1961; *Onychiurus flavescens* Kinoshita, 1916; and *Folsomia stella* Christiansen-Tucker, 1977.

HOLOTYPE (female), ALLOTYPE (male) and PARATYPES from California, Santa Cruz County, three miles north-northeast of Soquel, at Grover Gulch near Bates Creek. Specimens were collected in Tanbark-oak and Pacific madrone leaf litter in the following months: 11/Jan/81, 7/Feb/81, 7/Mar/81, and 11/Apr/81 by Suzanne Muzzio. Holotype, allotype, two mounted paratypes, and fifteen specimens in alcohol deposited at California Academy of Sciences, San Francisco; two at the Entomology Museum, San Jose State University; and one to Dr. P. F. Bellinger, Northridge University.

ACKNOWLEDGMENTS

The author wishes to thank Brian, Andrew and Michael Muzzio for their assistance with the collection of specimens, and Drs. P. F. Bellinger and R. J. Snider for reviewing this manuscript.

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The Publication Committee of the Pan-Pacific Entomologist has resolved that all submitted manuscripts by authors be accompanied by an abstract which will be printed with the article. This policy is effective immediately and will be implemented by the Journal in volume 61, 1985.—Editor

THE PAN-PACIFIC ENTOMOLOGIST

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Lanellus, a New Subgenus of Primitive, California "Horse Flies" (Diptera, Tabanidae)

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Tabanid flies related to the generalized genus, *Apatolestes,* comprise a rather primitive and sometimes pestiferous group in the Tribe Pangoniini. It consists of 13 described species from western North America, 11 of which are known to occur in California (Middlekauff and Lane, 1980). Some deviation from the ancestral stem has occurred, which permitted separation of the subgenus (now genus) *Brennania* Philip. Information on the biologies of *Apatolestes* species has remained fragmentary until quite recently when studies conducted by Dr. Robert S. Lane, University of California, Berkeley, and colleagues (Lane and Anderson, 1983; Lane et al., 1983) significantly added to our knowledge of *Apatolestes actites* Philip and Steffan, an inhabitant of sandy ocean beaches in California. Morphological and behavioral peculiarities of this species indicated the need to distinguish it at least subgenerically from other members of the genus.

The new subgenus of *Apatolestes,* viz., *Lanellus,* n. subg., is proposed here with *actites* (1962) designated as subgenotype species. Distinctive morphological characters of this subgenus are as follows: females with very wide fronts, strongly convergent above, with subequal sides and basal widths and small but prominent basal callosities; mandibular and maxillary stylets reduced and simple, the mandibles lacking the usual serrated teeth characteristic of blood sucking tabanids. Bodies of both sexes unusually pilose, obscuring the palpi and mouthparts. Palpi of males more attenuate, less truncated than in most other *Apatolestes* species (except *rossi* Philip and *colei* Philip). Eyes bare, unbanded in life.

Some unusual biological features of *actites* were observed initially by Dr. Lane, for whom the subgenus is cordially named. Among tabanids, females of *A. actites* are unique by laying their eggs subterraneously in amphipod or isopod burrows, and by possessing the capability to produce two batches of eggs autogenously. Neither flower visitation nor mating was noted in the vicinity of the breeding sites. The psammophilous larvae are cylindrical, elongate, and non-tabaniform in appearance; they live in the upper beach (supralittoral zone) in soils that are aridic for at least six months annually.

Mackerras (1954) postulated that the primitive tabanid progenitors were generalized flies that fed "on the juices of plants," and that an "adaptation to blood sucking" was an early trend in their evolution. Almost all modern tabanid species females require a blood-meal to mature their developing eggs. By contrast, *A. actites* is the first member of a predominantly blood-sucking brachycerous taxon that can develop more than a single batch of eggs autogenously (Lane and Anderson, 1983), which suggests that *A. actites* never deviated from the progenitorial non-biting line.

Apatolestes colei is the other member of the genus that may be subgenerically related to *A. actites*. This rare horse fly was originally taken along the sandy banks of the Santa Ana dry wash at La Quinta in southern California. The frons of the female is likewise unusually wide, with an index of about 1/1. It also has a reduced and bare basal callosity, the eyes are unbanded in both sexes, and males have attenuated palpi. The mouthparts have not been examined because to do so would require dissection, and only one more female has been reported (Middlekauff and Lane, 1980) since description of the holotype in 1941. Consequently, non-hematophagy and autogenic egg development accompanied by reduced mouthparts, though postulated, remain to be confirmed.

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High Summer Mortality of Black Pineleaf Scale (Homoptera: Diaspididae)

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Abstract.—Catastrophic summer mortality among first-instar larvae of the black pineleaf scale occurred as a result of combined high temperatures and low relative humidity.

Although density-independent factors are unlikely to regulate or stabilize animal populations, infrequent catastrophes affect the density and abundance of insects. Because long-term observation is required, documentation of such environmental episodes is rare. We have studied populations of the black pineleaf scale (*Nuculaspis californica* (Coleman)) in eastern Washington since 1955 and have quantitative yearly data on reproductive success since 1973. The sedentary life history of these insect herbivores allows direct observation of seasonal patterns of mortality and survivorship. Edmunds (1973) has shown that abrupt early winter or spring episodes of freezing weather causes annual shifts in the lower elevation at which black pineleaf scale survive, and excludes the species from large areas in one eastern Washington valley. Higher altitude kills are infrequent and unpredictable, occurring about one year in five.

Here we report a catastrophic episode of high summer mortality among first-instar larvae of the black pineleaf scale during their dispersal period. Eggs hatch in July as the new needle crop of ponderosa pines reaches its full elongation. The tiny larvae move from beneath the mother's scale, and travel 5 to 25 cm before establishing positions on new pine needles. The entire population completes this dispersal within a 10 day interval. During this period in July 1979, unusually high daytime maxima ranged near 40.5°C, and midday relative humidity dropped to 5%. The long-term means for this period in the Spokane area are 30°C and 28% relative humidity. We observed many moribund or dead larvae as a result of desiccation, and more than two-thirds of the insects died before completing their normal dispersal and establishment. The resulting colonization patterns were highly variable and abnormal in distribution, and the number of established colonists was substantially below that which we have observed in other years. No similar summer catastrophe has occurred since our observations began in 1955.

We quantified the effect of this event on the 1979–1980 scale insect population with random twig samples from 37 infested ponderosa pine in the spring of 1980, and compared these observations with data collected in the spring of 1982. Scale cover numbers on the pine needles were used to estimate insect population densities, which were scored in 11 density categories (0–10) representing infestations ranging from 0 to 80 insects per needle. These data were compared with similar density estimates from the 1978–1979 needles on the same twigs, and with 1981–1982 needles from new twigs sampled from the same plot of pines.

On 4 of the 37 trees, the population density class was the same on 1979 needles and 1978 needles (all carried low densities (class = 1)). Population density was lower for the 1979 needles on 33 of 37 trees. Eighteen of the 37 trees showed a reduction in density to one half or less of the 1978 level. One sample dropped from class 10 to class 3. The comparison of the two years' populations cannot be precise because the 1978 needles also have some 1979 scale insects, and many of the 1978 scale coverings were gone. Nevertheless, the work was done in long-term study plots where we have repeatedly sampled, and it was obvious that the scale population fell to less than half its previous density. In recent years many of the trees in the plot would have carried population class 8 to 10. The highest population interval assigned to any of the twigs for 1979 needles was 5, although previously a number of the trees would have had twigs of population intervals 6 to 10, and such densities were reestablished on 1981 needles.

Another evidence of the interference of the hot, dry period is the position of the needles on which the larvae settled. Usually the scale population is distributed rather evenly on the needles of a twig. The distribution of scale insects on 1979 needles was strongly biased toward basal needles on each twig, positions that require the shortest movement. Twigs were randomly sampled from 44 infested trees and the scale population estimated and assigned to population intervals on the needles of the basal ¼ and of the apical ¼ of the twig. On 9 of 44 samples the populations at the base and apex of the twig were assigned to the same population class. The other 35 twigs all had lower population classes at the apex with an average reduction of 2.0 population classes. Twigs longer than 6 inches had a more striking reduction from base to apex than those shorter than 6 inches, the average population class drop being 2.6 classes as contrasted with 1.77 on those less than 6 inches. A count of scales on 10 twigs 6 or more inches long showed an average of 81.8 scales on needles of the basal ¼ of the twig and 3.8 on the apical ¼. We repeated such measurements in the same small plot in 1982. Thirty-eight of 52 samples had the same population class at the base and apex. Of the other 14, the apex on 4 had higher populations than the base and 10 had lower populations than the base. There are no significant differences in populations at the base and apex, and no difference in distribution on the 12 twigs longer than 6 inches (0.3 classes higher at apex vs. 0.1 higher at apex) as compared to the 40 twigs shorter than 6 inches.

The combination of direct observations on the moribund and dying scale larvae in July 1979 and data from scale densities and within twig distribution in May 1980 and May 1982 indicate that this was a short-term climatic mortality episode that directly affected the scales, although we cannot rule out that stress on the host pine may have played a role. It is likely that high temperature-low humidity episodes during the crawler stage affect the population dynamics of other scale species.

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Notes on the Autecology, Cytology, Morphology, and Crepitation of *Trimerotropis* Grasshoppers (Orthoptera: Oedipodinae)

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Abstract.—Numerous additions to the known cytological, morphological, and crepitational characteristics of the *Trimerotropis* grasshoppers are presented. Autecological data are given for several infrequently collected species. *T. santamonica* Rentz and Weissman is synonymized with *T. thalassica* Bruner.

Recent efforts have resulted in many additions and a few corrections making a supplement to our 1980 paper (Weissman and Rentz, 1980) on the cytological, morphological, and crepitational characteristics of the oedipod grasshopper genus *Trimerotropis* Stål appropriate at this time. Specifically, characteristics of several other species have been investigated; Baja California, Mexico, has been thoroughly collected; large series at the Academy of Natural Sciences of Philadelphia (ANSP) and University of Michigan Museum of Zoology (UMMZ) have been examined; and overlooked literature references have been found. Several problem areas concerning species' ranges and species' identifications have been uncovered.

The 62 species (Rentz and Weissman, 1980, 1981, 1984) presently constituting the genus show chromosomal, morphological, and crepitational variation both geographically and within populations. There are several reasons for supplementing this catalogued variation, although the significance of such variation is not always understood. First, chromosomal variation within species (e.g., White, 1951b) may be indicative of incipient speciation. Thus, the geographical variability in karyotype number seen in the *gracilis* subspecies and in *cyaneipennis* Bruner may actually represent different species. A similar situation exists in eastern U.S. *verruculatus* (Kirby) (2N ♂ = 21) and western U.S. *suffusa* Scudder (2n ♂ = 23). Both species are morphologically similar. Helwig (1955) was readily able to hybridize the two forms yet unequivocally believed them not to be conspecific based on ecology, behavior, and cytology. In any case, only detailed study of such variable taxa, especially in areas of overlap, can resolve the question of conspecificity, although there is also no agreement as to what degree of reproductive isolation is necessary to constitute such speciation. Second, chromosomal variation between species may serve as a species' identification marker. For example, until recently (Rentz and Weissman, 1981), any coastal California *Trimerotropis* with blue legs and greenish wing disks was called *occidentalis* (Bruner) and Strohecker et al. (1968) list its range as extending east to Idaho. Yet this species has a unique karotype consisting of only 21 chromosomes, a telocentric X (sex) chromosome, and inversion polymorphism in several autosomes (see below). Such information has enabled me to considerably restrict the range of this species (see below). Also, chromosomal variation between species has permitted confirmation of suspected hybridization (John and Weissman, 1977; John et al., 1983). Third, knowledge of the range of morphological variation can facilitate discovery of cryptic species; for example, the "abberant" blue legged specimens of *californica* Bruner noted by Strohecker et al. (1968) were actually an undescribed species—*topanga* Rentz and Weissman. Morphological variation in the genus is most notable in wing disk and hind tibia color. Examination of large series at ANSP and UMMZ shows greater color variation in hind tibia than previously noted (Weissman and Rentz, 1980): species primarily with yellow hind tibia have some individuals with brown ones; yellow tibia are also associated with orange ones, and blue are associated with brown. When polymorphic, such variation is usually present in each population. Some of this variation, when described from museum specimens, may be related to changes after death. Those species variable for wing disk color usually do not have all morphs represented in each population.

Species are discussed below in alphabetical order. Table 3 is arranged by karyotypic characteristics and supplements information in Table 1 in Weissman and Rentz (1980). Karyotypic Section A contains species whose chromosomes are all rod shaped or telocentric. Section B species (but not all individuals) have some autosomes metacentric with the X chromosome always (except in *occidentalis*) metacentric. The latter species has a telocentric X but is considered a Section B species because of two characteristics only possessed by *Trimerotropis* taxa in that group: inversion polymorphism and reduced chromosome number. Also it can form viable hybrids with another Section B species, *thalassica* Bruner, from which it differs by only one reciprocal translocation (John and Weissman, 1977). I believe species within these respective chromosomal Sections are more closely related to each other than to species in the other Sections (discussed in Weissman and Rentz, 1980). For ease of discussion the autosomes are arbitrarily divided into three size classes: large (L), medium (M), and small (S), and are numbered from the largest to the smallest. Crepitational terminology is after Weissman and Rentz (1980).

T. californica.—In California, this species was separated from *strenua* McNeill by Rentz (pers. comm.) in Strohecker et al. (1968) on the following basis: in *californica* the tegminal bands are light, narrow, and tend to be obscure or speckled; in *strenua* the bands are heavy, dark, and not speckled. I feel these species may still be distinct for the following reasons, although crepitationally, cytologically, and ecologically inseparable. In California any one population does not contain both above morphs. On the other hand several populations of *strenua* morphs that I collected from San Luis Obispo and Santa Barbara Counties were variable for tegminal band intensity: of 21 males and females from the Santa Ynez Mountains, 6 lacked the bands completely (making them the palest *Trimerotropis* specimens known), 5 had fully developed bands, and the rest had intermediate bands. Similar intensity variation has never been observed in a California population containing *californica* morphs (but see Hebard, 1906, for notes on specimens from Utah) in which the tegminal bands are fairly uniform. Because of these differences in population variation, further investigations on the relationship of these two taxa seem warranted.

T. cyaneipennis.—Although recorded (Strohecker et al., 1968) from western Texas to California (of questionable occurrence in the latter state—see Rentz and

Weissman, 1984 under *leucophaea,* new species) and north to southern Idaho, several species may be involved. Specimens at ANSP and UMMZ from Utah, Nevada, and Idaho consistently have blue wing disks. Some Oregon, Arizona (Tinkham, 1948), and most New Mexico specimens (also see Hebard, 1935) have disks that are green, green-blue, or yellow with a blue tinge at the base (some of these may be hybrids between *cyaneipennis* and *suffusa*—see John et al., 1983). Crepitation is a crackle similar to *fratercula* McNeill in Otte (1970, p. 123) (including those from Harney Co., Oregon—listed in error in Weissman and Rentz, 1980) as noted in Rehn and Hebard (1908), Hebard (1935), Strohecker et al. (1968) and confirmed in specimens from Kane Co., Utah (Weissman, unpubl.).

T. fontana Thomas.—This species is polymorphic for wing color and crepitation. Wing disk color is yellow-green, but specimens from near Laguna Hanson, northern Baja California, have some blue in the wings. This case represents the *only Trimerotropis* with blue in the wing that contains no metacentric chromosomes (*arizonensis* Tinkham is not yet known). Populations are variable for crepitation pattern from northern Baja California to northern California. They vary from a buzz to a pulse buzz to a crackle (Caudell, 1908; Fulton, 1930; Strohecker et al., 1968; Weissman, unpubl.) frequently with two types heard in one population. One of three individuals from 9.6 km S Ruth, Trinity Co., California, was heterozygous for a supernumerary segment in a small autosome. *T. fontana* from Santa Rosa Island also had similar segments (Rentz and Weissman, 1981, Fig. 132). The X chromosome in the Ruth heterozygote also showed neometacentric activity at metaphase I.

T. fratercula.—One male from Sandoval Co., New Mexico, was examined cytologically: 2N ♂ = 23, Section B, 3 large, 6 medium, and 2 small autosomes; L1, L2, L3, and M5 were inversion homozygotes, X a metacentric. On the basis of its yellow wings, yellow hind tibia (rarely individuals have a hint of green), definite tegminal bands, crackle crepitation, and Section B chromosomal pattern, this species is probably a member of the Pallidipennis Group (see Weissman and Rentz, 1980).

T. helferi Strohecker.—This species was restudied 2 August 1980, at Cleone, Mendocino Co., California, on a clear, sunny day. Individuals were extremely difficult to collect, approaching *Scirtetica clementina* Rentz and Weissman in wariness (Rentz and Weissman, 1981, p. 75). Male crepitation was a pulse buzz similar to *cincta* (Thomas) in Otte (1970), not a buzz as listed in Weissman and Rentz (1980). Females made more of a flight noise than an actual crepitation. Flights by both sexes were low and from 2 to 30 m in length. One last instar female was seen; adult females contained nearly mature eggs. In the 14 captured specimens, wing disk color was variable: clear ($n = 3$); greenish tinged ($n = 7$); greenish yellow ($n = 4$). All these wing colors apparently fade out completely after death as judged by most museum specimens.

Otte (pers. comm.) notes the morphological similarity in body shape and hirsuteness, among other characters, between this species and another California oedipod *Microtes occidentalis* (Bruner) that likewise exclusively inhabits coastal sand dunes. Such similarity is most probably the product of convergence from inhabiting a similar habitat. Such convergence is widespread among the grasshoppers, the genera *Anconia* Scudder, *Xeracris* Caudell, and *Spaniacris* Bruner being a classic example. The three are found, often sympatrically, in sandy desert

Table 1. Karyotype frequency (2N ♂ = 21) of 80 *T. occidentalis* from Woodside, San Mateo Co., California, during 1973 (habitat since destroyed for houses—see Murphy and Ehrlich, 1980).

Karyotype (all autosomes telocentric except those cited)	6 June	5 July	13 September	30 October
L1 TM	0.41	0.33	0.35	0.45
L1 TM 1 B	0.18	0.06	0.05	0.20
L1 TM 2 B	0.00	0.06	0.00	0.00
L1 MM	0.27	0.44	0.35	0.35
L1 MM 1 B	0.05	0.00	0.10	0.00
L1 MM M5 TM	0.05	0.06	0.00	0.00
Basic	0.05	0.06	0.15	0.00
Total specimens	22	18	20	20

TM = heterozygous bivalent.
MM = homozygous metacentric.
B = supernumerary chromosome.
Basic = no inversions present.

areas and were once considered by Hebard (1937) to form the Group Anconiae. These three genera are now each considered to represent different subfamilies. *T. helferi* has a metacentric X and inversion polymorphism (references in Weissman and Rentz, 1980) placing it cytologically in Section B of *Trimerotropis.* On the other hand, *M. occidentalis* and *M. nicola* Rentz and Weissman have the usual acridid karyotype of all telocentrics (Rentz and Weissman, 1981). So unusual (White, 1973, p. 245; Hewitt, 1979, p. 12) are pericentric inversions in acridids that their occurrence in a species would argue for phylogenetic relationship with that genus that also possesses such inversions. I believe convergence in this cytological character is far less likely than in the morphological characters cited above.

T. munda (Scudder).—Seven males from 9.6 km S Ruth, Trinity Co., California, were examined cytologically: 2N ♂ = 23, Section A, 3 large, 6 medium, and 2 small autosomes. The X had occasional neometacentric activity; one male had a supernumerary segment in the S10. Flights were low, usually 2 to 5 m, male crepitation was a medium fast buzz similar to *campestris* Bruner in Otte (1970). Some males and females were teneral on 3 August 1980. They were found in a sandy, dry river bed bottom with *fontana,* 3 species of *Dissosteira,* and a *Conozoa* species. The only *munda* female caught had small eggs (Stage I; see Weissman and French, 1980). Strohecker et al. (1968) noted the similarity between *munda* and *pacifica* Bruner. Except for the smaller size of the former, the taxa are indistinguishable in morphology, cytology, and crepitation.

T. occidentalis.—The inversion polymorphism (L1 and M5) present in populations from the San Francisco Bay Area was noted by Rentz and Weissman (1981). Eighty individuals from one population had the karyotypes listed in Table 1. There is no apparent inversion or B chromosome frequency change through the flight season. Specimens now have been examined cytologically (Table 2) from Kern Co. in southern California to Klamath Co. in southern Oregon (these may represent its south-north extremes). Populations in Oregon have an inversion in a large autosome not found in California. When compared to the Woodside

Table 2. Karyotype frequency of *T. occidentalis* from California (first four columns) and Oregon (last column). Abbreviations as in Table 1.

Karyotype (all autosomes telocentric except those cited)	Tehachapi, Kern Co.	Zenia, Trinity Co.	Bridgeville, Humboldt Co.	Redding, Shasta Co.	2 localities, Klamath Co.
L1 TM	0.33	0.20	0.58	0.40	0.38
L1 MM	0.00	0.40	0.08	0.20	0.25
L1 TM L2 TM	0.00	0.00	0.00	0.00	0.06
L1 MM L2 TM	0.00	0.00	0.00	0.00	0.06
L1 TM M5 TM	0.00	0.00	0.08	0.00	0.00
L1 MM M5 TM	0.00	0.00	0.08	0.00	0.00
L1 MM M5 TM 1 B	0.00	0.20	0.00	0.00	0.00
L2 TM	0.00	0.00	0.00	0.00	0.06
Basic	0.66	0.20	0.17	0.40	0.19
Total specimens	3	5	12	5	16

population (Table 1), these northern California and southern Oregon populations are smaller in number of individuals and have less inversion heterozygosity, consistent with the pattern found in *pseudofasciata* Scudder (Weissman, 1976; and below) and *helferi* (Schroeter, 1968). The range of *occidentalis* probably extends no farther east than western Nevada as morphologically similar individuals from eastern Nevada identified in the ANSP and California Academy of Sciences collections as *occidentalis* have 23 chromosomes and no inversion polymorphism (Weissman, unpubl.) and probably represent *fontana.*

T. pacifica.—Ten males were examined cytologically from Bakersfield, Kern Co., California: 2N ♂ = 23, Section A, 3 large, 6 medium, and 2 small autosomes. One male had a medium sized telocentric B chromosome. Males flew 3 to 10 m. Crepitation was a medium fast buzz similar to *campestris* in Otte (1970) made during the last ⅔ of flight. Only 1 of 5 females caught 6 August 1980, had developed eggs. They were found on sandy substrate with short sparse grass associated with *p. pallidipennis* (Burmeister).

T. p. pallidipennis.—Populations of this species from alkaline soil habitats (with salt grass *Distichlis*) are morphologically very different from conspecifics on other types of soil. The alkaline soil ecotypes are much lighter in body and tegminal color, have reduced or no tegminal and wing bands, and a pale yellow or colorless wing disk. These alkaline forms integrade into their darker conspecifics with intermediates present over distances as short as 20 m (7.2 km N Beatty, Nevada) to ½ km (Borax Lake, Alvord Hot Springs, Oregon (D. C. Lightfoot, pers. comm.)). Crepitation and other flight characteristics were similar in both morphotypes. The alkaline soil forms near Beatty may mature later. That these alkaline forms are indeed distinctive in appearance is indicated by the population north of Beatty being considered a distinct species by both White (1951a, p. 311; 1973, p. 331) and Tinkham (pers. comm.). A similar population from Lake Abert, Oregon, was even considered a second distinct species (Tinkham, pers. comm.). *T. p. salina* McNeill may represent another ecotypic color phase on alkaline soils (see discussion by Hebard, 1928, p. 254).

In North America hundreds of males of this widespread species have been examined cytologically by White, Helwig, Coleman, and myself (see references in

Table 3. Supplement to cytological, morphological, and crepitational characteristics of *Trimerotropis* grasshoppers—see Table 1 of Weissman and Rentz (1980). Only those species, and that specific category with additions herein, are listed below. Parentheses denote uncommon condition. Conditions without reference numbers refer to museum specimens. Reference superscript numbers refer to citations at bottom of Table; reference superscript letters refer to specific localities at bottom of Table. See Rentz and Weissman (1980) for species' authors.

	2N ♂	Hind tibia color	Wing disk color	Crepitation	Comments
SECTION A					
agrestis				crackle[3]	
a. barnumi				buzz[15]	
a. gracewileyae				crackle[10]; buzz[15]	
a. hewitti	23[13(C)]			crackle[7]	2 large, 7 medium, 2 small autosomes[13(C)]
albescens					supernumerary segments[13(B)]
arenacea		(yellow)	(green)	crackle[7]	B chromosomes, supernumerary segments[13(F)]
bilobata					B chromosomes[12]
campestris					supernumerary segments[13(G)]
cincta		(red)		buzz[5,8,20]; crackle[13(E)]	
citrina		(yellow)			
fontana			(blue tinge)	buzz to crackle[16]	supernumerary segments[9,16]
inconspicua		(blue)	yellow-green[1,7]	buzz[7,13(A)]	red tibia in Helfer[6] probably another species
koebelei		(yellow)			
latifasciata				crackle[13(H)]	
maritima		green-yellow, (red)[2]			
munda	23[16]			buzz[16]	
pacifica				buzz[16]	B chromosomes[16]
pistrinaria		(yellow)			
pogonata				buzz[16]	
strenua		(yellow)			
texana		(red)		crackle[13(D)]	
titusi	23[16]	(red)[16]		buzz[16]	
tolteca modesta				crackle[5,6,13(E)]	female also crepitates[5,13(E)]

Table 3. Continued.

	2N ♂	Hind tibia color	Wing disk color	Crepitation	Comments
SECTION B					
cyaneipennis		(brown)	yellow, green-blue, blue	crackle only[5,6,19]	
fratercula	23[16]	(green tinge)		crackle[20]	
gracilis sordida				crackle[3,11]	
helferi			clear to greenish yellow[16]	pulse buzz[16]	
p. pallidipennis			colorless on alkaline soil; blue tinge at base in typical[16]		B chromosomes[16]
pseudofasciata		(yellow)	colorless, blue-green	buzz, pulse; buzz, crackle[16(I)]	
saxatilis		green-yellow			
sparsa			colorless, yellow, green, blue[4,17]	buzz[5]	?supernumerary segment[14]
suffusa		yellow			
thalassica			yellow-green, blue-green		B chromosomes[16]

Reference numbers for Table 3—complete citation in Literature Cited

1 Barnum, 1964
2 Blatchley, 1920
3 Brooks, 1958
4 Hebard, 1928
5 Hebard, 1935
6 Helfer, 1953
7 Hewitt and Barr, 1967
8 Hubbell, 1922
9 Rentz and Weissman, 1981
10 Tinkham, 1960
11 Walker, 1902
12 Walters, 1968
13 Weissman, unpub.
14 White, 1951b
15 Willey and Willey, 1971
16 Weissman, this report
17 Hagen, 1982
18 Hebard, 1906
19 Rehn and Hebard, 1908
20 Hebard, 1929

Reference letters for Table 3—locality of Cited Data

California
A Inyo Co.
I Fresno Co.

Mexico
B Baja California Norte

Nevada
C Humbolt Co.

New Mexico
D Dona Ana Co.
E Sandoval Co.

Oregon
F Deschutes Co.
G Lake Co.

Arizona
H Coconino Co.

Weissman and Rentz, 1980). The only reported populations with B chromosomes were those from alkaline soils. Of 5 males I examined from near Beatty (also see White, 1951a), one had a single B. One of 10 males from Summer Lake, Oregon, had one B chromosome. Five normal colored males from nearby had no Bs. Individuals of both morphs frequently had ditactic bivalents, a condition unusual in the acrididae (Hewitt, 1979; Rentz and Weissman, 1981, p. 80 and Fig. 132).

T. pogonata Strohecker.—Individuals were locally very common at Los Osos sand dunes, San Luis Obispo Co., California. Male flight was 1 to 2 m, crepitation was a fast buzz similar to *Encoptolophus costalis* (Scudder) in Otte (1970), and they were easy to catch. Females were more sluggish and had shorter flights. This species was found microsympatric with *Microtes occidentalis* at Oso Flaco Lake, San Luis Obispo Co., but the buzz crepitation in the latter species is slower. Schroeter (1968, pers. comm.) found the karyotypes of 40 males to be uniform.

T. pseudofasciata.—Weissman (1976) noted that California Channel Island males had a fixed L2 inversion homozygote, and had 5 autosomes polymorphic. Mainland populations from northern Baja California to northern Oregon and east to Nevada had 4 autosomes fixed and 4 polymorphic. However, 3 males from Vandenberg Air Force Base, coastal Santa Barbara Co., California, had only the L2 inversion fixed and only the M5 polymorphic. This mainland habitat resembled that of San Nicolas Island, Ventura Co., as did the karyotype of the males examined. Despite intensive searching at the former locality, only 5 (3 ♂, 2 ♀) specimens were collected. This pattern is consistent with that noted by Weissman (1976) where ecologically marginal populations with low densities have little inversion polymorphism.

California Central Valley populations have a reproductive dormancy (Weissman and French, 1980) and do not crepitate until late summer–early fall. Males from Jacalitos Canyon, Fresno Co., in the Central Valley, collected on 19 November 1982, represent the first *Trimerotropis* population to contain individuals that buzz, pulse buzz, and crackle. Many males would buzz in the beginning of flight and pulse buzz at the end.

T. strenua.—See under *californica* for discussion as to possible synonymy. Rarely individuals of the former have yellow hind tibia.

T. thalassica.—Under this species I here place *santamonica* Rentz and Weissman in synonymy. In our 1981 description of the latter, we noted its similarity to *thalassica* but cited differences in wing disk color, tegminal bands, antennal annulation, and ground color. Continued collecting at the type locality of *santamonica* south into Baja California demonstrated that we were dealing with a cline for these characters. Baja California specimens were almost uniform for blue-green wings, distinct tegminal bands, and definite antennal annulation.

Seven additional males from the Santa Monica Mountains, Los Angeles Co., have been examined cytologically: they agree in inversion diversity with those in Tables 6 and 7 in Rentz and Weissman (1981). Specimens examined from near Laguna Hanson and near Sierra San Pedro Martir National Park, both northern Baja California, had only four autosomes heterozygous and 12% (2 of 17) had B chromosomes.

This species normally occurs at low elevations in chaparral habitats. Flights there are usually short and crepitation is a fast buzz heard only late in the flight season (see Rentz and Weissman, 1981). These patterns are maintained in northern Baja California except for the populations bordering the Vallecitos meadow area at 2350 m in the San Pedro Martir Park area. There, individuals morphologically and cytologically indistinguishable from those living in typical habitat at lower elevations, inhabit open areas under and around pines. These populations are dense, individuals fly long distances, and crepitation, which is made during the entire flight season, is a pulse buzz similar to *pallidipennis* in Otte (1970). Whether these differences reflect edaphic features or represent a cryptic species need further investigation.

T. titusi Caudell.—Eight males were examined cytologically from Pinnacles National Monument, San Benito Co., California: 2N ♂ = 23, Section A, 2 large, 7 medium, and 2 small autosomes. Males flew 2 to 5 m, crepitation was a medium fast buzz similar to *campestris* in Otte (1970) usually made in last ¼ of flight but occasionally in last ¾. Several females contained nearly mature eggs on 1 August, 1980. One female was teneral. Specimens were variable for tegminal band intensity; in one female the band was nearly absent. Four of 32 specimens had red hind tibia rather than the usual yellow. At Pinnacles it was sympatric with *occidentalis, p. pallidipennis,* and *Cibolacris parviceps* (F. Walker) in a dry wash with gravelly substrate and sparse grass cover.

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New Genera and Species of Neotropical Cerambycidae (Coleoptera)

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Abstract.—Four new genera and five new species of Cerambycidae are described from Mexico and Central America: *Lycoplasma formosa* from Panama (Hemilophini); *Noctileptura squamosa* from Mexico and *N. seriata* from Guatemala (Lepturinae); *Oraphanes binotatum* from Mexico (Hesperophanini); and *Giesbertia rugosa* from Mexico (Purpuricenini).

While identifying cerambycids from the faunas of Mexico and Central America, a number of interesting new taxa were discovered. Because of their unique nature, we are describing some of these here.

Lycoplasma, NEW GENUS

Form moderate-sized, elytra very broadly explanate from behind humeri. Head with front transverse, slightly convex, median line extending onto neck; mandibles stout, gradually arcuate to apices; genae subparallel, as long as lower eye lobes; eyes finely faceted, deeply emarginate, upper lobes small, widely separated; antennal tubercles flattened, widely divergent; antennae rather stout, shorter than body, scape subequal to third segment, fourth slightly shorter than third, remaining segments gradually decreasing in length, eleventh short, tapering, segments lightly ciliate beneath, ciliae becoming less numerous toward apex. Pronotum broader than long, sides obtusely tuberculate behind middle; apex and base broadly, shallowly impressed transversely; disk convex; prosternum narrow, intercoxal process narrow, broady expanded at apex, coxal cavities closed behind; procoxae exserted, cavities strongly angulate externally; mesosternum with intercoxal process rather narrow, arcuate, lying well below tops of coxae; metasternum with a strongly impressed median line, episternum broad, gradually narrowing posteriorly. Elytra very broadly expanding from behind numeri; sides briefly vertical behind humeri above bases of lateral margins; disk rather strongly costate, costae uniting near apex to form a somewhat reticulate pattern; lateral margins lightly fringed with short hairs; apices rounded. Legs short, femora moderately broad, sublinear; tibiae short, sulcations vague; tarsi broad, third segment cleft to base. Abdomen normally segmented.

Type species.—Lycoplasma formosa, n. sp.

This genus is apparently very similar in appearance to *Ites* Waterhouse (1880). Lane (1954) presented a lengthy discussion on the similarity of *Ites* with *Lycodesmus* Melzer (1927) and concluded that the two were identical. Since the second and third antennal segments are of the same length, Melzer speculated that the true second segment was hidden and listed *Lycodesmus* as having 12-segmented

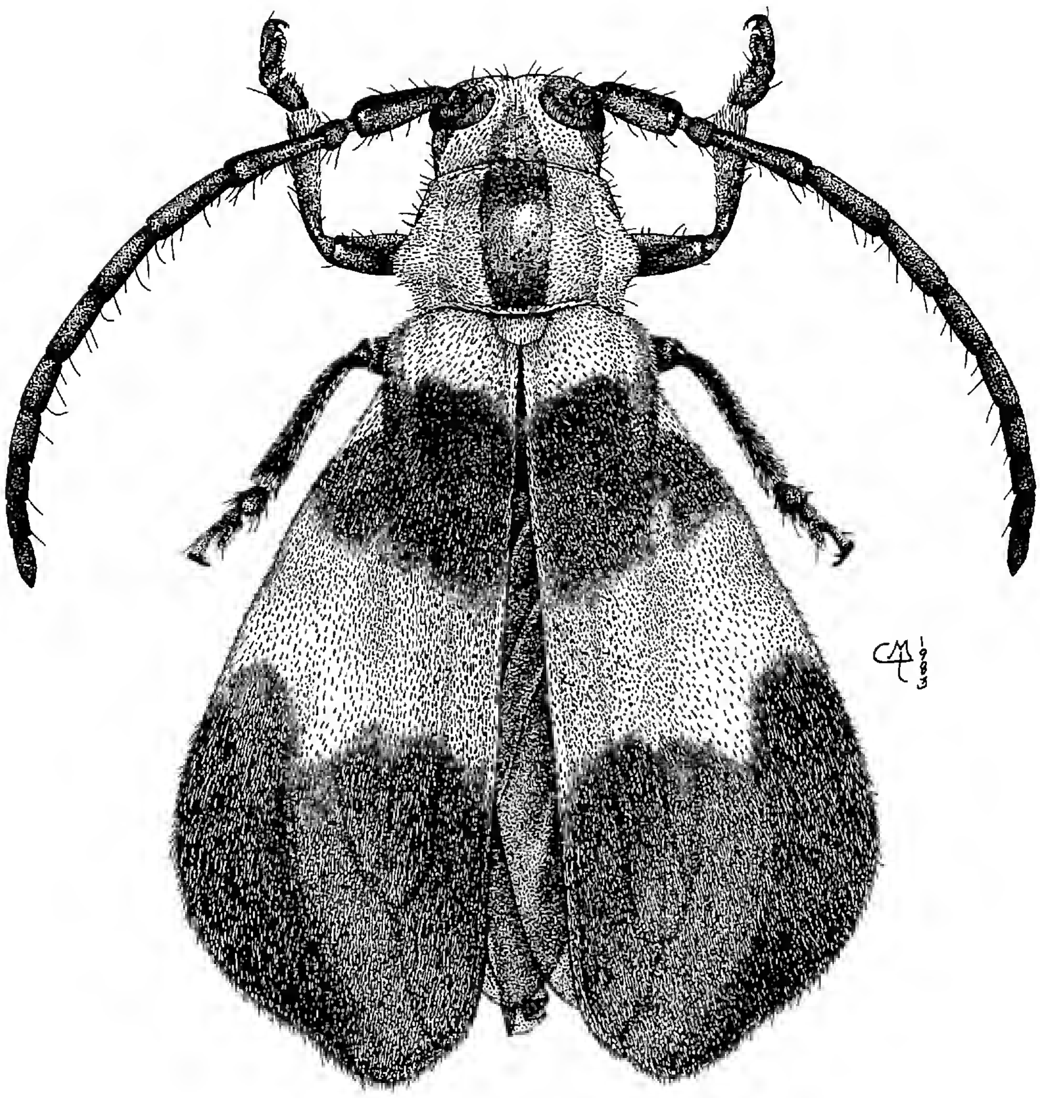

Figure 1. *Lycoplasma formosa* Chemsak and Linsley, ♀.

antennae. Apparently the first two segments are equal in length and the antennae contain only 11 segments. This unusual situation readily separates *Lycoplasma* from *Ites*. In addition to the differences in the proportions of the antennal segments, *Lycoplasma* has rather strong costae on the elytra.

The tribe Hemilophini contains a number of lycid-like genera in the Neotropical region. These differ primarily in characters of the antennae and shape of the elytra. Most can be separated from *Lycoplasma* on these bases. Assuming that Lane's characterization of *Ites* and *Lycodesmus* is accurate, *Lycoplasma* represents a distinct genus.

***Lycoplasma formosa*, New Species**

(Fig. 1)

Female.—Form moderate sized, elytra very broadly explanate behind humeri; integument brownish, head yellowish except for broad dark bands behind eyes and a median triangular dark band on vertex which narrows between eyes, pronotum with a broad, dark median, longitudinal band and a band on each side below lateral tubercles, elytra with a broad post basal band which narrows toward lateral margins, apical band broad, covering about apical ⅓, apical margin of apical band notched medially, elytral bands with a strong violaceous caste, antennae dark, legs dark except basal halves of femora, underside except prosternum dark. Head with front moderately coarsely, rather densely punctate at middle, vertex more coarsely punctate on subglabrous dark spot; pubescence dense, appressed, erect ciliae sparse, more numerous on antennal tubercles; antennae extending to about apical ⅓ of elytra, scape finely punctate, moderately densely clothed with short, dark, appressed pubescence, outer segments densely clothed with very short, dark pubescence, basal segments with a few erect setae beneath, these diminishing in number toward apex. Pronotum broader than long, sides obtusely tuberculate behind middle; median dark vitta subglabrous, sparsely, coarsely punctate; pubescence dense, appressed, pale yellowish, dark on dark vittae, long erect hairs sparse at sides; prosternum densely pubescent; meso- and metasternum moderately densely clothed with appressed pale and dark pubescence, pubescence not obscuring surface, punctation minute. Elytra about as long as greatest width, base slightly broader than pronotum; punctures on basal ⅓ moderately coarse, contiguous, becoming finer on middle ⅓ and dense and confluent on apical ⅓; each elytron with 4 costae, two outside and two inside pairs joining near apex; pubescence dense, depressed, colored as background. Legs short, femora bicolored; front tibiae arcuate. Abdomen minutely, densely punctate, densely clothed with fine, appressed, pale and dark pubescence; last sternite longer than fourth, apex rounded, lightly notched at middle. Length, 16 mm.

Holotype female (University of California, Davis) from Barro Colorado Island, Panama, 14 May 1980 (H. Wolda). One female paratype with same data, 30 April 1980.

The only variation evident in the two available specimens is some reduction of the pronotal dark vitta in the paratype. Although this species greatly resembles some Mexican and Central species of *Lycus,* its model is probably a species of *Calopteron* as evidenced by the violaceous caste and reticulated appearance of the dark bands of the elytra.

Noctileptura, New Genus

Form small to moderate sized, subparallel; pubescence of body modified into squamae. Head with front short, transversely impressed medially; tempora moderate, slightly convergent, abruptly constricted behind; palpi rather slender, unequal; eyes rather large, coarsely faceted, deeply emarginate, upper lobes small, widely separated; antennal tubercles prominent, widely divergent; antennae slender, 11-segmented, longer than body, insertions almost in eye emarginations, scape cylindrical, shorter than third segment, fourth shorter than third, fifth longer than fourth, segments from third slightly expanded at apices, fifth more so, segments from sixth carinate beneath, with sensory areas extending length of segments, expansion of fifth segment containing sensory areas. Pronotum longer than broad, sides angulate; apex much narrower than base, broadly impressed transversely; base shallowly impressed; disk tumid behind apical impression; prosternum broadly impressed, intercoxal process slender, arcuate, expanding at apex, coxal cavities closed behind; mesosternal process almost plane, about even with tops of coxae; metasternum with episternum slender, gradually narrowing posteriorly. Elytra subparallel, narrowing toward apex; apices subtruncate. Scutellum small. Legs slender, femora linear, posterior tarsi short, first segment shorter than following two together, third segment cleft to base. Abdomen normally segmented.

Type species.—Noctileptura squamosa, n. sp.

This genus is unlike any of the other New World Lepturinae. The shape of the

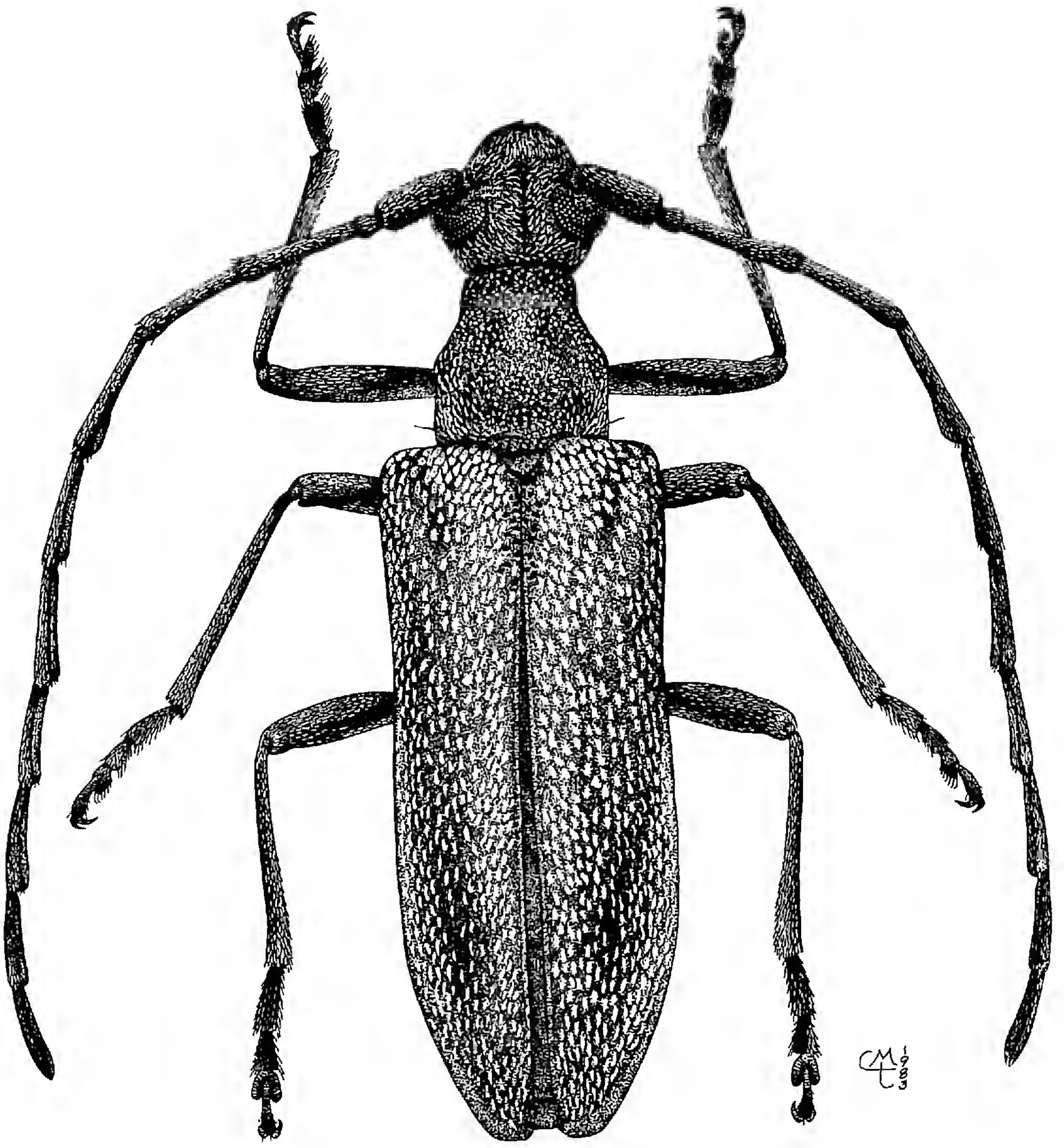

Figure 2. *Noctileptura squamosa* Chemsak and Linsley, ♀.

head and pronotum, coarsely faceted eyes, and structure of the antennae make it distinctive. The most unique characteristic is the presence of recurved, spatulate scales on the body. These appear to be modified hairs and are not known to occur on any other Western Hemisphere Cerambycidae.

Two undescribed species are presently known.

Noctileptura squamosa, New Species
(Fig. 2)

Female.—Form moderate sized, subparallel; integument reddish brown, opaque; pubescence of body modified into whitish, flattened squamae, pubescence of appendages normal. Head densely, confluently punctate, finely scabrous; surface densely clothed with small, pale scales; antennae slender, slightly longer than body, scape finely, densely punctate, opaque, outer segments slightly shining, segments clothed with very fine, short, pale, appressed pubescence. Pronotum as broad as long, sides angulate; disk tumid behind apical impression, tumosity vaguely impressed at middle; punctures moderately coarse, very dense; surface densely clothed with pale scales; prosternum densely punctate except on anterior ⅓, moderately densely clothed with scales; meso- and metasternum densely, shallowly punctate, sides densely clothed with scales. Elytra more than twice as long as broad, subparallel to apical ⅓, then tapering; punctures coarse, contiguous; scales dense, larger than those on pronotum; sides narrowly margined behind middle; apices truncate. Legs finely, densely punctate, densely clothed with fine, pale, appressed pubescence. Abdomen finely, shallowly punctate, finely scaled; last sternite broadly rounded at apex. Length, 12 mm.

Holotype female (Canadian National Collection) from 12 mi N Tuxtla Gutierrez, Chiapas, Mexico, 7 June 1969 (J. M. Campbell).

This is one of the most distinctive and unique species of Lepturinae in this hemisphere. The most unusual covering of scale-like hairs will readily identify it.

Noctileptura seriata, New Species

Female.—Form small; integument subopaque, reddish brown, head and pronotum darker; pubescence rather sparse, finely scale-like. Head densely micro-punctate, densely clothed with appressed, narrow scales; antennae about as long as body, segments densely clothed with fine, scale-like pubescence. Pronotum longer than broad, sides vaguely angulate; apex narrower than base; base shallowly impressed transversely, apex broadly impressed; disk uneven, vaguely tumid behind apical impression; punctures coarse, dense, subconfluent; scales rather sparse; prosternum coarsely, shallowly punctate, scales sparse; meso- and metasternum coarsely, shallowly punctate, scales sparse. Elytra slightly more than twice as long as broad, sides subparallel, tapering near apex; punctures very coarse, deep, contiguous, arranged in longitudinal rows; scales narrow, recurved, serially arranged; apices truncate. Legs moderately densely clothed with thin scales. Abdomen shallowly punctate, scales sparse; last sternite subtruncate at apex. Length, 9 mm.

Holotype female (National Museum of Natural History) from Livingston, Guatemala, 6 May (Barber & Schwarz). One female paratype with same data, 8 May.

This species is readily separated from *N. squamosa* by the smaller size, much sparser and serially arranged scales of the elytra, and by the more elongate, less dorsally tumid pronotum.

Oraphanes, New Genus

Form moderately elongate, somewhat depressed, subparallel. Head with front short, oblique; palpi unequal, apical segments rather small, triangular; mandibles short, strongly arcuate at apical ½; eyes large, moderately coarsely faceted, deeply emarginate, upper lobes narrow, widely separated; genae very short; antennae longer than body in male, eleven segmented, segments from third slightly produced apically, obtusely carinate dorsally, scape conical, short, third segment about twice as long as first, fourth shorter than third, fifth longer than fourth, eleventh longer than tenth, basal segments with a few suberect setae beneath. Pronotum about as long as broad, sides with small rounded tubercles slightly behind middle; disk somewhat flattened, middle with a low glabrous callus; prosternum transversely impressed, intercoxal process slender, not extending beyond coxae, coxal cavities wide open behind, angulate externally; mesosternal process more than twice as wide as prosternal, rather abruptly declivous anteriorly, coxal cavities open to epimeron; metasternum with episternum narrow, tapering posteriorly. Elytra about three times as long as broad, sides subparallel; each elytron with two, fine, median costae; apices narrowly rounded. Legs elongate; femora gradually enlarging toward apices; tibiae slender, not carinate; posterior tarsi slender, first segment as long as two following together, third segment cleft almost to base. Abdomen normally segmented.

Type species.—Oraphanes binotatum, n. sp.

In the key to the genera of Mexican Hesperophanini (Chemsak and Linsley, 1963) this genus comes out to couplet 6 with *Eucrossus.* The lack of antennal and elytral spines on *Oraphanes* will immediately separate the two. *Oraphanes* appears unrelated to the other hesperophanine genera of Mexico.

Oraphanes binotatum, New Species

(Fig. 3)

Male.—Form moderately large, subparallel; integument reddish brown, elytra pale brownish, with two, median, elongate, pale spots with small dark spots anteriorly and larger, irregular dark spots posteriorly. Head finely, densely punctate, sparsely clothed with short appressed pubescence; antennae longer than body, scape finely, densely punctate, remaining segments minutely, densely punctate, densely clothed with short pubescence. Pronotum with disk very finely, densely punctate, median callus and lateral tubercles glabrous; pubescence very fine, short, pale, denser appearing at sides, sides with a few long erect hairs; prosternum anteriorly plicate, glabrous, pubescence fine; meso- and metasternum minutely, densely punctate, densely clothed with pale, subdepressed pubescence. Elytra finely, densely punctate, punctures becoming finer and sparser toward apex; pubescence very short, recurved, sparse; pale median spots not eburneous; costae uniting a little before apex; apices narrowly dehiscent, narrowly rounded. Legs minutely, densely punctate, femora finely pale pubescent, tibiae with pubescence appearing golden in oblique light. Abdomen minutely, densely punctate, moderately densely pale pubescent; last sternite broady rounded at apex. Length, 24 mm.

Holotype male (California Academy of Sciences) from 20 mi SW Colima, Colima, Mexico, 24 June 1967 (A. Hardy).

The reddish integument and dark testaceous elytra with two pale spots bordered anteriorly and posteriorly by dark patches make this species quite distinctive.

Giesbertia, New Genus

Form stout, subdepressed. Head with front subvertical, short, narrowly impressed transversely, with a deep pit below each antennal tubercle; palpi slightly unequal, short, apical segments cylindrical; mandibles stout, broad, emarginate-truncate at apices; genae narrow, subacute; eyes finely faceted, deeply emarginate, upper lobes small, broadly separated; antennal tubercles slightly elevated, divergent; antennae slender, longer than body in males, shorter than body in females, segments from third slightly expanded at apices, scape conical, shorter than third segment in males, subequal in females, fourth subequal to third in males, shorter in females, fifth longer than fourth. Pronotum broader than long, sides with very large, blunt tubercles at middle; disk in males with a broad, distinctly delimited, amphora-like median area, females with five, coarsely punctate calluses on disk; prosternum narrow, transversely impressed, intercoxal process narrow, abruptly declivous, lightly tuberculate, coxal cavities wide open behind, rounded externally; mesosternum with intercoxal process gradually arcuate, lying below tops of coxae; metasternum with episternum rather narrow, subparallel, scent glands distinct.

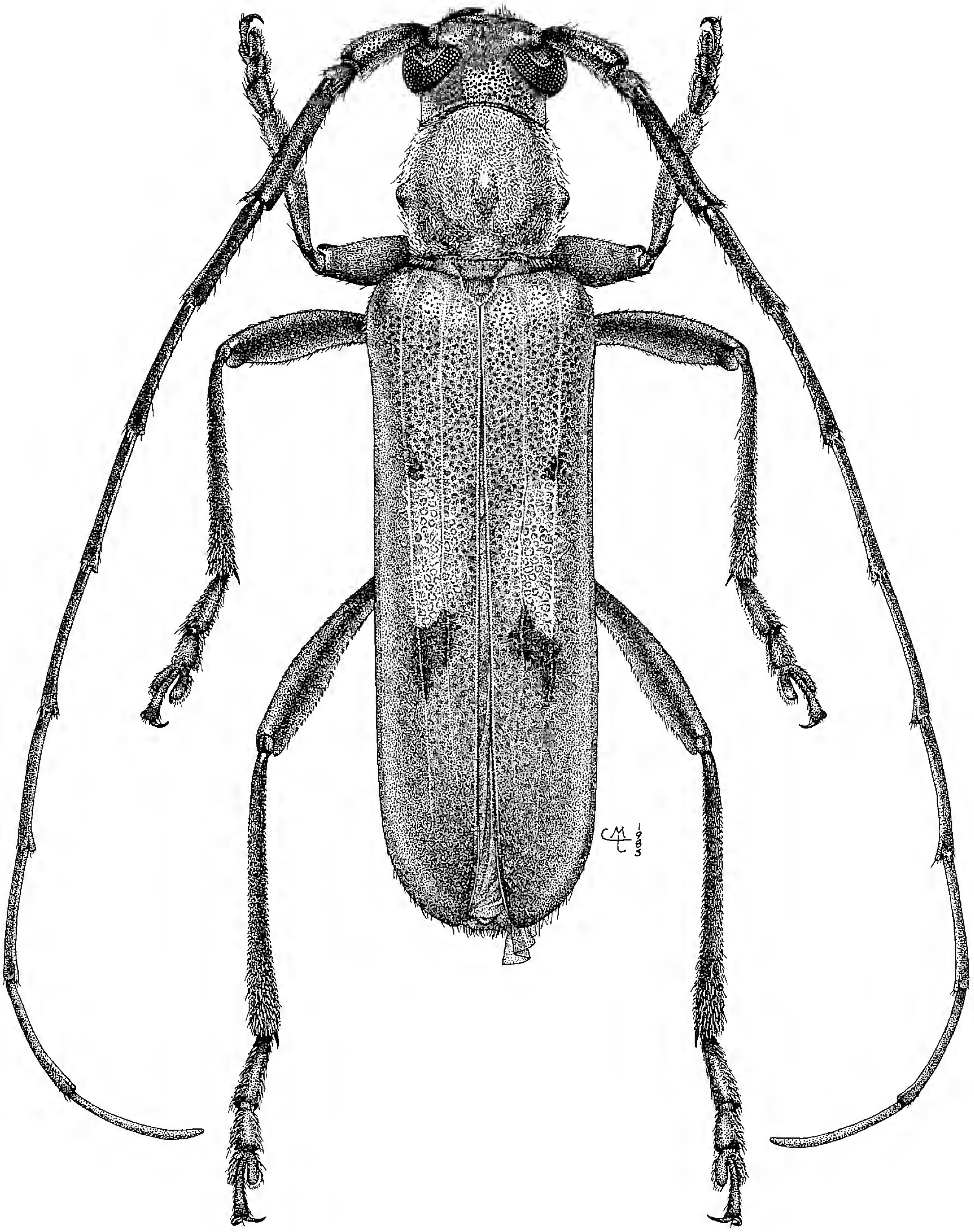

Figure 3. *Oraphanes binotatum* Chemsak and Linsley, ♂.

Elytra broad, slightly tapering, surface submetallic; apices slightly sinuately rounded. Scutellum longer than broad, apex acute. Legs stout, femora gradually enlarging toward apices, front pair subparallel; tibiae slender, not elongate; posterior tarsi slender, first segment shorter than following two together, third segment cleft almost to base. Abdomen normally segmented.

Type species.—Giesbertia rugosa, n. sp.

This genus appears to be related to the *Crioprosopus* and *Deltaspis* (sensu lato) group of Purpuricenini. *Giesbertia* differs from *Crioprosopus* by the shorter genae, more robust mandibles, sexual differences of the pronotum, much narrower prosternal process, and less prominent mesosternal process. Additionally, the metepisternum is narrower and subparallel. Since the genus *Deltaspis,* as presently constituted, contains a variety of forms, we can only compare *Giesbertia* with the type species of *Deltaspis, auromarginata* Serville. That species has finer, apically acute mandibles, smaller eyes, less prominently tuberculate sides of the pronotum, thicker antennae (at least in females) and strongly metallic integument.

We cannot ascertain the exact nature of the male antennae of *Giesbertia* since the only available specimen possesses only eight segments of one antenna.

It is a pleasure to dedicate this genus to E. Giesbert for his contributions to the knowledge of Cerambycidae.

***Giesbertia rugosa,* New Species**

(Fig. 4)

Female.—Form moderately large, subdepressed; integument black, head partially reddish, pronotum reddish along apical margin and on lateral tubercles, elytra vaguely metallic, blueish, narrowly reddish basally and laterally, underside medially reddish, femora reddish except apically; pubescence sparse dorsally, pale. Head finely, rugosely punctate; pubescence fine, pale, suberect, dense on basal ½ of mandibles; antennae extending to apical ⅓ of elytra, scape densely punctate, obtusely carinate, basal segments shining, outer segments opaque, segments three and four with longer, subdepressed pubescence, outer segments densely clothed with minute appressed pubescence, third segment subequal to scape, fourth shorter than third, fifth subequal to fourth, eleventh short, slender. Pronotum much broader than long, lateral tubercles prominent; disk coarsely, confluently punctate, with five calluses, one on each side before middle, one median behind middle and one on each side near base; pubescence long, pale, suberect; prosternum deeply, confluently punctate, finely, densely pubescent; meso- and metasternum densely, minutely punctate, densely clothed with pale, subdepressed pubescence. Elytra about twice as long as broad; basal ½ densely, coarsely, rugosely punctate, punctures becoming finer toward apex; pubescence on basal ½ pale, long, suberect, becoming short and appressed toward apex; apices slightly sinuately rounded. Legs densely punctate, moderately densely pubescent. Abdomen minutely, densely punctate, first four segments transversely glabrous at apices; pubescence fine, pale, suberect and appressed; last sternite broadly subtruncate at apex. Length, 28 mm.

Male.—Form similar, sides tapering slightly. Antennae longer than body, third segment longer than scape, fourth subequal to third, fifth longer than fourth. Pronotum with lateral tubercles less robust; disk vaguely callused, middle with a delimited amphora-like area enclosing dense, coarse, irregular punctures, outside areas more deeply, closely punctate; prosternum with a delimited, deeply punctate area. Abdomen with last sternite rather narrowly truncate. Length, 26 mm.

Holotype female (California Academy of Sciences) from 5 mi N Huetamo, Michoacan, Mexico, July 1976 (A. Lau). Paratypes as follows: 1 female, Cañon de Zopilote, 24 mi N Chilpancingo, Guerrero, Mexico, 11 July 1970 (E. Fisher, P. Sullivan); 1 male, Cuernavaca, Morelos, Mexico, 7000 feet, 29 July 1961 (R. and K. Dreisbach).

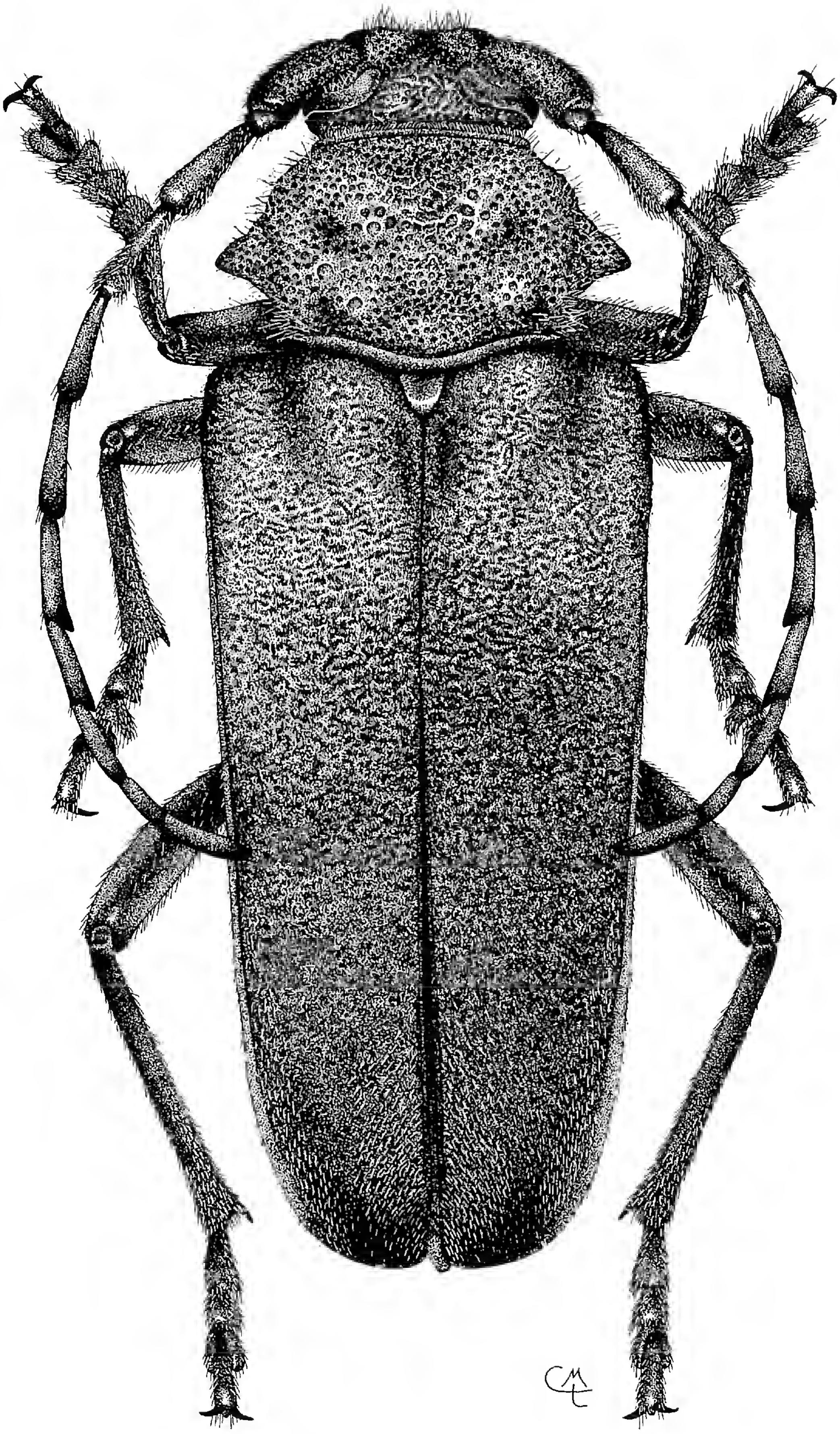

Figure 4. *Giesbertia rugosa* Chemsak and Linsley, ♀.

Some color variation is expressed in the amount of red on the head, pronotum, elytra, and underside.

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New Cynipid Wasps from California (Hymenoptera: Cynipidae)

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Five new cynipid species from Southern California are described in this paper plus a discussion of the biology of *Andricus reticulatus* Bassett. *Andricus reticulatus* Bassett was previously thought to occur on species of white oaks (*Lepidobalanus*) in the Southwest United States only but is now known to occur on several white oaks in California.

Gall-forming wasps are unique in the insect world in that the formations they produce are usually distinctive for each species; thus, galls collected long after the exit of the original makers give evidence of both described and undescribed species. The galls produced by the cynipid wasps described in this paper, have been known to other investigators; however, because of the difficulties involved in rearing the insects, sufficient numbers of the adults have never been obtained. In "Cynipid Galls of the Pacific Slope" (1957) Lewis Weld estimates that approximately one-third of the oak, gall-forming wasps in this region are still undescribed. A few new species have been described since this time (Dailey, 1973, 1977; Burnett, 1974) but there are many that are known from their galls only. There is still great need for ecological studies in this group since many known species represent the center of complex biological communities involving alternating generations and a host of parasites, hyperparasites and inquilines or guest wasps. Eighteen of these life cycles have been demonstrated (Lyon et al.) and circumstantial evidence indicates the existence of others. There are probably alternating generations in some of the following new species but experimental work will be necessary to demonstrate this. The terminology reviewed by Tulloch (1929), Eady and Quinlan (1963), and Dailey (1973) is used in describing cynipid thoracic and wing morphology in this paper.

Neuroterus chrysolepis, NEW SPECIES

Unisexual female.—Black except legs which are smoky yellow, proximal portions of coxae fuscous as are the femora and terminal tarsal segments. Front, clypeus, mandibles and lower cheeks piceous. First three segments of the antennae yellow, remaining segments fuscous. Ocelli brown. Head from above, transverse, broader than the thorax, granulo-coriaceous; from in front, broader than high, cheeks broadened behind the eyes; interocular area twice as broad as high, coarsely granular; malar space one-fifth the length of the eye with striations; face and clypeus beset with prominent, long, whitish bristles; antennae 14-segmented with terminal segment sometimes indistinctly divided in smaller specimens giving the appearance of 13 segments. Mesoscutum finely coriaceous with a few scattered white hairs; faint traces of notaulices visible, also traces of anterior lines. Scutellum joined to mesoscutum without a suture. Scutellum longer than broad with coriaceous disk, almost rugose in some lights. Disk margined on the sides with a broad, deep, shining groove at the base. Mesopleuron granulorugose beneath tegulae like the sides of the pronotum, rugose in lower portions. Mesosternum prominently bulging below. Propodeum with several longitudinal wrinkles. Wing, short, ciliate on front margin, longer cilia on posterior margin, pubescent, veins heavy and smoky brown. First abscissa of radius arcuate, at right angles to the second which is heavy and curves slightly upward; areolet well formed, reaching one-fourth the distance to the basal (Rs+M). M_1 reaching basal; distinct cloudy areas around basal cross vein and also in the anal area; radial cell elongated, four times as long as broad. Abdomen nearly as long as head and thorax combined, longer than high, compressed laterally, collapsed in pinned specimens; all tergites visible along the dorsal curvature. Ventral spine short, twice as long as broad, ovipositor projecting straight out from behind. Tarsal claws simple. Range in length of 59 specimens 1.7 mm. Average length 1.9 mm.

Types.—The holotype female and eight paratypes are in the collection of the U.S. National Museum. Other paratypes are in the collections of the California Academy of Sciences, Los Angeles County Museum, Weld Collection at Los Angeles City College and the collection of Charles Dailey.

Host.—*Quercus chrysolepis* Liebm.

Gall (Fig. 1A).—An abrupt, blister-like, monothalamous swelling that arises on the young stems of *Quercus chrysolepis.* The galls mature slowly and require at least nine months to complete their development. Developing galls contained large larvae in March, pupae in April and yielded adults in late April and early May. At this time, adult females could be taken as they oviposited into the new leaf buds and stem growth. Infestation was quite heavy on some trees and in many instances, the new growth was severely damaged or completely killed. This is the first *Neuroterus* to be described from *Quercus chrysolepis* or from related oaks in this group. Insects of this genus had previously been known from galls on white oaks only. This species shows distinct differences in sculpture from other Pacific Slope members of the genus.

Locality.—Specimens in the type series were collected at Pasadena, California.

Andricus reticulatus Bassett

This species, originally described by Bassett, 1890, has been recorded from a number of white oaks in the Southwest (Arizona, New Mexico and West Texas). The cynipids of the Southwest have been considered to be sharply separated from those of the Pacific Slope; therefore it is surprising to find this species producing galls on *Quercus engelmanni* Greene in Southern California (Fig. 1B). Specimens were collected on a number of trees near Los Angeles and Pasadena with the insects emerging in late February. Infestation was particularly heavy on some trees, usually younger ones, and in several instances, the trees were nearly defoliated. Female wasps were ovipositing in the unopened buds on 23 February in La Canada, California. These sites were marked with colored thread and with the opening of the new leaves, 23 March the young galls were immediately visible. The young galls were covered with pinkish, white hairs and growth was rapid so that galls were full sized by 23 April although the developing larvae were still small. The appearance of the new galls only one month after emergence of the adults indicates that an alternate bisexual generation does not exist in this species,

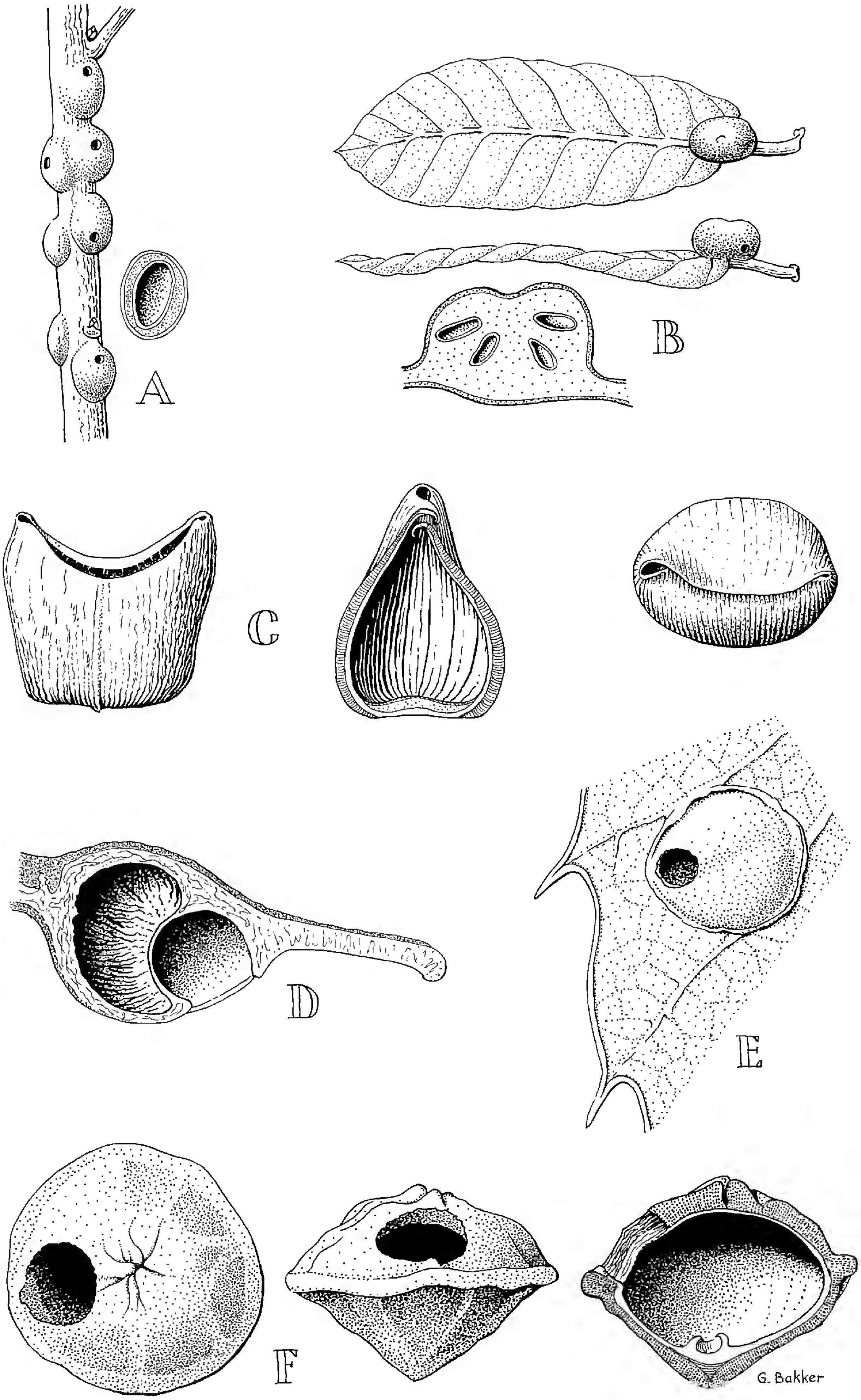

Figure 1. A. Blister galls of *Neuroterus chrysolepis* Lyon showing the typical arrangement of the galls on a young twig from *Quercus chrysolepis* Liebm. B. Petiole gall of *Andricus reticulatus* Bassett on *Quercus engelmanni* Greene with sagittal section showing arrangement of the larval cells. C. Characteristic leaf cup spangles produced by *Andricus bakkeri* Lyon on *Quercus dumosa* Nutt. D. Double chambered leaf gall of *Heteroecus crescentus* Lyon on *Quercus chrysolepis* Liebm. Larval chamber is shown on left side. E. Leaf blister gall produced by *Heteroecus devorus* Lyon on *Quercus chrysolepis* Liebm. F. Typical biconvex, lens-shaped galls produced by *Callirhytis lentiformis* Lyon. Galls are spherical when fresh.

at least in this area. The adult females were compared with paratypes of *Andricus reticulatus* Bass. from New Mexico and they appear to be the same, although the notaulices are incomplete in some specimens from *Quercus engelmanni.* Lewis Weld collected this California *Andricus reticulatus* many years ago and his notes indicate that he could not separate it from Arizona specimens. Figure 172 in "Cynipid Galls of the Pacific Slope," Weld, shows the gall as an undescribed species but notes similarity to *Andricus reticulatus* Bassett and an Eastern species, *Andricus petiolicola* (O.S.). There are twelve specimens of the California *reticulatus* in the Weld collection. Charles Dailey has sent in females of this species from galls collected on *Quercus turbinella* Greene, ssp. *turbinella* Tucker growing at El Condor, Baja California, Mexico and also from a hybrid oak, *Quercus dumosa* × *Quercus turbinella* Greene, ssp. *california* Tucker growing at Gorman, California. They are typical *Andricus reticulatus* Bass.

Andricus bakkeri, New Species

Unisexual female.—Uniform reddish brown except the posterior tergites and ovipositor sheaths which are dark brown; eye, ocelli, tips of the antennae, sides of the propodeum, metapleura and bases of the coxae, dark brown. Head transverse, coriaceous, as broad as the thorax; when viewed from the front, shows a distinct flattened hump in the ocellar area; cheeks not broadened behind the eyes; face beset with long, whitish hairs; interocular area more than twice as wide as high; malar space striated, one-third the length of the eye. Antennae 14-segmented, the third segment longer than the fourth and the terminal segment longer than the preceding one. Mesoscutum as broad as long, microscopically coriaceous, sparsely pubescent with scattered punctures. Notaulices percurrent and strongly curved. A short median groove can be seen in some specimens. Lateral lines smooth, slightly depressed. Scutellum rounded behind, rugose and pubescent; pits deep, separated, with bottoms smooth and shining. Mesopleura smooth, polished and bulging slightly below. Wing hyaline, pubescent, ciliate; veins brown, areolet small and faint; M_1 not reaching the basal (Rs+M); radial cell three times as long as broad. Legs pubescent, tarsal claws toothed. Propodeum with arcuate carinae, area between, smooth. Abdomen longer than high with tergites II and III only, showing along the dorsal curvature. All tergites punctate along the posterior borders. Ventral spine almost bare, six times as long as broad. Range in length of 26 females, 1.3–2.0 mm. Average length 1.6 mm.

Types.—The holotype female and six paratypes are in the collection of the U.S. National Museum. Other paratypes are in the collections of the California Academy of Sciences, the Los Angeles County Museum, the Weld collection at Los Angeles City College and the collection of Charles Dailey.

Host.—*Quercus dumosa* Nutt.

Gall (Fig. 1C).—A monothalamous, cup-shaped leaf spangle, 3–3.5 mm in height. The larval cell occupies the base of the cup whose margins are collapsed at maturity. The galls appear on the leaves during the early summer months and grow rapidly until they reach full size in August. At this time the galls are red and contain small larvae. Pupation occurs in late October and early November. Mature, fully winged, active adults can be cut out in early December; however, normal emergence takes place in February and March, and later in some areas. The gall resembles the gall of an Arizona species *Andricus scutella* Weld but is somewhat smaller. The adult females of *Andricus bakkeri* can be distinguished from *A. scutella* by the following characteristics: When viewed from the front, the head shows a prominent, flattened hump in the ocellar area; the cheeks are not broadened behind the eyes; the antennae are 14-segmented; wing more densely pubescent; the abdomen is distinctly longer than high. *A. scutella* does not have the flattened ocellar hump, the cheeks are slightly broadened behind the eyes, the antennae are 13-segmented and the abdomen is almost as high as long. A similar gall is frequently associated with the galls of *A. bakkeri.* This gall is also a monothalamous, cup-shaped leaf spangle but the edges are inrolled like the gall of *Phylloteras cupella* (Weld) from Arizona, although the insects do not resemble the latter. This associated cup spangle is doubtfully distinct from *A. bakkeri* but there are some minor morphological differences. Photographs of the galls are both shown in Weld's "Cynipid Galls of the Pacific Slope."

Locality.—The type and paratypes were collected at La Crescenta, California. Galls have also been taken on *Quercus garryana* Dougl., *Quercus engelmanni* Greene and probably occur in many areas where these oaks are found.

***Heteroecus crescentus,* NEW SPECIES**

BISEXUAL GENERATION

Female.—Deep reddish brown, almost black. Parts of the head, mesoscutum and abdomen yellowish. Antennae yellow. Head transverse, as wide as the thorax, rugocoriaceous, only slightly broadened behind the eyes. Interocular space, twice as wide as high. Malar space rugose, one-third the length of the eye. Ocellar area appearing flattened when viewed from the front. Occiput concave. Antennae 13-segmented, the third segment longer than the fourth, terminal segment twice as long as the preceding one and appearing to be divided in some specimens. Mesoscutum broader than long, roughly coriaceous with scattered pubescence. Notaulices incomplete, very deep posteriorly with ridged bottoms. Median groove deep extending one-third the distance to the forward margin. Lateral lines represented by smooth, raised lines. Scutellum rounded behind, coarsely rugose especially on the posterior portion. Pits deep, separated, with ridged bottoms. Mesopleuron aciculate, smoother ventrally and slightly bulged. Wing hyaline, pubescent and short ciliate. Veins very light, areolet present but faint. M_1 not reaching basal (Rs+M). Radial cell five times as long as broad. First abscissa of radius angled. Legs pubescent, tarsal claws simple. Propodeum with arcuate carinae, area between ridged. Abdomen higher than long, tergite II only visible tergite along the dorsal curvature, smooth and occupying nearly all the abdomen in side view. Other tergites visible when abdomen distended with eggs. Ventral spine bare, five times as long as broad. Range in length of 14 females, 1.5 mm to 1.8 mm. Average length 1.65 mm.

Male.—Body black, except abdomen which is dark, reddish brown and legs which are yellow. Head with very large eyes, malar space narrow, one-fifth the length of the eye. Interocular space twice as wide as high. Ocelli protruding conspicuously. Antennae fuscous with 15 segments. Mesoscutum uniformly rugose, not as coarse as female. Pits deep and confluent. Wings pubescent with conspicuous cilia along the posterior margins. Areolet small, absent in some specimens. M_1 reaching the basal. Abdomen with tergites II and III visible along the dorsal curvature. Range in length of 14 specimens, 1.4–1.8 mm. Average length 1.6 mm.

Types.—The holotype female, the allotype male and four paratypes are in the collection of the U.S. National Museum. Other paratypes are in the collections of the California Academy of Sciences, the Los Angeles County Museum, the Weld collection at Los Angeles City College and collection of Charles Dailey.

Host.—*Quercus chrysolepis* Liebm.

Gall (Fig. 1D).—A small, green blister two and one-half mm in length, showing on both sides of the leaf. Galls are double chambered with the developing larvae and pupae occupying the lower chamber. The adult insects emerge from the lower side of the leaf.

Locality.—The type and paratypes were collected from galls on *Quercus chrysolepis* Liebm. in La Crescenta, California.

***Heteroecus devorus,* NEW SPECIES**

BISEXUAL GENERATION

Female.—Reddish brown, antennae and legs amber. Head transverse, as wide as the thorax, roughly granular, not broadened behind the eyes. Interocular space two-fifths as high as wide. Malar space slightly depressed, two-fifths the length of the eye. Ocellar area somewhat flattened when viewed from in front; anterior ocellus depressed. Occiput concave. Antennae 13-segmented, the third as long as the fourth, terminal segment almost twice as long as the preceding one. Mesoscutum broader than long, roughly coriaceous with scattered pubescence. Notaulices incomplete, wide and deep posteriorly with ridged bottoms. Median groove represented by a small notch. Lateral lines visible as smooth, raised ridges. Scutellum rounded behind, coarsely rugose, especially posteriorly. Pits deep, separated, bottoms slightly ridged. Mesopleuron aciculate, slightly bulged. Wing hyaline, pubescent, not ciliate; veins light brown, areolet distinct, reaching one-fourth the distance to the basal (Rs+M). M_1 not reaching basal; radial cell six times as long as broad; first abscissa of radius arcuate. Legs pubescent, tarsal claws simple. Propodeum with parallel carinae. Abdomen longer than high, all tergites visible along the dorsal curvature. Tergite II the largest with posterior margin punctate. Ventral spine long and slender, eight times as long as broad with a few scattered bristles. Range in length of eight females, 1.4–2.2 mm. Average length 1.8 mm.

Male.—Body orange yellow, head and eyes black, ocelli amber. Eyes very large, malar space narrow, only one-tenth the length of the eye. Interocular space three-fifths as high as wide. Ocelli large and protruding with rugose surrounding area. Antennae with 15 segments. Mesoscutum not as rough as female with a median groove extending one-third the distance to the pronotum. Scutellar pits deep and confluent. Wing pubescent with conspicuous cilia along the posterior margin. Areolet small but well defined. M_1 reaching basal (Rs+M). Range in length of four specimens 1.65 mm.

Type.—The holotype female and the allotype male are in the collection of the U.S. National Museum. Paratypes are in the collection of the California Academy of Science.

Host.—*Quercus chrysolepis* Liebm.

Gall (Fig. 1E).—A small, monothalamous leaf blister 2.3 mm in length. The galls are visible on both surfaces of the new leaves and mature rapidly. Adults emerge from the upper surface of the gall 24 May–7 June.

Locality.—The types and paratypes were collected from galls growing on the leaves of *Quercus chrysolepis* Liebm. in Pasadena, California.

Callirhytis lentiformis, NEW SPECIES

Unisexual female.—Uniform reddish brown, ovipositor sheaths chocolate. Head transverse, slightly narrower than the thorax, cheeks bulging prominently behind the eyes. Malar space depressed, striated, less than one-half the length of the eye. Interocular space three times as wide as high. Ocellar area coriaceous with a few scattered punctures. Anterior ocellus depressed. Occiput strongly concave. Antennae 14-segmented, the third segment slightly longer than the fourth, the terminal segment longer than the preceding one. Mesoscutum as long as broad, coriaceous, sparsely pubescent with scattered, shallow punctures. Notaulices percurrent, very deep and strongly arcuate. Median represented by a small notch. Lateral lines very short depressed. Scutellum coarsely rugose, margined, pits deep, separated, with the bottoms smooth and shining. Mesopleuron shining, slightly aciculate with a smooth area under the base of the wing. Wing hyaline, ciliate, pubescent with brown veins. Areolet large, reaching one-fifth the distance to the basal (Rs+M). M_1 not reaching basal. Radial cell nearly four times as long as broad. First abscissa of radius sharply angled and with a faint cloud. In some specimens, this vein shows a distinct spur. Legs amber, claw simple. Propodeum with parallel carinae, area between, smooth. Abdomen higher than long, smooth, polished except posterior tergites which are slightly punctate. All tergites showing along the dorsal curvature. Ventral spine long and slender, six times as long as broad with a few bristles. Ovipositor sheaths protruding. Average length of 230 females, 2.8 mm.

Type.—The holotype female and ten paratypes are in the collection of the U.S. National Museum. Other paratypes are in the collections of the Los Angeles County Museum, the California Academy of Science and the collection of Charles Dailey.

Host.—*Quercus agrifolia* Nee.

Gall (Fig. 1F).—A spherical, deciduous, bud gall that drops to the ground in October. The galls resemble the galls of *Callirhytis agrifolia* Bassett but are much smaller and quickly shrivel to a biconvex, lens-shaped gall 3.5 mm in diameter. The galls contain large larvae at the time they drop from the tree but adults do not emerge until the following summer (July, August and September).

Locality.—The type and paratypes were collected from *Quercus agrifolia* Nee growing in the San Gabriel Mountains north of Pasadena, California.

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A Digger Wasp Preying on a Jerusalem Cricket

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Palmodes spp. (Hymenoptera: Sphecidae) are primarily predators on katydids (Orthoptera: Tettigoniidae) (Bohart and Menke, 1976). The only known exception to this is *P. carbo* Bohart and Menke whose single reported prey species is *Cyphoderris strepitans* Morris and Gwynne (Haglidae) (Evans, 1970). We observed the nesting cycle of a *P. carbo* female preying on a Jerusalem cricket, *Stenopelmatus fuscus* Haldeman (Stenopelmatidae) and are reporting it here both to add to the paucity of prey records for *P. carbo* and to report this species as the first known hymenopteran predator of Jerusalem crickets, a widespread group of Orthoptera in the Southwestern U.S. (Tinkham and Rentz, 1969).

At approximately 0845 on 13 July 1981, 8 km N of Dutch John, Daggett Co., Utah, a female *P. carbo* was located by her intermittent buzzing as she excavated her prey near the base of a sagebrush plant. With alternate movements of her forelegs she excavated soil from around a Jerusalem cricket located 1–2 cm beneath the soil surface. The prey was on its back and kicking vigorously when uncovered by the wasp. Working rapidly, the wasp uncovered the cricket, grasped it with her legs and stung it in the neck region. The paralyzed prey was then dragged away by the wasp. At this point a plastic bag was placed over the pair and the insects were observed in the bag. The wasp continued to grasp her prey and was released from the bag at the point of capture a few minutes later. She straddled the cricket and, holding it in her mandibles, dragged it headfirst over the ground (Fig. 1). The prey was left three times while the wasp searched in the area. The third time this occurred, the wasp located and opened the entrance to her nest. She returned to her prey 2.3 min later and dragged it to the nest entrance. She then proceeded to back into the burrow dragging the prey. At this point we interrupted her by pulling the cricket a few cm from the entrance in order to take photographs. The prey was then dragged into the nest headfirst and the wasp reappeared at the nest entrance 3.1 min later. Nest closure took 26.5 min with the female alternately throwing soil to form a mound at the nest entrance and turning to push the soil into the burrow with her head and foretarsi. Occasionally, she carried debris to the nest entrance and packed it into the burrow. At one point she used a small stone, held in her mandibles, to push the soil. The entire nesting cycle was estimated at ca. 50 min (subtracting the times that we disturbed the wasp). The single prey, some 8 times heavier than the wasp (1.508–0.185 g wet weight) was positioned on its right side, 5 cm deep and ca. 8 cm from the nest entrance. The 3.5 mm egg was attached to the first abdominal segment and was positioned transversely over the left metathoracic coxa (Fig. 2, arrow).

Thus, *P. carbo*'s only known prey are fossorial orthopterans in that it takes both Jerusalem crickets and haglids (individuals of both groups are nocturnal and

Figures 1–2. 1. *Palmodes crabro* shown grasping her prey (a Jerusalem cricket) with her mandibles while dragging it into her nest. 2. Arrow indicates position of wasp's egg.

burrow into the soil during the day). This is in contrast to the known prey of the six other *Palmodes* species, all of which take bush inhabiting Tettigoniidae (Bohart and Menke, 1976).

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Observations on the Behavior of *Triepeolus* nr. *eldredi* Cockerell (Hymenoptera: Anthophoridae)

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Bees in the genus *Triepeolus* Robertson (Anthophoridae) are cleptoparasites (nest parasites) of several species of the bee genus *Melissodes* Latreille (Anthophoridae) (Bohart, 1970). Of the species of *Melissodes* whose nesting biologies are known, it has been reported that the entrance tunnels in the nests of two species (*M. pallidisignata* Cockerell, *M. rustica* (Say)) are continuously plugged with loose sand from the time of initial nest construction to cell closure (Thorp, 1964; Clement, 1973). Thorp (1964) suggested that the absence of parasites from the nests of *M. pallidisignata* was possibly due to the plugged tunnels. Clement (1973) reported, however, that the plugged entrance tunnels of *M. rustica* nests were no deterrent against parasitism by *Triepeolus* nr. *eldredi* Cockerell. In fact, examination of 51 single celled nests of *M. rustica* revealed that 24 had been parasitized by the cleptoparasite.

This paper makes available information about the behavior of *T.* nr. *eldredi* at a nest site of *M. rustica.* Observations were carried out during the 1972 nesting cycle and thereafter on one day during each of the nesting cycles of 1977 (July 30), 1978 (July 27), and 1979 (July 26). The study site, which is located in Yellowstone National Park, was previously described during a study of *M. rustica* (Clement, 1973).

On warm (>18°C) sunny days of observation numerous individuals of both sexes of adult *T.* nr. *eldredi* were seen flying in a search pattern a few cm above the ground of the *M. rustica* nest site. Additionally, both sexes of the parasitic bee were seen visiting nearby flowers of *Eriophyllum integrifolium* (Hook.) Smiley (Compositae). As reported earlier (Clement, 1973), *M. rustica* females relied exclusively on this floral source for pollen.

On several occasions, females of *T.* nr. *eldredi* alighted at the edge of an active nest where an incoming host bee was in the process of searching for her nest entrance (Fig. 1). While a host bee remained inside her nest ($n = 12$ obs.; 11–30 min), I observed a continuous turnover of parasitic bees waiting near the nest entrance. In contrast to the observations of Rozen et al. (1978) on another parasitic anthophorid bee, *Protepeolus singularis* Linsley and Michener, I did not observe individual bees wait for extended periods near a nest entrance while a *Melissodes* host was inside the nest. Although the significance of the behavior depicted in Figure 1 is unclear, it may be used by this parasitic bee to learn the positions of nest entrances, thereby allowing them to leave and then find the same nest again. A discussion of nest-location learning behavior in other parasitic bees is provided by Rozen et al. (1978).

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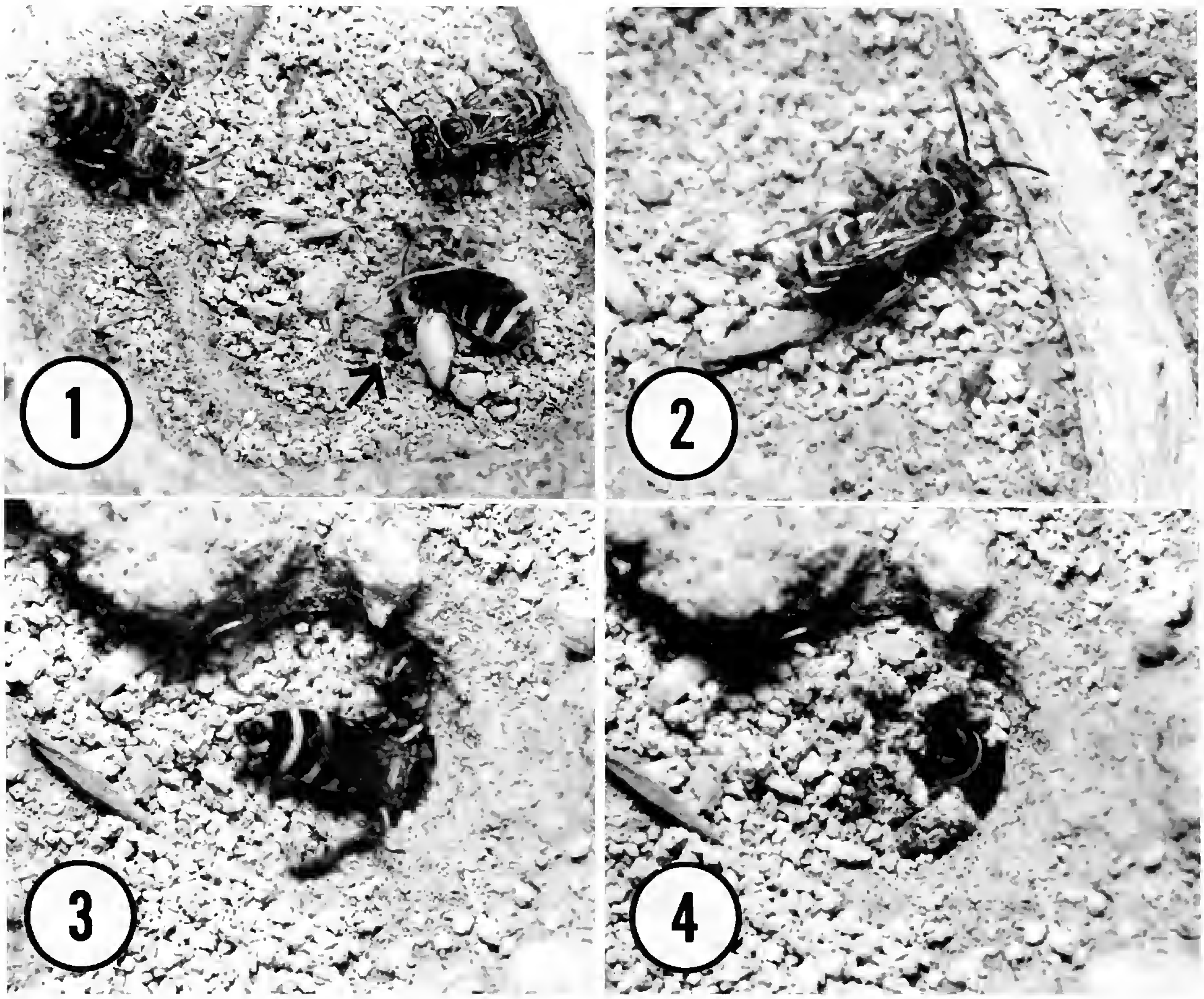

Figures 1–4. 1. Incoming female *Melissodes rustica* (arrow) searching for nest entrance with parasitic females of *Triepeolus* nr. *eldredi* resting above her. 2. *T.* nr. *eldredi* female searching the ground of the nest site. 3. *T.* nr. *eldredi* female entering the burrow of a *M. rustica* nest. 4. Same parasitic bee penetrating loose sand of burrow plug.

On 31 occasions I observed parasitic bees enter and remain in nests for 7–20 min, leaving before the host bee returned. These bees appeared to locate nest entrances by either randomly searching the ground of the nest site (Fig. 2), or by observing host bees leave their nests. In the latter case, parasites alighted near nest entrances as the host bees were in the process of digging out of plugged burrows. In 5 instances, however, I observed a parasite enter a nest while the host bee was in the nest, but these bees exited the nest within 1 min after disappearing into the plugged burrow. Thus, it would appear that the avoidance behavior just described serves to reduce disturbance of the host while she is provisioning her nest.

Once a nest entrance was located it usually took several minutes of parasite digging activity ($n = 18$ obs.; 2–10 min) before the head and most of the thorax disappeared into the burrow plug (Fig. 3). After gaining this foothold in the burrow plug, a bee usually all but disappeared (Fig. 4) in <1 min. During the initial digging phase (Fig. 3 and before), female bees scraped loose sand particles out of the tunnel entrance with their forelegs and probably their mandibles. The next action involved backing away from the entrance for a short distance (<6 cm) during which the kicking and scratching activity of the two posterior pairs of legs propelled sand particles away from the nest entrance. It was apparent that *T.* nr. *eldredi* experienced more difficulty in gaining entrance to a nest than did the host bee. As previously reported (Clement, 1973), burrowing host bees quickly disappeared (12–28 sec) once they located their nest entrance.

I frequently observed parasitic females briefly grapple with each other on the ground near nest entrances. Sometimes these encounters simultaneously involved 2–4 bees. Intraspecific aggressive behavior may have interfered with the ability of individual bees to perch for extended lengths of time near nest entrances. Interestingly, a specific form of antagonistic behavior was observed in one instance where two parasites were seen attempting to pull a third from a nest entrance. I did not observe any aggressive behavior between *Melissodes* and *Triepeolus* bees, an observation that agrees with Bohart's (1970) statement that host bees usually ignore inquilines that approach or enter their nests. In contrast, aggressive interactions involving host bees and cleptoparasitic bees have been reported by Thorp (1969), Rozen et al. (1978), and Eickwort and Abrams (1980).

A unique feature of the behavior of *T.* nr. *eldredi* is its ability to dig through the plugged tunnels of active nests of *M. rustica.* Moreover, a parasitic bee must penetrate a plug that covers a linear distance of 6–20 cm in order to reach and parasitize a cell (Clement, 1973 and unpubl. data). Other parasitic Anthophoridae, namely melectine bees, are known to dig through the soil plug of completed host nests (see Thorp, 1969). This is the first report that documents "digging behavior" by a nomadine bee.

In their studies, Thorp (1964) and Clement (1973) noted that cell provisions emitted a moderate or strong fermenting odor. Stephen et al. (1969) reported that a similar type of odor has been detected in the abdominal venter of some adult females in the Anthophorini and that this odor may serve as an attractant to the nesting site. Is it possible that *Melissodes* and *Triepeolus* females are directed in part by a chemical cue in nest plugs when they search (as shown in Fig. 2) for nest entrances at the Yellowstone nesting site? In this context, Tengo and Bergstrom (1977) presented evidence suggesting that odor correspondence between cleptoparasites (*Nomada* bees) and hosts (*Andrena* bees) permitted female parasites to locate and then gain access to a host nest more easily.

Acknowledgments

I dedicate this paper to Professor R. M. Bohart who first encouraged me to study the biology and behavior of insects. I thank Dr. R. W. Rust for field assistance and Dr. W. L. Rubink for reviewing the manuscript.

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Phobetus desertus, a New Melolonthine Scarabaeidae (Coleoptera) from the Central Desert of Baja California, Mexico

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Phobetus was first reported from Baja California, Mexico, with the description of *Phobetus chearyi* Hardy (1973). Since then *Phobetus sleeperi* Hardy was described from a single male specimen collected 11.7 km east of El Rosario. The present paper describes a third endemic species to the peninsula, *Phobetus desertus* n. sp. This species is distinguished from *P. sleeperi* by its larger size, black color, white ventral thoracic pile and smooth elytra. Only limited biological information has been reported for *Phobetus comatus* LeConte, *Phobetus palpalis* Saylor (Cazier, 1937) and *P. chearyi* (Hardy, 1973). Shook (1979) reported an adult *P. comatus* as a prey item for the tiger beetle *Cicindela purpurea auduboni* LeConte. Males of *P. desertus* flew during a light rain shower in January 1976, on a clear morning in January 1981 and following a night of showers in January 1982, being attracted to and mating with stationary females. Little is known of the larvae and host plants of the genus. Cazier (1937) reported larvae of *P. comatus* from roots of *Artemisia californica* Less., and Ritcher (1949, 1966) provided a description of the *P. comatus* larva. To our knowledge there is no published description of the *Phobetus* egg. Some biological observations are reported for the new species, as well as meteorological information and soil parameters for the type locality.

Resumen

El género *Phobetus* se fue divulgado primero de Baja California, Mexico, con la descripción de *Phobetus chearyi* Hardy (1973). Desde entonces *Phobetus sleeperi* Hardy se fue describido del único ejemplar masculino colectado 11.7 km este de El Rosario. Este papel describe la tercera especie endémica de la península, *Phobetus desertus* n. sp. Este especie se distingue de *P. sleeperi* por su tomaño mas grande, color negro, pelo blanco y ventral torácico, y élitros lisos. Sola la información biológica que es limitada ha divulgado de *Phobetus comatus* LeConte, *Phobetus palpalis* Saylor (Cazier, 1937) y *P. chearyi* (Hardy, 1973). Shook (1979) divulgó un *P. comatus* adulto como una cosa de rapiña por *Cicindela purpurea auduboni* LeConte. Los machos de *P. desertus* volaron durante una lluvia ligera en el enero de 1976, en una mañana clara en enero de 1981 y después de un noche de lluvia ligera en el enero de 1982, se fueron atraidos y se aparearon con las hembras estacionarias. No mucho se sabe de las larvas y plantas de hostias del género. Cazier (1937) divulgó las larvas de *P. comatus* de las raíces de *Artemisia californica* Less., y Ritcher (1949, 1966) proveyó una descripción de las larvas de *P. comatus.* De nuestro conocimiento no hay una descripción publicado del huevo de *Phobetus.* Algunas observaciones biológicas se divulgan por las especies nuevas, así como la información meteorológica y parámetros de la tierra por la locilidad del tipo.

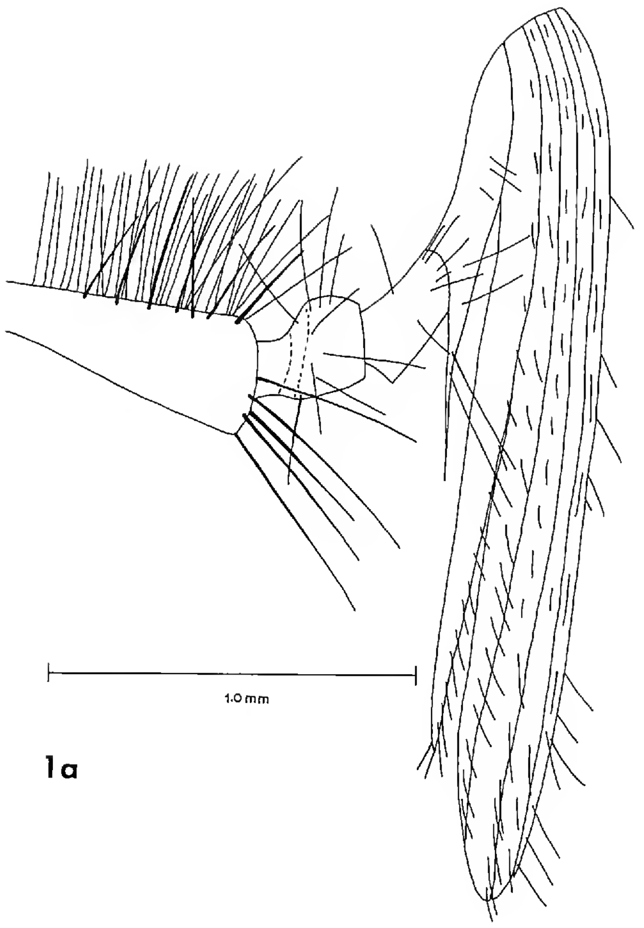
Phobetus desertus, New Species

Holotype male.—Length 13.6 mm, width 6.0 mm (elytra humeri). *Head:* Black, clypeus and frons densely punctate, with scattered short brown setae; vertex smooth, shining, with scattered punctures laterally. Antennae (Fig. 1a) 9 segmented, with 6 segmented club, lamellae of segments four 0.52 and five 0.83 length of remaining lamellae; ratio of length of scape to maximum lamellae 1:2.8, venter of scape with long white setae, apex and lateral margins with erect brown setae. Palpi 3 segmented, first 0.47, second 0.31 mm, black, slender; terminal segment 0.62 mm black to fuscous, apex white, slightly inflated. Venter covered with long, white to yellow setae. *Prothorax:* Width 5.0 mm; black, shining, with fine punctures; marginal bead complete; setae cream anteriorly, paler laterally, white posteriorly; disc glabrous. *Elytra:* Black, shining, length 9.6 mm, expanded behind humeri, appearing smooth to naked eye, but with faint striae, transverse rugulosities and scattered micropunctures which are larger and more concentrated anteriorly; surface with long, white setae anteriorly, and a row of stout, brown to black setae laterally, becoming shorter posteriorly, absent apically. *Pygidium:* Black, shining, with scattered punctures, white setae. *Legs:* Profemora fuscous to black with long, white setae ventrally, single median row of stout black setae dorsally; protibiae black with brown spot dorsally, tridentate, apical spur subequal to distal tooth; tarsal claws bifid; meso-, metatibiae with circle of apical teeth, two large posterior apical spurs. *Abdomen:* Black, six free sternites, with scattered, fine punctures and white setae. *Genitalia:* Figure 2. Brown, finely wrinkled. Parameres contiguous in basal ⅓, separate distal ⅔; distal ⅕ swollen to twice medial paramere width; mesal margins with two emarginations; pronounced lateral carina and declivity in basal ⅓. Apex of parameres with median carina.

Allotype female.—Length 14.4 mm; width 6.5 mm (elytra humeri). Differs from holotype as follows: *Head:* Antennae (Fig. 1b) 9 segmented with 5 segmented club; ratio of scape length to maximum lamellae length 1:1.5; setae brown. *Prothorax:* Width 5.3 mm, black with faint fuscous markings as stripe medially, two spots laterally, band on posterior margin. *Elytra:* Length 9.2 mm; translucent, yellow to brown, margins fuscous to black, punctulate, with internal features resembling fracture lines. *Legs:* Profemora with dorsal row of brown setae.

Material examined.—Holotype male (CAS #14103), allotype female, 220 paratypes (206 male, 14 female): Mexico, Baja California Norte, 9 km NW Rancho Santa Inés, Lat. 29°46′N, Long. 114°46′W, 550 m, 6 January 1982, William H. Clark and Paul E. Blom. Twenty-four male paratypes, above locality, 22 January 1976, Dave Ward. Thirty-six paratypes (35 male, 1 female), above locality, 22 January 1976, William H. Clark. Two hundred male paratypes: Mexico, Baja California Norte, 7.7 km N Catavinacito, 19 January 1981, E. L. Sleeper. Primary types at California Academy of Sciences, San Francisco; paratypes deposited at Orma J. Smith Museum of Natural History, College of Idaho, Caldwell; Universidad Nacional Autonoma de Mexico, Coyoacan; Instituto Nacional de Agricolas, Chapingo; Los Angeles County Museum of Natural History, California; San Diego Natural History Museum, California; California Department of Agriculture, Sacramento; Santa Barbara Museum of Natural History, California; California State University, Long Beach; University of Idaho, Moscow; and collections of the authors.

Variation in paratypes.—Males: Elytra length 8.1 to 11.0 mm. Pronotal width



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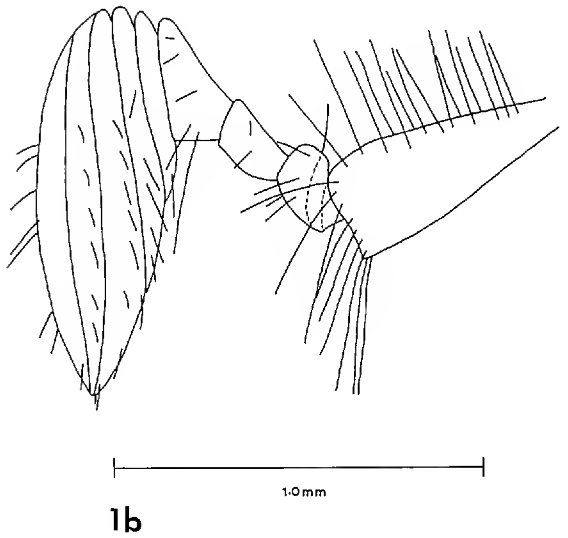

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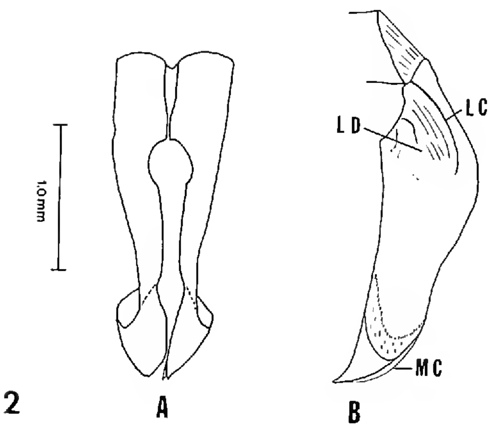

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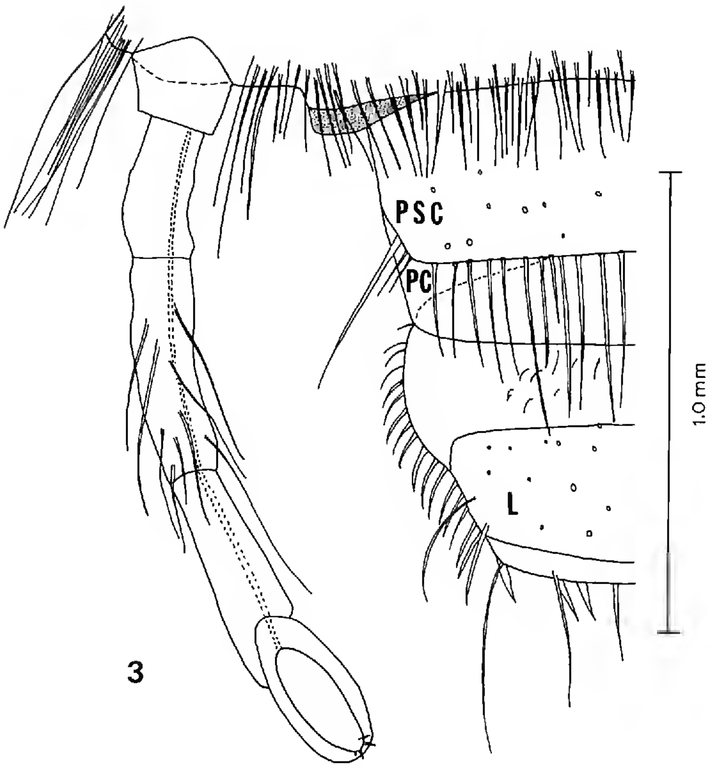

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Figures 1–3. 1. Antennae of *Phobetus desertus* primary types; 1a, holotype male; 1b, allotype female. 2. Genitalia of *Phobetus desertus* holotype male; 2a, frontal view; 2b, lateral view; MC = median carina, LC = lateral carina, and LD = lateral declivity. 3. *Phobetus desertus* first instar larva head and antenna, frontal view; L = labrum, PC = preclypeus, PSC = postclypeus.

4.0 to 5.7 mm. Head setae predominately brown, grading to black in a few specimens. Palps brown to black. Elytra predominately black occasionally grading to slightly fuscous. Legs black to fuscous. Females: Elytra length 7.5 to 10.3 mm. Pronotal width 4.0 to 5.7 mm. Frons fuscous to black. Pronotum light brown with black markings to black. Elytra with or without internal features resembling fracture lines.

Diagnosis.—Phobetus desertus males can be distinguished from all other species of *Phobetus* except *P. sleeperi* by the six segmented club. *Phobetus desertus* keys to *P. sleeperi* in Hardy's key (1978), but differs from this species by the white pile, black pronotum and elytra, larger size and significantly smoother elytra. Specimens of *P. desertus* which approach fuscous in elytra color still appear black to the naked eye, thus differing from the holotype of *P. sleeperi.* Male genitalia of *P. desertus* have the lateral carina long and the declivity pronounced and deep, while *P. sleeperi* has only a short lateral carina with a small shallow declivity. Mesal margins of the parameres in *P. desertus* are usually with 1 or 2 emarginations, whereas in *P. sleeperi* it is straight. An apical medial carina occurs in *P. desertus,* but is lacking in *P. sleeperi.* Female *P. desertus* resemble males of *Phobetus saylori* Cazier, but can be distinguished by their blunt, five segmented club.

Remarks.—There is a marked resemblance between *P. desertus* and *P. sleeperi.* However it is impossible to assess the variation of *P. sleeperi* as the species is known from only the single male holotype. The six segmented club of the male and the dark coloring are the most evident similarities between the species. Close examination of *P. desertus* reveals slight rugulosities in the elytra and a few of the paratypes show a translucent character to the elytra and a shading to fuscous, reinforcing the similarity. The genitalia of *P. desertus* are also similar to that of *P. sleeperi.* However, specific distinction is proposed here for *P. desertus* based on the following differences: Size of *P. desertus* is much larger than *P. sleeperi.* Hardy (1978) measures the length of *P. sleeperi* as 11.7 mm; our measurements (with an ocular micrometer from the dorsal aspect), which correspond to those for male *P. desertus* of $\bar{x} = 13.4$ mm ($n = 258$), show the length of *P. sleeperi* at 10.5 mm. Hardy (1978) also reports a width for the thorax of *P. sleeperi* at 4.25 mm, comparing to a mean pronotal width of 5.0 mm for *P. desertus* ($n = 265$, $s = 0.58$). The ratio of elytra length to pronotal width is 1.95 for male *P. desertus* ($n = 260$, $s = 0.061$) and 2.5:1 for *P. sleeperi,* showing *P. desertus* to be much more robust. While in *P. desertus* the ventral pile is consistently white grading to cream only on the anterior margins of the pronotum, the thoracic setae are uniformly brown in *P. sleeperi.* Head setae of *P. desertus* like those of *P. sleeperi* are brown. The consistently black appearance of *P. desertus* differs obviously from the fuscous color of *P. sleeperi,* though with microscopic examination a few of the *P. desertus* shade to fuscous. Transverse rugosities and striations are obvious in *P. sleeperi,* but obscure in *P. desertus.*

At present the genitalia of *Phobetus* provide minimal information for specific determination. Strong genital similarities between *P. sleeperi* and *P. desertus* are also shared by *P. saylori.* Such interspecific similarities coupled with intraspecific variation in *P. comatus* and *P. desertus* accord this character little value. Cazier (1937) reports genitalic similarity between the externally distinct *Phobetus mojavus* Barrett and *P. palpalis* and considers the character of limited value. See illustrations in Cazier (1937) and Hardy (1978).

Locality information on the holotype of *P. sleeperi* and subsequently reported in Hardy (1978) is "5 mi E El Rosario." However, according to the collector, E. L. Sleeper (pers. comm.), this is an error for the collection was actually made 11.7 km (7.25 mi) east of El Rosario, Baja California, Mexico, placing the collection

Table 1. Soils data for six areas at our *Phobetus desertus* collection site 9 km NW Rancho Santa Ines, Baja California, Mexico (— parameter not analysed).

		Parameter							
Sample	Depth (cm)	Electrical conductivity of saturation extract (μmhos)	Sodium-adsorption ratio	pH	Texture	Calcium carbonate	Phosphorus (ppm)	Potassium (ppm)	Nitrate nitrogen (ppm)
1 a	305	0.7	5.25	7.8	Coarse sand	Slight	2.6	73	<10
b	915	0.6	3.44	8.6	Coarse sand	Moderate	4.3	56	<10
c	1220	0.20	0.80	8.5	Coarse sand	Slight	8.7	1230	20
2 a	0–50	0.35	0.22	6.7	Coarse sand	0	18.4	128.1	2
b	150–200	0.35	0.78	7.1	Coarse sand	0	9.3	54.7	2
3 a	50–150	0.5	0.40	7.4	Coarse sand	0	17.2	195	—
b	305	0.25	0.64	7.9	Moderately coarse sand	0	2	132	<10
c	458	0.35	1.57	8.4	Coarse sand	Moderate	11.8	1220	20
4 a	50–150	0.30	0.37	7.5	Coarse sand	0	5.8	215	10
b	305	0.45	1.43	7.9	Coarse sand	0	9.7	381	<10
5 a	3	0.7	0	7.1	Coarse sand	0	6.7	25	—
b	20–25	0.35	0.894	7.8	Coarse sand	0	5.9	25	—
6 a	3	0.6	0.555	6.9	Coarse sand	0	7.0	25	—
b	20–25	0.2	1.15	7.4	Coarse sand	0	7.0	25	—

on the northern edge of the Central Desert, approximately 180 m (590 ft) elevation. While these two locations are in the Central Desert they differ ecologically: El Rosario is still subject to coastal climatic influence, whereas the Cataviña Region is a granitic boulder field equidistant from the Gulf of California and the Pacific Ocean. This difference is exemplified by the various definitions and subdivisions given to regions of the Central Desert by various authors (Nelson, 1922; Tinkham, 1957; Shreve and Wiggins, 1964; Aschmann, 1967; and Wiggins, 1969, to list a few).

Type locality.—The Cataviña area is characterized by the shrubs *Larrea tridentata* (Sesse and Moc. ex DC.) Coville, *Ambrosia dumosa* (A. Gray) Payne and *Ambrosia chenopodifolia* (Benth.) Payne as well as several cactus species: *Opuntia echinocarpa* Engelm. and Bigel., *Opuntia cholla* Weber, *Opuntia molesta* Brandegee, *Pachycereus pringlei* (S. Wats.) Britt. and Rose, *Lophocereus schottii* (Engelm.) Britt. and Rose and *Ferocactus gracilis* Gates. For a more detailed botanical and zoological survey of this site see Bratz (1976).

Soils of the Cataviña site are characterized in Table 1 by eight parameters. Fourteen soil samples from six selected soil pits near the *Phobetus* collection locality are listed in the table. Each soil profile is characterized by a surface or near surface sample and one or two deeper samples depending on depth possible. The entire study site is dominated by coarse grus produced by the weathering of Cretaceous granite (tonalite) of the Jaraguay block (Gastil et al., 1975). The table shows that all samples are considered to be coarse sandy soil (one is moderately coarse indicating a sandy loam situation). The electrical conductivity was low, 0.2–0.7 μmhos at the site. Sodium values were generally low, ranging 0–5.25

(sodium adsorption ratio). The soil was usually neutral to slightly basic (alkaline), pH 6.7–8.6. The pH values were always lower on the surface. In 70% of the samples calcium carbonate was not detected, while in four samples slight to moderate amounts were found. Phosphorus concentrations varied greatly, from <2 to 18.4 ppm. Half of the areas showed the highest phosphorus concentrations at or near the ground surface. Potassium levels were low in about 50% of the samples (<25–73 ppm) and higher in the rest (128.1–1230 ppm). Nitrate as nitrogen was not examined for each sample, but was low when detected (2–20 ppm).

The mean annual precipitation for the Cataviña area is about 96 mm (3.8 in.) (Hastings, 1964; Hastings and Humphrey, 1969). The data was collected at several weather stations in the area operated by the Secretaria de Recursos Hidraulicos. According to a rain gauge established at the type locality on 9 July 1981, the cumulative precipitation recorded on 4 January 1982 was 46 mm (1.81 in.).

Biology.—Collections of *P. desertus* were made on 6 January 1982, 22 January 1976 and on 19 January 1981 (by E. L. Sleeper) at the Cataviña type locality. Sleeper's 1981 collection of 7.7 km N Catavinacito is within 1 km of our 1976 and 1982 collections, and considered the same locality. The 1976 collections were made between 0700 and 0900 h PST following a brief rain. A temperature of 15–19°C and barometric pressure of 1028 mb (30.04 in.) was recorded during this time by a Weathermeasure Meteorograph. In 1982 a large emergence of *P. desertus* was encountered beginning at 0545 h, just prior to daylight (ca. 0620h), and was continuing at 0830 h. Flight activity was initially sporadic but became extensive by dawn. Barometric pressure was estimated to be 999 mb (29.5 in.) by a vehicle altimeter and a temperature range of 9–10.5°C was recorded with a Reotemp dial thermometer. This last emergence was preceded by an evening of rain that soaked the substrate to a depth of 2.5 cm by the following morning, and took place during heavy fog conditions. Major activity was in the sandy areas between the large granitic outcrops. Males actively flew within 1 m of the soil surface and congregated around emerging females. The females were not observed to fly. Females would frequently be found in open spaces between vegetation and at or near the base of the dominant shrub, *Larrea tridentata.* Approaching males attempted to copulate (Fig. 4a) and would often displace one another. In one instance, an estimated 20 males were observed flying about a *L. tridentata* with a single female at its base. During copulation the female would enter her burrow, usually followed by the remaining unattached males. As many as six males were removed from the burrows of individual females, to a depth of 10 cm. Some burrows were open, others were closed with loose soil but easy to recognize by the tumulus. Initially it appeared that males were attracted to the female. In some cases, however, a female emerged from her burrow and the males continued their downward digging rather than following the female (Fig. 4b). Dissipation of the fog around 0830 h did not seem to influence the flight activity. The time of flight termination was not observed in 1982 as we drove north along the highway to try and determine how widespread the emergence was.

The 1981 collections by E. L. Sleeper (pers. comm.) were made on a "bright and sunny" morning. The most recent rain had been eight days previous, with the last noticeable dew four days after. The overnight low had been 5.0°C, and when the flight activity began at 0830 h the temperature was 5.8°C. Activity was

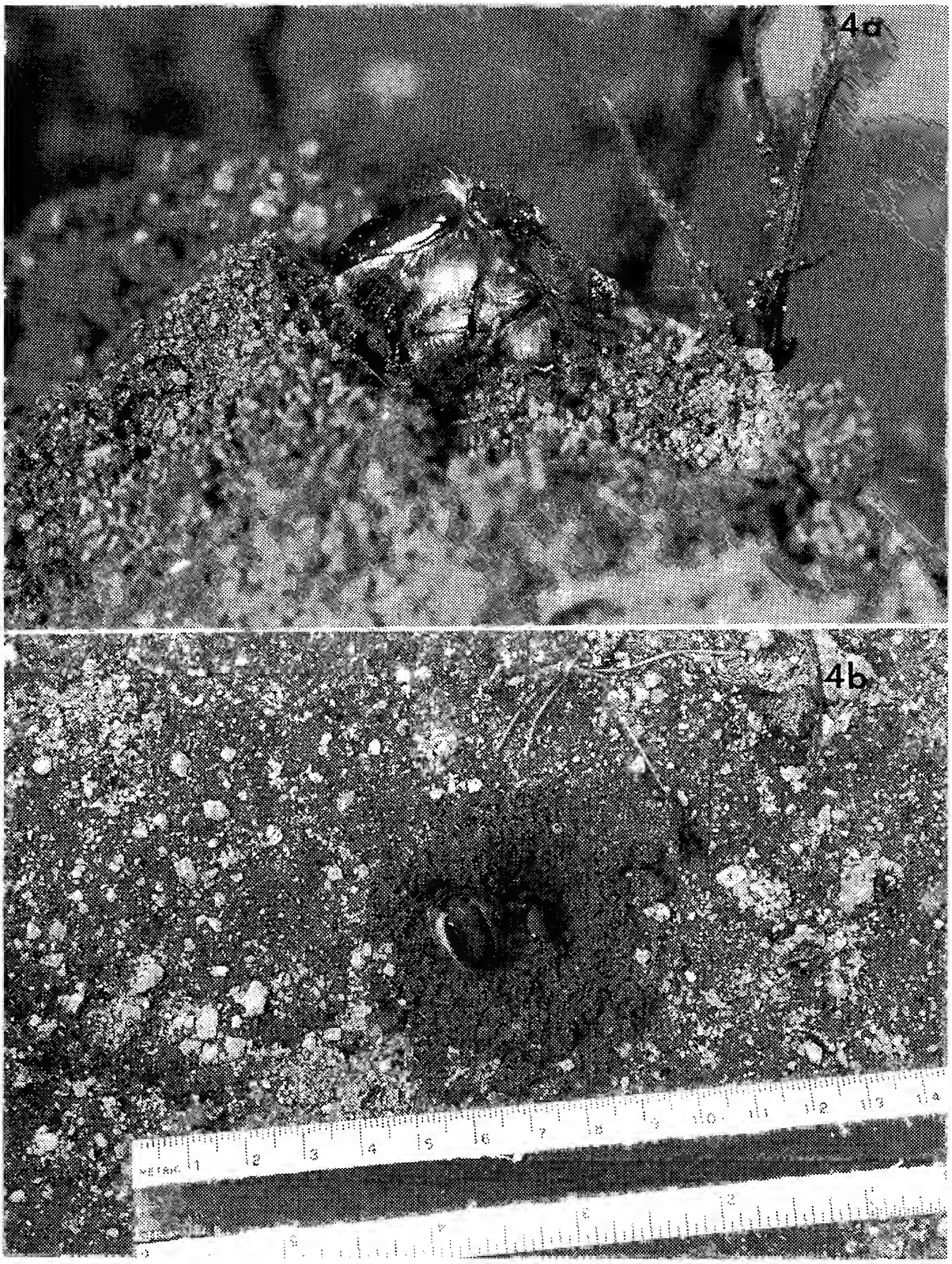
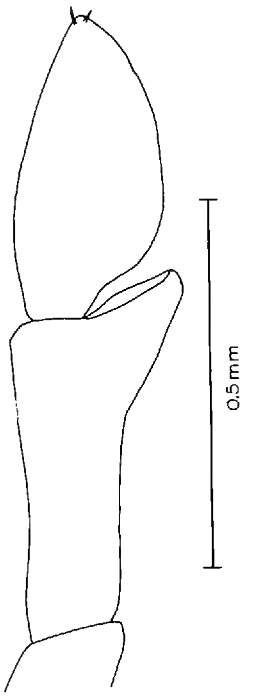


Figure 4. 4a, copulating *Phobetus desertus* on rim of burrow, 6 January 1982; 4b, copulating pair of *Phobetus desertus* on edge of burrow with one of several males continuing downward movement into burrow, 6 January 1982. Photos by William H. Clark.

heavy by 0900 h (6.2°C). Little air movement was noted and none registered by his meteorological equipment. For many of the males activity lasted for only an hour, when they began to drop to the ground in a "stupor." A number of these individuals were attacked by ants. *Acromyrmex versicolor* (Pergande) and *Pheidole yaqui* Creighton and Gregg were identified from parts still grasping tarsi of preserved *P. desertus*.



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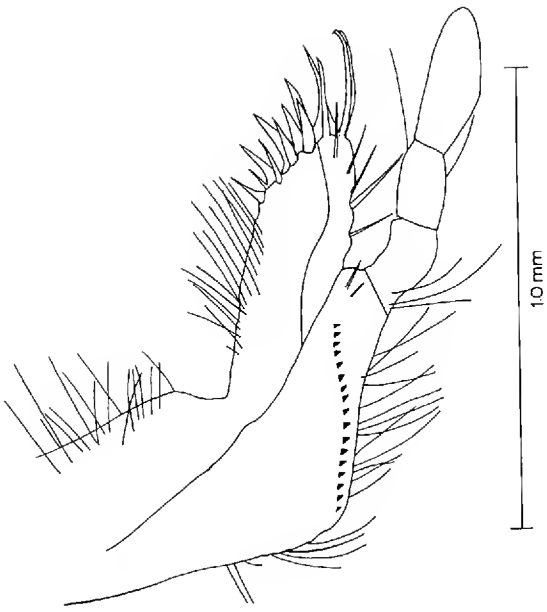

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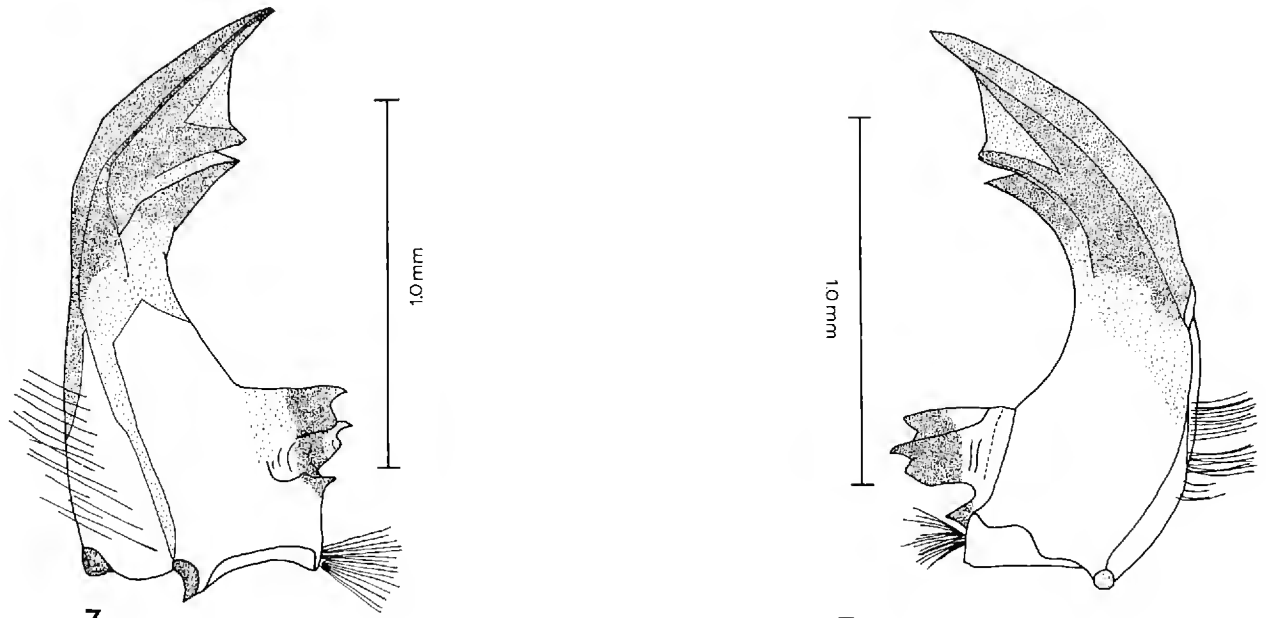

7a

7b

Figures 5–7. 5. Lateral view of antennal segments 4 and 5. 6. Right maxilla of first instar *Phobetus desertus* larva, dorsal view. 7. Mandible of *Phobetus desertus* first instar larva; 7a, dorsal; 7b, ventral; stippling indicates relative sclerotization.

Several copulating pairs of the 1982 *P. desertus* were placed in quart jars with 0.5–0.8 cm of loose soil. Inspection of the soil after two months revealed up to 18 eggs and larvae per jar. Most of the eggs were laid around the periphery of the jar bottom; one egg was located only four centimeters below the soil surface in a small (ca. 2 cm diameter) earthen cell. Embryological progression is evident by the development of segmentation and progressive degrees of mandibular sclerotization. Larvae worked their way to the surface after hatching. Females were recovered from a variety of depths in the soil; all but one were dead.

Immature forms.—The egg is white. The chorion is translucent, without surface sculpturing. Length 3.9–4.2 mm ($\bar{x} = 4.05$, s = 0.138, $n = 6$), width 2.5–3.2 mm ($\bar{x} = 2.81$, s = 0.23, $n = 6$). First instar larvae of *P. desertus* generally agree with Ritcher's (1949) description of third instar *P. comatus.* Larvae of *P. desertus* do appear to have long setae on the anterior margin of the post-clypeus, which are lacking in Ritcher's (1949) illustration of *P. comatus.* Figures 3, 5–7 illustrate the front, antenna, palp and mandible of *P. desertus* larva. Total length $\bar{x} = 10.2$ mm ($n = 12$). Head capsule width $\bar{x} = 2.1$ mm ($n = 12$). Pigmentation of the head capsule takes place after hatching.

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The Genus *Phyllophaga* Harris, 1826 (Coleoptera: Scarabaeidae) in Cuba. II. Descriptions of Eleven New Species and Illustrations of Female Genitalia of Twelve Other *Phyllophaga*

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When I first started the study of the family Scarabaeidae in Cuba, I concentrated my attention on the genus *Phyllophaga,* because it was the most economically important. All species of *Phyllophaga* are polyphagous and are pests of numerous agricultural crops, among them sugar-cane, which is the principal Cuban crop. Moreover, some species of this genus have been reported as hosts of some parasites (Garcia, 1975).

During my preliminary organization of the material available in the Cuban collections, I found some specimens misidentified and many without any identification. After a long period of work I separated the species already described from those that did not fit the previous descriptions. This was possible only with male *Phyllophaga.* Females are very difficult, almost impossible to identify, if they are separated from males of the same species.

The descriptions of the first five new species were published in 1978 (Garcia, 1978), as a first part of a series about the genus.

The majority of the species have been established based upon male descriptions, with illustrations of genitalia, but the genitalia of the female of these species, in most cases, are not available. Even when the species has been established from female material, the illustrations of the genitalia have not been published, which makes identification more difficult.

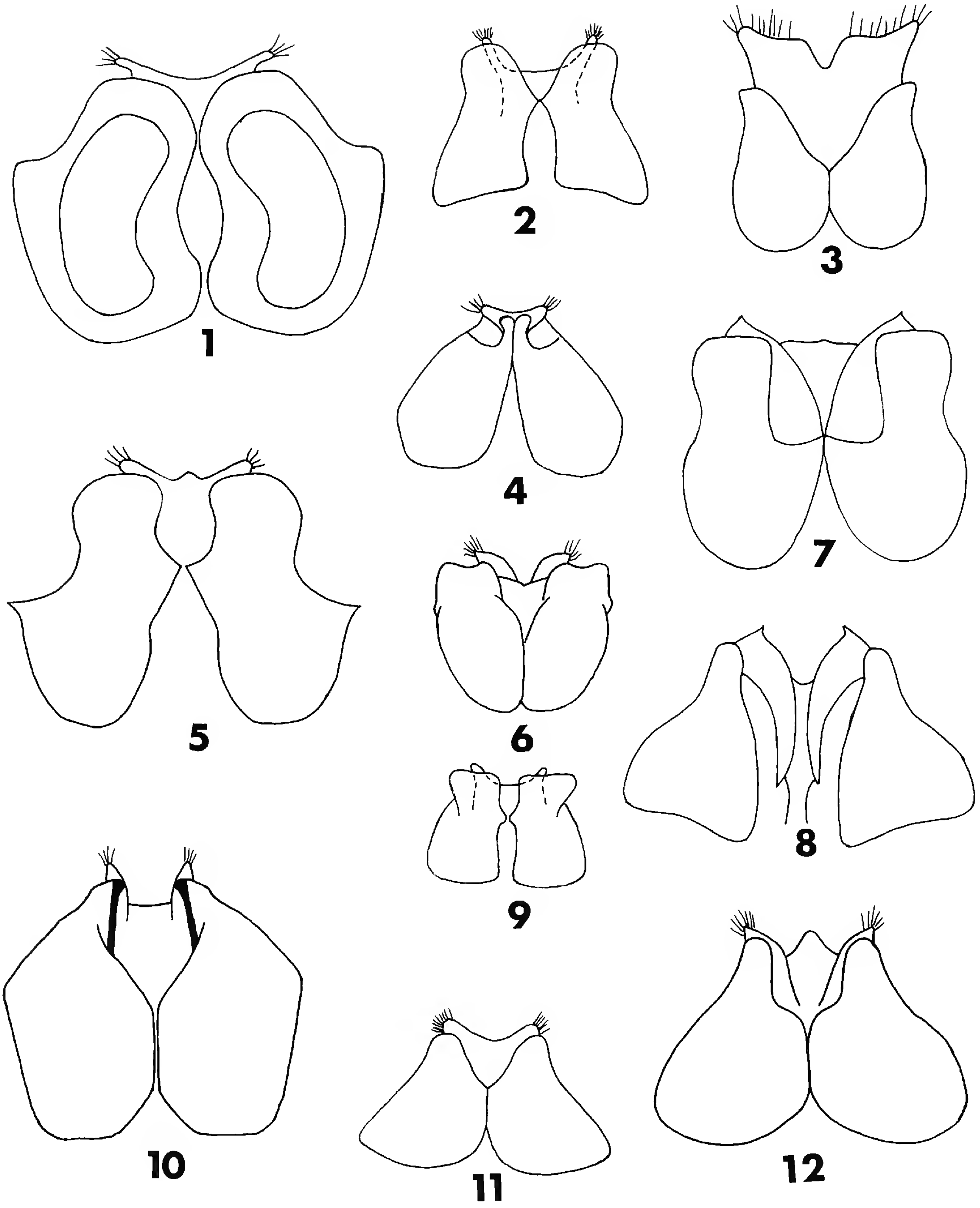
In the present paper I present illustrations of genitalia of the females of twelve species already described (*P. explanicollis* Chapin, *P. expansa* Chapin, *P. onchophora* Chapin, *P. tuberculifrons* Chevrolat, *P. bimammifrons* Saylor, *P. puberula* Du Val, *P. patruelis* Chevrolat, *P. crenaticollis* Blanchard, *P. baracoana* Chapin, *P. signaticollis* Burmeister, *P. jaronua* Chapin and *P. cubana* Chapin. In the Cuban collections I could not find identified females of the other Cuban *Phyllophaga.* There are many females in these collections that could not be determined. I hope the plates of the female genitalia will help in identification.

In this paper also, I include the descriptions of eleven new species, including the illustrations of male and female genitalia.

The plates of the female genitalia were made by the author of this paper. I wish sincerely to thank Dr. Alan Hardy, from the CDFA in Sacramento for the pictures of the male genitalia and for reviewing this paper. I also want to express my gratitude to the late Dr. Fernando de Zayas for the loan of the specimens in his collection for my studies and for his advice and support.

Phyllophaga bimaculata, NEW SPECIES

Male.—Submedium, pruinose. Elytra, legs, underparts rufocastaneous; sutural margin, disc of pronotum dark brown; margin of pronotum lighter with an almost



Figures 1–12. 1. *Phyllophaga onchophora* Chapin. Female genitalia. 2. *Phyllophaga cubana* Chapin. Female genitalia. 3. *Phyllophaga baracoana* Chapin. Female genitalia. 4. *Phyllophaga puberula* Du Val. Female genitalia. 5. *Phyllophaga expansa* Chapin. Female genitalia. 6. *Phyllophaga signaticollis* Burmeister genitalia. 7. *Phyllophaga crenaticollis* Blanchard genitalia. 8. *Phyllophaga explanicollis* Chapin. Female genitalia. 9. *Phyllophaga jaronua* Chapin. Female genitalia. 10. *Phyllophaga tuberculifrons* Chevrolat genitalia. 11. *Phyllophaga patruelis* Chevrolat. Female genitalia. 12. *Phyllophaga bimammifrons* Saylor. Female genitalia.

circular spot medio-laterally; head piceous. Clypeus densely, coarsely punctured; punctures with different shapes; margins abruptly reflexed; median indentation deep, angulate; clypeo-frontal suture almost obliterated, absent on median line. Frons densely, coarsely punctured, but less than clypeus; punctures deep, of different sizes; basal margin and median line impunctate. Pronotum less densely punctured than head; punctures umbilicate, more orderly distributed; margins entire; anterior angles acute, posterior obtuse, rounded; sides broadly dilated medially. Scutellum more sparsely punctured; small punctures forming rows, disc impunctate. Elytra slightly more densely punctured than pronotum, but punctures smaller; with short, thick, straight hairs; sutural margin tumid, darker, not elevated, wider posteriorly. Pygidium more densely punctured than elytra but punctures smaller, shallower, with short, thick, straight hairs; dark spot covering ⅔ from anterior margin; ⅓ light castaneous; apex broadly rounded; margins bearing hairs longer than those on disc and reflexed. Antennal club 3-segmented, elongate, about twice the stem. Protibiae tridentate; upper tooth distant; median stouter than distal. Sternites densely, finely punctured; hairs fine. Coxal plates with few thick, straight hairs. Urosternites somewhat less densely punctured than sternites; fifth segment with a tuft of long, fine, straight hairs laterally; last segment narrowly, transversely grooved, with fine, long, straight hairs. Longer calcar of metatibia acuminate, about as long as first tarsal segment with its spines. Claws slightly curved; median tooth fine. Length: 12 mm. Figures 13, 14.

Holotype.—Male, collected by J. Valdes, from Puerto Boniato, Oriente, June 1963. Deposited in CAS Collection No. 14281.

This species is very characteristic by its coloration and antennal club, which is one of the longest I have observed in a Cuban species.

***Phyllophaga caneyensis,* New Species**

Male.—Submedium, pruinose, slightly ovoid. Elytra, pronotum, head piceous; legs, underparts castaneous-ferrugineous. Frons densely, coarsely punctured; punctures irregular; base impunctate; irregular depression toward median line; clypeo-frontal suture almost obliterated. Clypeus punctured as frons; punctures smaller toward clypeo-frontal suture; irregular depression toward median line, but smaller than on frons; margins broadly reflexed, moderately elevated; median indentation not very deep, subangulate; punctures umbilicate, very irregularly distributed. Pronotum scarcely punctured; punctures big; margins entire; sides broadly dilated medially; long, thick, reflexed hairs on lateral margins; anterior angles slightly acute, almost straight; basal curved; median line conspicuous. Scutellum scarcely punctured on sides; disc impunctate. Elytra more densely punctured than pronotum, but less than frons; punctures smaller than on pronotum but more regularly distributed; sutural margins not elevated. Pygidium castaneous-ferrugineous, punctured as elytra but punctures smaller, more regularly distributed; apex broadly curved, with fine, straight, long hairs on margins. Antennal club very well developed, 5-segmented, segments about same size, longer than stem. Protibia tridentate; upper tooth smaller, distant from others; median as stout as distal. Coxal plates scarcely punctured; punctures different, with thick, straight hairs. Sternites densely, finely, regularly punctured, pubescent; hairs fine, long. Urosternites punctured as sternites; fifth segment with tuft of long, fine, straight hairs laterally; last segment transversely grooved. Longer calcar of meta-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tibia stout, elongate, acuminate. Claws slightly curved; distal tooth elongate, slender. Length: 11.5–12 mm. Figures 17, 39.

Holotype.—Male, collected by F. de Zayas, June 1967, from Gran Piedra, Caney Oriente. In CAS, No. 14282.

Paratype.—Same data as holotype, male. In USNM.

This species is close to *P. cardini* Chapin, but is smaller. The antennal club is very unusual because of its size and well developed fifth segment.

Phyllophaga complexipennis, NEW SPECIES

Male.—Medium, piceous, pruinose. Frons sparsely punctured with moderate irregular punctures; base impunctate. Clypeus slightly more densely punctured than frons with bigger punctures; almost flat; margins slightly reflexed; median indentation deep, angulate. Pronotum moderately punctured; punctures small; margins entire; sides moderately dilated medially; anterior angles acute, posterior obtuse, curved. Scutellum punctured as pronotum, but punctures more regularly distributed. Elytra slightly more densely punctured than pronotum but punctures similar; sutural margin tumid, slightly elevated. Pygidium punctured as pronotum; apex subtruncate; margins bearing short, thick, straight hairs. Antennal club 3-segmented, slightly smaller than four preceding segments as whole. Protibia tridentate; teeth almost equidistant; upper slightly smaller than median; distal elongate, blunt. Sternites densely punctured; punctures fine, regularly distributed; pubescent, hairs straight, short. Coxal plates with some thick, straight hairs. Urosternites less densely punctured; hairs similar; fifth segment with tuft of long fine, straight hairs laterally; last segment shallowly grooved. Longer calcar of metatibia elongate, fine, acuminate, slightly longer than first tarsal segment with its spines. Claws strongly curved; apical tooth finer than median, equal in length. Length: 17 mm. Figures 15, 16, 36.

Holotype.—Male, collected by F. de Zayas, from Vinales, Pinar del Rio, April 1964. In CAS, No. 14283.

The antennal club is atypically short. The aedeagus is very complex. It possesses two long spines, curved downward, arising from the internal sac. From the backsides of each arises another spine, one of which is smaller that its precedent and the other projects out of the aedeagus.

Phyllophaga chalumeaui, NEW SPECIES

Male.—Large, shining, elongate, yellowish-castaneous. Frons densely, coarsely punctured; punctures of different sizes and shapes, irregularly distributed; base impunctate; clypeo-frontal suture conspicuous. Clypeus more densely, coarsely

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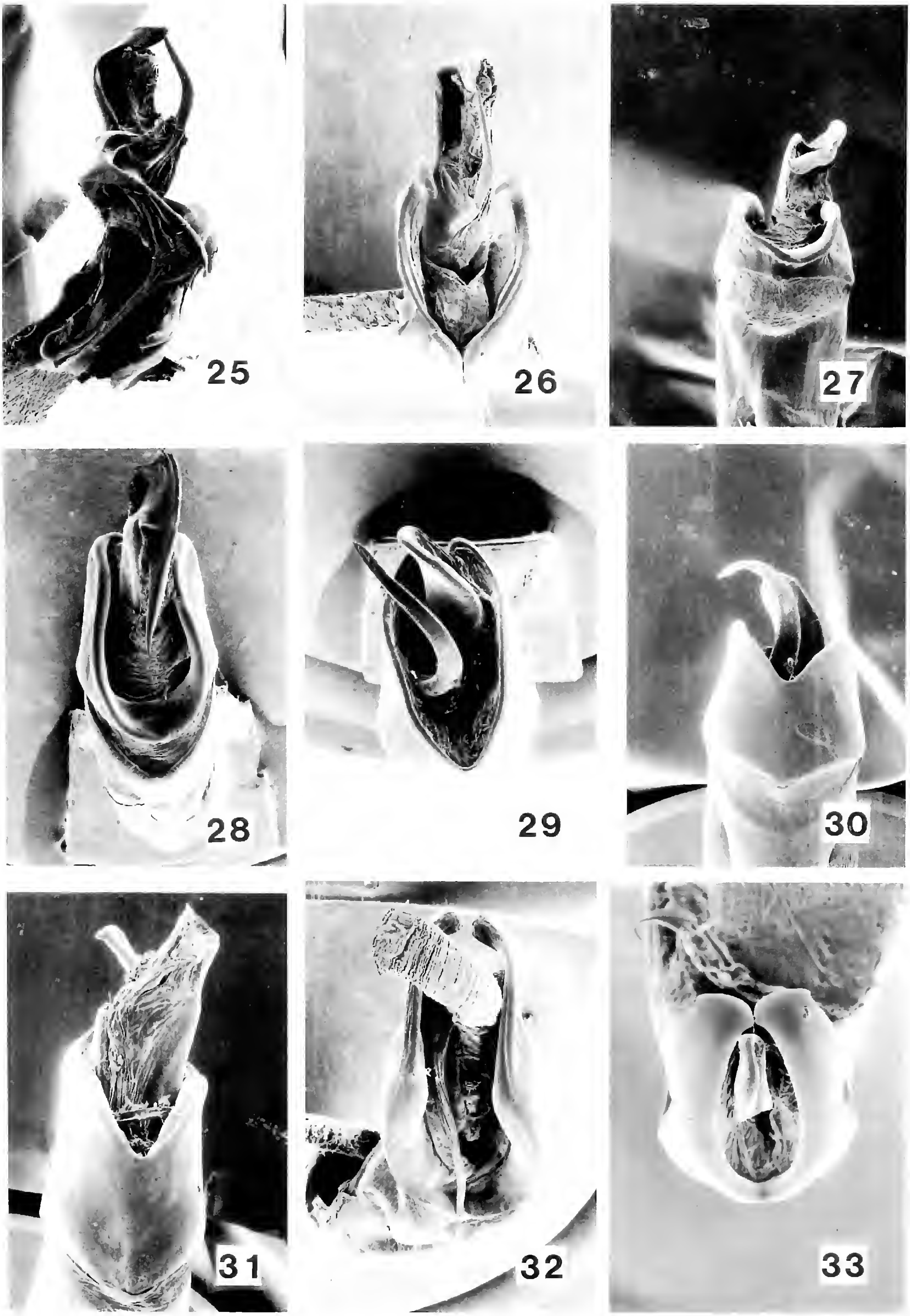
Figures 13–24. 13. *Phyllophaga bimaculata,* n. sp. Aedeagus, frontal view. 14. *Phyllophaga bimaculata,* n. sp. Aedeagus, lateral view. 15. *Phyllophaga complexipennis,* n. sp. Aedeagus, lateral view. 16. *Phyllophaga complexipennis,* n. sp. Aedeagus, frontal view. 17. *Phyllophaga caneyensis,* n. sp. Aedeagus, lateral view. 18. *Phyllophaga chalumeaui,* n. sp. Aedeagus, lateral view. 19. *Phyllophaga franciscana,* n. sp. Aedeagus, lateral view. 20. *Phyllophaga hernandezi,* n. sp. Aedeagus, lateral view. 21. *Phyllophaga hernandezi,* n. sp. Aedeagus, frontal view. 22. *Phyllophaga independentista,* n. sp. Aedeagus, lateral view. 23. *Phyllophaga hardyi,* n. sp. Aedeagus, lateral view. 24. *Phyllophaga maestrensis,* n. sp. Aedeagus, lateral view.



Figures 25–33. 25. *Phyllophaga migratoria,* n. sp. Aedeagus, lateral view. 26. *Phyllophaga migratoria,* n. sp. Aedeagus, frontal view. 27. *Phyllophaga maestrensis,* n. sp. Aedeagus, dorsal view. 28. *Phyllophaga maestrensis,* n. sp. Aedeagus, dorso-frontal view. 29. *Phyllophaga independentista,* n. sp. Aedeagus, frontal view. 30. *Phyllophaga independentista,* n. sp. Aedeagus, dorsal view. 31. *Phyllophaga spinicola,* n. sp. Aedeagus, dorsal view. 32. *Phyllophaga hernandezi,* n. sp. Aedeagus, frontal view. 33. *Phyllophaga hardyi,* n. sp. Aedeagus, frontal view.

punctured, but punctures more regularly distributed; margins broadly reflexed, more elevated on both sides of median indentation, which is deep, angulate; margins bearing long, thick, reflexed hairs. Pronotum punctured as frons; punctures bigger, deeper; margins entire; sides broadly dilated medially; anterior angles slightly acute, posterior broadly curved; lateral margins with long, thick, reflexed hairs. Scutellum punctured as pronotum; disc impunctate. Elytra somewhat more densely punctured than pronotum, but punctures slightly smaller; sutural margin tumid; very sparsely punctured, punctures shallower, irregularly distributed; apex moderately curved; short, straight hairs on margins. Antennal club 3-segmented, about as long as four preceding segments as a whole. Protibia tridentate; distal tooth elongate, acuminate. Sternites densely pubescent; hairs long, fine, straight, arising from small, shallow punctures. Coxal plates sparsely pubescent; hairs thick, long, straight. Urosternites less pubescent; hairs shorter, finer; last segment widely, transversely, posteriorly grooved; sparsely pubescent. Longer calcar of metatibia elongate; sides almost parallel, very slender, blunt, about as long as first tarsal segment with its spines. Claws slightly curved; median tooth stouter than distal. Length 24 mm. Figures 18, 38.

Holotype.—Male, collected by J. Acuna, from Loma de Cala to P. Mocha, Sierra Maestra, Cuba, 16 May 1948 at 3600–3900 ft altitude. In CAS, No. 14284.

This species is dedicated to Dr. F. Chalumeau, from the Institut de Recherches Entomologiques de la Caraibe.

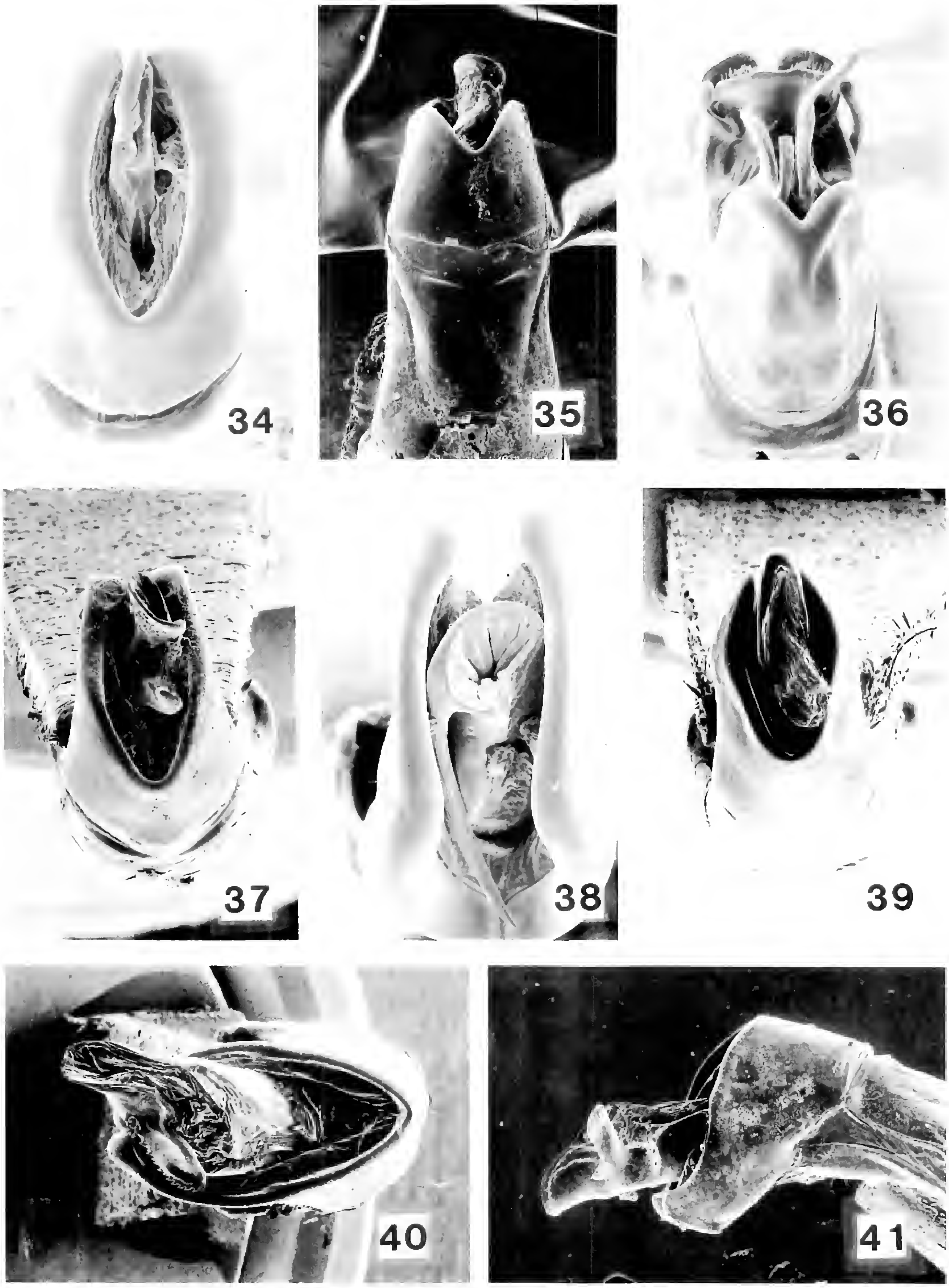
Phyllophaga franciscana, New Species

Male.—Submedium, pruinose. Elytra dark castaneous; legs, underparts yellowish-brown; head piceous; pronotum dark castaneous with light ferrugineous band on each side of median anterior region. Clypeus densely punctured; punctures moderate; margins abruptly reflexed; median indentation moderately deep, subangulate. Frons densely punctured, but less than clypeus; base impunctate, with shallow depressions along median line. Pronotum less densely punctured than head; punctures similar but more regularly distributed; band brighter laterally; anterior, posterior margins entire; lateral subcrenulate; sides broadly dilated posteriorly, their widest part almost on posterior angles, which are obtuse; anterior slightly acute. Scutellum moderately, irregularly punctured; punctures similar to those on pronotum but deeper; disc impunctate. Elytra densely, coarsely punctured; punctures irregular, deeper than on pronotum; sutural margin tumid, wider posteriorly. Pygidium irregularly punctured; punctures fine, shallow, more numerous on disc; apex truncate. Protibia tridentate; upper tooth distant from others; median same length as distal. Sternites densely punctured; punctures fine, shallow. Coxal plates with large punctures; hairs thick, short. Urosternites densely punctured, but less sparsely than sternites; punctures similar; last segment almost completely, transversely grooved. Longer calcar of metatibia acuminate. Tarsi, antenna missing. Length: 12.5 mm. Figures 19, 35, 37.

Holotype.—Male, collected by Noel Gonzalez, from Sierra del Grillo, Havana, Cuba, 14 December 1974, on the ground. In CAS, No. 14286.

Phyllophaga hardyi, New Species

Male.—Small, shining. Body castaneous to dark brown; head piceous. Frons densely, coarsely punctured; punctures of different sizes, irregularly distributed;



Figures 34–41. 34. *Phyllophaga hardyi,* n. sp. Aedeagus, dorsal view. 35. *Phyllophaga franciscana,* n. sp. Aedeagus, dorsal view. 36. *Phyllophaga complexipennis,* n. sp. Aedeagus, dorso-frontal view. 37. *Phyllophaga franciscana,* n. sp. Aedeagus, frontal view. 38. *Phyllophaga chalumeaui,* n. sp. Aedeagus, dorso-frontal view. 39. *Phyllophaga caneyensis,* n. sp. Aedeagus, frontal view. 40. *Phyllophaga spinicola,* n. sp. Aedeagus, frontal view. 41. *Phyllophaga spinicola,* n. sp. Aedeagus, lateral view.

base impunctate. Clypeus punctured as frons; margins broadly reflexed, elevated; median indentation inconspicuous; margins bearing long, fine, reflexed hairs. Pronotum moderately punctured; punctures more regularly distributed than on frons; anterior and posterior margins entire; lateral subcrenulate, bearing long, fine, reflexed hairs; sides broadly, medially dilated; anterior angles acute; posterior slightly obtuse, curved. Scutellum with small punctures toward margins; disc impunctate. Elytra more densely punctured than pronotum; punctures slightly deeper; sutural margin tumid, slightly elevated, wider posteriorly, with some punctures. Pygidium more densely punctured than elytra with smaller punctures; apex broadly curved; margins with long, fine, straight hairs. Mesosternite densely punctured; punctures small, regularly distributed; with fine, long hairs. Coxal plates with thick straight hairs. Urosternites less densely punctured than sternites; long, fine hairs arising from punctures; last segment transversely, posteriorly grooved. Protibia tridentate; teeth equidistant. Antennal club 3-segmented, longer than funicle. Longer calcar of metatibia slender, acuminate, longer than first tarsal segment. Claws very slightly curved; distal tooth long and fine, median small. Length: 11 mm. Figures 23, 33, 34.

Holotype.—Male, collected by F. de Zayas, from Tortuguilla, Provincia Oriente, Cuba, June 1965. In CAS, No. 14287.

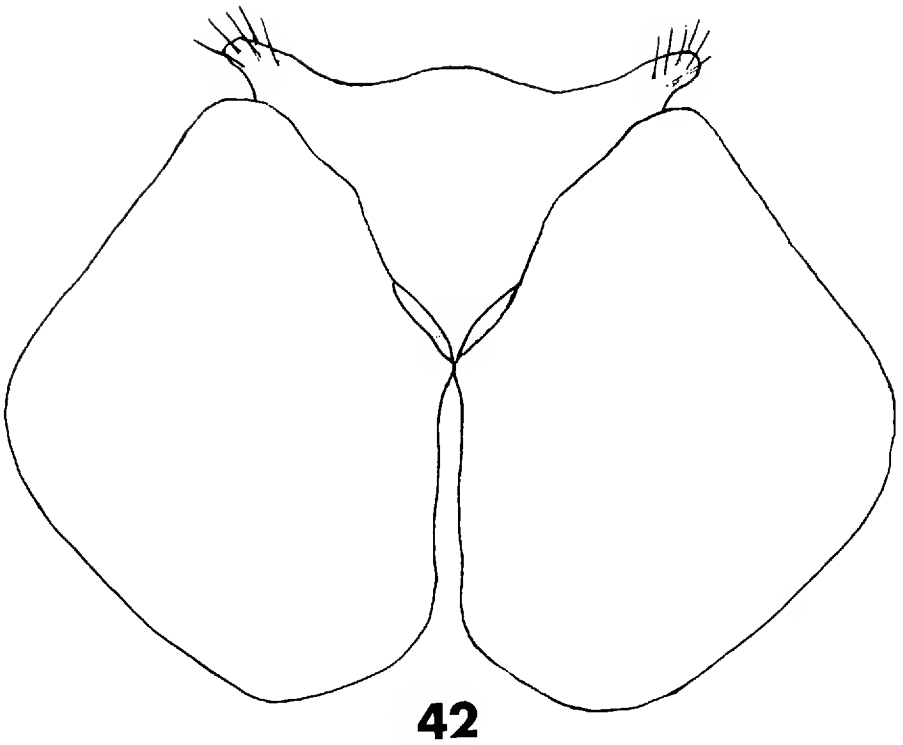
Paratypes.—One male, collected by F. de Zayas from Tortuguilla, Prov. Oriente, Cuba, June 1965, in CAS. One male, col. F. de Zayas, from Tortuguilla, Prov. Ote. Cuba, June 1964, in USNM.

This species is dedicated to Dr. Alan Hardy from the CDFA in Sacramento.

Phyllophaga hernandezi, New Species

Male.—Large. Elytra yellowish-castaneous; pronotum, legs, underparts rufotestaceous; head dark brown. Clypeus densely, coarsely punctured; margins broadly reflexed, slightly elevated; median indentation moderately deep, subangulate; clypeo-frontal suture conspicuous. Frons densely punctured, but less than clypeus; punctures small, more numerous toward impunctate base. Pronotum densely punctured, but less than frons; punctures bigger, umbilicate, more regularly distributed; margins entire; sides broadly, medially, posteriorly dilated; anterior angles almost straight, posterior curved; lateral margins with thick, long, reflexed hairs; one small depression on side of medio-posterior region aligned with eyes. Scutellum semicircular, completely punctured; punctures as on pronotum. Elytra more densely punctured than pronotum but with finer punctures; hairs long, thick, straight. Sutural margins tumid. Pygidium densely punctured, slightly more than elytra, but punctures shallower; apex narrowly rounded. Antennal club 3-segmented, about as long as funicle. Protibia tridentate; upper tooth distant from others; median wider than distal at base. Coxal plates with thick, long, straight hairs, which arise from fine punctures. Sternites pubescent; hairs long, fine, straight. Urosternites less densely punctured, with similar punctures, sparsely pubescent; last segment medially, transversely grooved. Longer calcar of metatibia slender, acuminate. Claws somewhat curved; median tooth stouter than distal. Asymmetric aedeagus with a long spine arising backward from internal sac. Length: 24 mm. Figures 20, 21, 32.

Female.—Median line conspicuous on frons; antennal club as long as three preceding segments as whole; apex of pygidium truncate; last urosternite wide,



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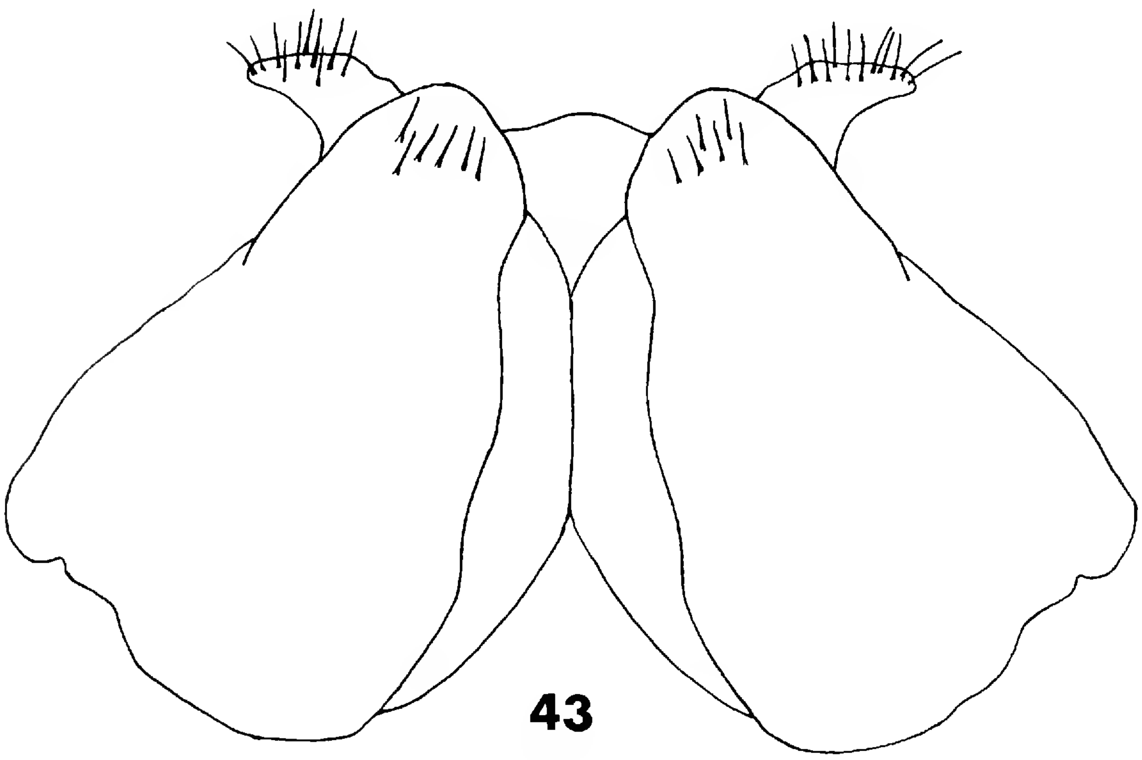

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Figures 42–43. 42. *Phyllophaga maestrensis,* n. sp. Female genitalia. 43. *Phyllophaga hernandezi,* n. sp. Female genitalia.

convex; longer calcar of metatibia slightly longer than first tarsal segment, slender, blunt, not typical for females. Length: 24.5 mm. Figures 20, 21, 32.

Holotype.—Male, col. Zayas and Valdes, from Sierra Maestra, June 1965. In CAS, No. 14288.

Allotype.—Same data as holotype. In CAS.

Paratype.—Female, same data as types. In USNM.

This species is dedicated to the Cuban Entomologist Luis R. Hernandez.

Phyllophaga independentista, New Species

Male.—Medium. Elytra, pronotum, legs light yellowish-castaneous; head piceous; underparts yellowish-brown; close to *Ph. alayoi* Garcia. Frons densely, coarsely punctured; punctures fine, irregular, more scarce on base. Clypeus densely punctured also, but punctures more regular; margins abruptly reflexed, not very elevated, lateral almost flat; median indentation deep, angulate; long, thick, reflexed hairs on margins. Pronotum densely punctured, but less than head; punctures large, umbilicate; anterior, posterior margins entire; lateral crenulate, with long, thick, reflexed hairs; sides broadly, medially, posteriorly dilated; anterior angles slightly acute; basal obtuse. Scutellum moderately punctured; punctures as on pronotum, almost in rows; disc impunctate. Elytra more densely, coarsely punctured than pronotum; punctures finer, shallower; sutural margins tumid, wider posteriorly. Pygidium densely punctured with fine, shallow punctures; thick, straight hairs of different lengths, longer posteriorly; apex truncate. Antennal club 3-segmented, about as long as four preceding segments together. Protibia tridentate; upper tooth small, median stouter than distal. Sternites densely pubescent, with fine, long, straight hairs arising from small, shallow punctures. Coxal plates with thick, long, straight hairs. Urosternite densely pubescent, but less so than sternites; hairs shorter, thicker; last segment completely grooved, with some hairs. Longer calcar of metatibia elongate, slender, acuminate, longer than first tarsal segment with its spines. Claws slightly curved; median tooth stouter than distal. Length: 18–19 mm. Figures 22, 29, 30.

Holotype.—Male, col. M. R. from Santiago de las Vegas, 10 October 1971. In CAS No. 14289.

Paratype.—Male, col. from Los Jazmines, 9 June 1971, col. unknown. In USNM.

Phyllophaga maestrensis, New Species

Male.—Medium, shining. Upper, underparts, legs yellowish-castaneous to castaneous-ferrugineous; sides almost parallel. Frons densely punctured; punctures fine, irregularly distributed; base impunctate; median line conspicuous. Clypeus densely punctured; punctures as on frons but more regularly distributed; margins broadly reflexed, elevated; median indentation moderately deep, subangulate. Pronotum less densely, coarsely punctured than frons, punctures bigger; margins entire; sides broadly, medially dilated; anterior angles almost straight, basal obtuse; lateral margins bearing long, reflexed hairs anteriorly. Scutellum punctured as pronotum; punctures regularly distributed. Elytra more densely, coarsely punctured than pronotum but less than frons; hairs short, straight; sutural margins tumid; lateral, posterior margins with fine hairs. Pygidium punctured as elytra; hairs fine, straight, mainly posterior; apex broadly curved. Antennal club with three very long segments, an incomplete fourth and a fifth shorter; longer than all preceding segments together. Protibia tridentate; upper tooth tiny, distant from others. Sternites densely punctured; punctures fine with fine, long hairs. Coxal plates sparsely punctured; punctures with short, thick hairs. Urosternites less densely punctured with shorter hairs; last segment transversely grooved. Longer calcar of metatibia blunt, slender, sides almost parallel, longer than first tarsal segment. Claws slightly curved, teeth rather slender. Length: 18–19 mm. Figures 24, 27, 28.

Female.—Apex of pygidium more narrowly curved; antennal club shorter but 5-segmented also, about as long as three preceding segments together; last urosternite convex; longer calcar of metatibia compressed dorsoventrally, about one and a half as long as first tarsal segment. Length: 18–19 mm. Figure 42.

Holotype.—Male, col. J. Ferra from "Capitolio," Rio Yara, Cuba, 15–19 May 1948, at about 1150 feet altitude. In CAS, No. 14290.

Allotype.—Col. J. Acuna, F. Valdes and C. Fortum from Rio Yara, Oriente, 15–20 May 1948, at about 1000 feet altitude. In CAS.

Paratypes.—One male, same data as holotype; one female, from Loma de Cala to P. Mocha, Sierra Maestra, Cuba, 16 May 1948, at 3600–3900 feet altitude, collector unknown. Both in USNM.

***Phyllophaga migratoria*, New Species**

Male.—Submedium, pruinose. Elytra, underparts, legs rufocastaneous to castaneous; pronotum dark castaneous; clypeus dark brown. Clypeus densely punctured; punctures rather large, irregular; margins abruptly reflexed; median indentation deep, angulate. Frons less densely punctured; punctures as on clypeus but more irregularly distributed; depression on disc and on median line; base impunctate. Pronotum less densely, coarsely punctured, punctures similar but shallower, regularly distributed; margins entire; borders rufocastaneous, disc dark castaneous; sides broadly, medially dilated; anterior angles slightly acute, posterior obtuse. Elytra more densely punctured than pronotum, but with finer punctures, more regularly distributed; sutural margin wider posteriorly, moderately elevated. Scutellum triangular, sparsely punctured; disc impunctate. Pygidium punctured as elytra, but more densely; short, straight hairs arising from punctures; apex subtruncate. Antennal club 3-segmented, longer than funicle. Protibia tridentate; upper tooth distant, median stouter than apical. Coxal plates sparsely pubescent; hairs thick, straight. Sternites finely densely punctured; hairs fine, long, straight. Urosternites less densely punctured than sternites with similar punctures; last segment transversely, posteriorly grooved. Longer calcar of metatibia elongate, slender. Claws slightly curved; median slightly stouter than distal. Length: 11.5–12 mm. Figures 25, 26.

Holotype.—Male, col. C. and P. Vaurie, from San Vicente, Pinar del Rio, 25–28 July 1956. In CAS, No. 14291.

Paratype.—Male, collected from Vinales, Pinar del Rio, June 1964, at light, collector unknown.

The paratype has lost it pruinosity, probably during the extraction of the genitalia.

***Phyllophaga spinicola*, New Species**

Male.—Large, shining. Head, protibiae castaneous to piceous, body rufotestaceous. Clypeus densely, coarsely punctured, especially toward median line; margins broadly, slightly reflexed, almost flat; median indentation deep, angulate; clypeo-frontal suture conspicuous. Frons punctured as clypeus, punctures small, base almost impunctate. Pronotum slightly less densely, coarsely punctured than head, but with larger punctures; anterior, posterior margins entire, lateral crenulate; anterior angles acute, posterior obtuse; sides medially, broadly dilated, with long, thick, reflexed hairs. Scutellum punctured as pronotum, but punctures smaller; disc impunctate. Elytra sparsely punctured; punctures smaller than on head; sutural margins conspicuous, not tumid. Pygidium punctured as elytra but slightly more coarsely; apex narrowly rounded. Antennal club 3-segmented, about as long as the four preceding segments. Protibia tridentate, upper tooth apart but well developed. Coxae very sparsely punctured, with thick, straight hairs. Sternites densely pubescent with long, straight hairs. Urosternites very sparsely punctured, punctures fine with few hairs; last segment shallowly, transversely grooved. Longer calcar of metatibia longer than first tarsal segment with its spines, blunt. Claws curved; distal tooth longer than median, which is fine. Length: 24–26 mm. Figures 31, 40, 41.

Female.—Antennal club about as long as three preceding segments; apex of pygidium narrower; longer calcar of metatibia about twice as long as first tarsal segment, compressed, wider than in male, acuminate; last urosternite not grooved, convex. Length: 22–26 mm.

Holotype.—Male, from Gran Piedra, Oriente, July 1953, col. Zayas and Alayo.

Allotype.—Col. Zayas-Alayo, from Gran Piedra, Oriente, June 1954. Both in CAS, No. 14285.

Paratypes.—Three males, col. Zayas-Alayo, from Gran Piedra, Oriente, July 1953; one in CAS, one in USNM, one in Illinois State Natural History Survey Division. Three females, col. Zayas-Alayo, from Gran Piedra, Oriente, June 1954; in CAS, USNM and ISNHSD. Two females from Gran Piedra, nr. Santiago, Prov. Oriente, 30–31 May 1959, Col. M. W. Sanderson; in ISNHSD.

This species is very characteristic by the punctures on pronotum.

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Reproductive Ecology of Three Cactophilic Diptera[1] (Diptera: Drosophilidae, Neridae, Syrphidae)

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If habitat is really the template for ecological strategies (Southwood, 1977), one should be able to predict reproductive and developmental characteristics of a given species from a knowledge of its habitat. Means for translating habitat characteristics into life history strategies have been proposed and are reviewed in Stearns (1976). Of numerous proposals, two general groups of theories are useful in explaining variations in life history characteristics. The first, derived from arguments of MacArthur and Wilson (1967), proposes that selection may favor either rapid population growth at the expense of competitive efficiency (r selection) or competitive ability and efficiency at the expense of population growth rate (K selection). A second proposal, the so-called "trade-off" theory, was developed largely by Schaffer (1974) from more general treatments of Murphy (1968). This theory proposes that habitat factors, which determine survival predictability at different stages in life history, in turn select levels of parental effort expended in immediate versus future reproduction. A number of theoretical studies have attempted to show how predictability and magnitude of environmental fluctuations can result in varying degrees of r or K selection or levels of reproductive effort (Schaffer and Rosenzweig, 1977; Felsenstein, 1979; Boyce, 1979; Livdahl, 1979).

Any attempt to correlate theory and observation requires habitat interpretation. Here I examine life history characteristics of dominant dipterans using the same tissues of a single plant species, the major purpose of this study being to examine habitat characteristics in order to explain certain life history strategies. Secondly, I examine levels of oviposition effort with respect to predictions of trade-off models relating immediate reproductive effort to adult self-maintenance for future reproductive effort.

ECOLOGY

In this paper three nonrelated dipterans which feed largely or exclusively on decaying stem tissues of saguaro (*Carnegea gigantia*) cacti in the Sonoran desert of Arizona and Sonora, Mexico, are compared. The species studied are *Drosophila nigrospiracula* Patterson and Wheeler (Drosophilidae), *Odontoloxozus longicornis* Coquillett (Neriidae), and *Volucella isabellina* Williston (Syrphidae). *Drosophila nigrospiracula* is restricted to the Sonoran desert and Baja, California; larvae in the upper Sonoran desert use stem tissues of saguaro cactus with rare incursions into similar tissues of other columnar cactus species. Larvae of *O. longicornis* use several columnar catci in the Sonoran desert; the species is distributed from

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Arizona and California south to Costa Rica. Larvae probably inhabit prickly pear (*Opuntia*) cacti extensively at higher elevations. *Volucella isabellina* is apparently restricted to Sonoran desert areas where saguaro cacti are distributed. I have not reared this species from *Opuntia,* but it uses several other columnar cactus species in Mexico. Generally, the larval habitat of these species over most of their Arizona distribution is limited to saguaro cacti. In studies of cactophilic *Drosophila* at the University of Arizona, hundreds of individuals of these three species have been reared from naturally occurring saguaro necroses.

Adults of these species appear to be attracted by similar olfactory and perhaps visual factors. Cacti with tissues just beginning to decay and having juice running down the surface of the stem are most likely to attract adults. This suggests that adult substrates are equally distributed for the three species.

It should be noted that while these dipterans are all classified in the suborder Cyclorapha, *V. isabellina* is in the division Aschiza. *Drosophila nigrospiracula* and *O. longicornis* are placed in the same division, Schizophora, and section, Acalyptratae, but are placed in widely separated superfamilies. Similarities and differences also appear in the adaptive potentials of the genera of these species. The genus *Odontoloxozus* is restricted to cacti and at present only one species is described. The genus *Volucella* includes at least 39 species in North and Central America where larval habitats include decaying succulent plant material and nests of social hymenoptera (Spradbery, 1973). The genus *Drosophila* may be one of the most adaptable animal taxa. Worldwide, substrates include decaying tissues of nearly all angiosperm families (Throckmorton, 1975).

Ecological and phylogenetic evidence suggests that genetic potential of the taxa and rigorous selection regime experienced by these species should have interacted to produce reproductive strategies relevant to larval and adult substrates and ambient communities.

METHODS

In order to compare these species on an r–K continuum, two main factors are evaluated: egg production potential is measured by ovariole number; and maturation rate is measured by egg to adult development time. Estimation of immediate versus future reproductive efforts for comparisons among these species is mainly by examination of a subjective degree of oviposition effort. General levels of adult fitness are estimated by thorax size which is assumed to be related to body volume and migratory ability. While these comparisons do not lend themselves to rigorous quantification, they do allow comparisons which suggest the more suitable hypotheses to explain differences in reproductive behaviors among these species.

Observations discussed here were made on naturally occurring saguaro necroses in Pima Co., Arizona and the region of Sonora, Mexico north and west of Hermosillo. Field data were collected in 1977 and 1978 for *O. longicornis* and 1975–1978 for *D. nigrospiracula* and *V. isabellina.*

Data included here for *D. nigrospiracula* were collected for a study of competitive interactions and host plant specificity (Mangan, 1978; Mangan and Heed, 1980). Dissection of reproductive systems employed methods described by Kambysellis and Heed (1971). Observations and dissections of *O. longicornis* were collected for study of mating behavior (Mangan, 1979). Observations of *V. isabellina* were taken from notes and dissections performed to gain comparative

Table 1. Characteristics of three cactophilic Diptera.

Characteristic	*D. nigrospiracula*	*O. longicornis*	*V. isabellina*
Ovariole number	30–60	100–190	?
Egg number/adult	200	33–156	200–500
Egg number/ovariole	1–4	1	?
Oviposition sites and pattern	single inserted fresh tissue	grouped inserted old tissue	grouped on protrusions outside cactus
Mating behavior	crepuscular on substrate	diurnal on substrate	mainly crepuscular in air
Adult number/cactus	10^2–10^4	10–20	1–3
Larval medium	freshly rotted tissue	old, dark firm tissue	old, anaerobic liquid tissue
Pupation	grouped on substrate surface	single, burrow in old substrate	migratory, burrow in sand
Development time (22°C; egg to adult)	16 days	30–50 days	>50 days
Adult thorax length (mm ± SD)	1.24 ± 0.32	3.68 ± 0.49	6.35 ± 0.38

ecological insight into species utilizing saguaro cacti in possible competition with *D. nigrospiracula.*

Observations of larval feeding and development were made under both laboratory and field conditions during 1976, 1977, and 1978. Laboratory rearings were conducted at room temperatures (19–22°C) at the University of Arizona in 1 gallon widemouth jars, ½ pint milk bottles, or 5 gallon aquaria. Development times were determined from naturally occurring eggs in saguaro necroses; both eggs and substrate were placed in the containers, with sand or newspaper to absorb excess exudate.

RESULTS

Observations and data are summarized in Table 1. The species show about as much interspecific variation in all aspects of life history strategies as can be found among any saprophagous diptera.

Female *D. nigrospiracula* are quite exacting in their oviposition requirements. While a typical saguaro rot pocket contains thousands of larvae, laboratory stocks can seldom be maintained without cactus tissue as an oviposition medium. Larvae develop well on laboratory media once eggs are elicited. Females may accumulate up to four eggs per ovariole in the laboratory if suitable media are not provided. Eggs are always inserted singly into the medium with space between consecutive eggs. In crowded population cages, however, thousands of eggs may be deposited on a single gram of cactus. Larvae are only weakly motile and pupation occurs in groups on open surfaces, usually inside the cactus or on the sides of rearing bottles.

Oviposition characteristics of *O. longicornis* differ from *D. nigrospiracula* in that while eggs are inserted into the medium, masses of eggs from one female are usually inserted through a single opening in the cactus epidermis or a single spot of laboratory medium. As described in Mangan (1979), males of this species hold territories at oviposition sites and restrict the movements of females until eggs are deposited. This behavior may increase the tendency of females to group eggs. Females, however, will oviposit on nearly any medium of soft, wet texture, though larval dietary requirements are quite restrictive and adult emergence from pupae reared in *Drosophila* medium is only about 20%. Larvae are quite motile, burrowing rapidly into the tissue when disturbed. Pupation occurs in the tissue mass; pupae have not been found exposed on the medium surface.

Female *V. isabellina* spend little time around rotting cacti except for oviposition. Eggs are commonly found attached to cactus spines or suspended in spider webs on the outside of decaying cacti. Female *V. isabellina* were difficult to capture or rear to reproductive maturity so fecundity estimates were made from numbers of eggs per egg mass. These masses are made up of groups of eggs which adhere to each other and surfaces to which they are attached. Eclosing larvae apparently drop to the ground then crawl up the cactus and burrow into the decaying tissues. Larvae feed in pockets of decaying, mucoid necrotic tissue which emit strong odor of anaerobic sulfur decay products. Larvae leave the cactus at the end of the third stadium and pupate in the soil.

DISCUSSION

These data and observations indicate that habitat characteristics described in terms of host plant tissue, decaying saguaro stem cortex, and host plant community, upper Sonoran desert, provide little predictive information relative to reproductive ecology and behavior. Mating behavior, oviposition behavior, larval development time, and pupation behavior are all shown to vary considerably among these species.

In attempting to explain such differences in traits among these species, two general classes of adaptations may be distinguished. Adaptations may be plesiomorphic traits which were retained during desert adaptation or they may be in situ apomorphic responses. Migratory ability, generation time, and perhaps preferred larval medium are probably ancestral traits. Other characteristics such as oviposition site preference, pupation site, and mating behavior are more likely adaptations to the saguaro substrate and evolved in the desert.

The greatest differences in habitats which would affect reproductive behavior are larval microhabitats. The short developmental period for *D. nigrospiracula* coincides with the microflora-rich larval medium (Starmer et al., 1976) and relatively small adult size. The larger species, *V. isabellina* and *O. longicornis,* use nutrient depleted, older tissue which, along with their larger adult size, incurs a two to three times longer developmental period. The adults, however, are probably more resistant to environmental fluctuations than *D. nigrospiracula* owing to their large size.

The use of sparsely distributed columnar cactus tissues over the large area of the upper Sonoran desert, by all three species, suggests that if substrate distribution is a selective factor in reproductive adaptation, differing migratory abilities of these species result in different predictabilities of adult migratory success. In terms of future versus immediate reproduction, the smaller *D. nigrospiracula* adults are more susceptible to environmental fluctuations in such factors as necrosis density than the larger species; this may affect future reproductive success.

The daily probability of larval substrate degeneration, mainly through desiccation, is identical for each species. Probability of habitat degeneration during the larval development period increases with larval development time. Since larvae cannot migrate to new cacti, the slower developing species face greater uncertainty in maturation than *D. nigrospiracula.* Assuming that female flies are unable to predict substrate degeneration, large investments in finding suitable larval substrates are not as likely to increase fitness for the larger species as for *D. nigrospiracula.*

Interaction of migratory success and larval development success probabilities are hypothesized to explain differing oviposition efforts among these species. Quick developing *Drosophila* with environmentally susceptible adults invest greater effort in oviposition site choice than the slower developing, but environmentally buffered and larger *O. longicornis* and *V. isabellina.* This situation approximates theoretical conditions suggested by Schaffer (1974) and Stearns (1976) for establishment of differing optimal reproductive strategies through immediate versus future reproduction trade-offs.

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Descriptions of the Life Stages of *Pyrausta orphisalis* (Lepidoptera: Pyralidae)[1]

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Abstract.—The life stages of *Pyrausta orphisalis* Walker (Lepidoptera: Pyralidae) are described, and the immature stages illustrated.

Pyrausta orphisalis Walker (Lepidoptera: Pyralidae) is a small, orange and brown, diurnal moth, which according to Munroe (1976), occurs across Canada's southern tier and along both coasts of the United States. In Washington, this species feeds on all commercial types of mint (*Mentha* spp.). The adult is compared briefly to two closely related species by Munroe (1976), but aside from this and the very short original description (Walker, 1859), no descriptions exist for any of the life stages. This paper describes all life stages of *P. orphisalis,* utilizing specimens collected (and also deposited) at the Washington State University, Irrig. Agric. Res. and Ext. Center, Prosser, Washington.

Egg (Fig. 1a).—The egg is creamy white, ca. 0.4 mm wide and 0.65 mm long, oval-shaped with a flattened venter, appearing as an elongated dome when viewed laterally. A distinct irregular sculpting is visible under scanning electron microscopy, which gives the egg an appearance of being encased by a net.

Larvae.—Chaetotaxy utilizes the terminology of Fracker (1915).

First instar (Fig. 1b).—Body length 1.2 to 2.5 mm. Head capsule width 0.21 to 0.23 mm. Head colored uniformly brown. Six stemmata arranged in a near semicircle, lenses usually appearing to surround a central collection of pigment cells. Antennae pale. Clypeus pale, labrum slightly reddish brown. Apices of mandibles reddish brown. Maxillae pale to lightly pigmented. Labium pale except for darkened anterior margin of mentum. Anterior corner of hypostomal lobe black. Head capsule with a small notch located at posterior-lateral margin and marked by a black patch; posterior margin of head capsule trimmed in black from black patch to sub-vertex. Prothoracic shield somewhat rectangular, lighter brown than head capsule, and bearing setae. Remaining thorax and abdomen pale, except for spot pigmentation at base of setae. Setae simple, primary, and prominent. Spiracles circular, pale, and brown rimmed, present on prothorax and abdominal segments 1 to 8. Suranal plate concolorous with prothoracic shield and bearing setae. Thoracic legs normally developed, bearing one pretarsal claw. Prolegs of abdominal segments 3 to 6 subequal and normally developed; pygopods appearing slightly larger. Crochets uniserial, triordinal, and arranged in a mesal penellipse, remaining this way throughout all instars.

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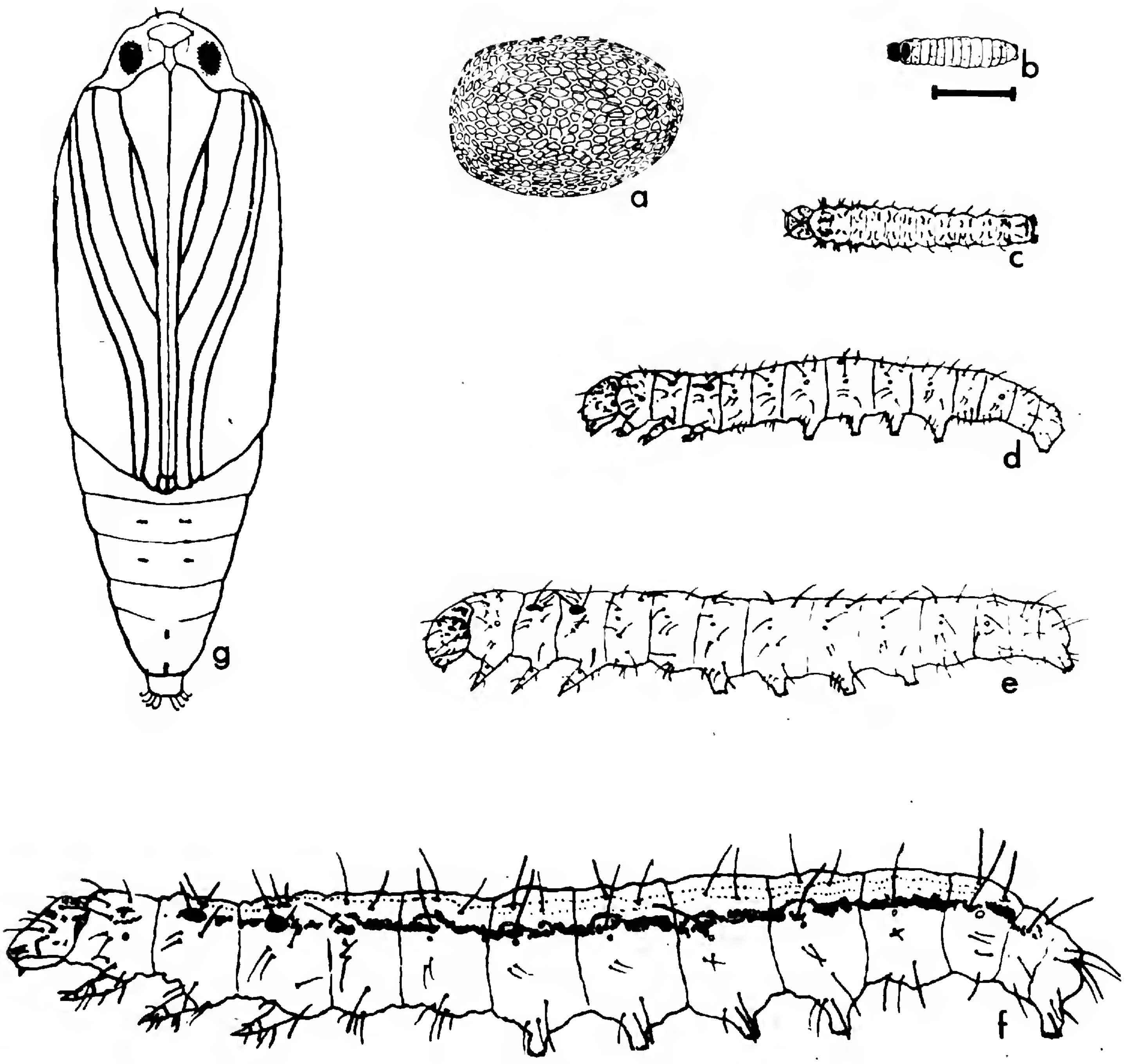

Figure 1. Immature stages of *Pyrausta orphisalis* Walker. a. egg; b. first instar; c. second instar; d. third instar; e. fourth instar; f. fifth instar; g. pupa. (Scale line with reference to egg = 0.2 mm; larvae and pupa = 1.0 mm.)

Second instar (Fig. 1c).—Body length 2.0 to 3.5 mm. Head capsule width 0.32 to 0.38 mm. Head beige to light brown and mottled. Six stemmata arranged in a near semi-circle, lenses of stemmata 1 to 5 overlaying obvious pigment cells. Antennae pale. Clypeus and labrum beige to light brown. Apices of mandibles reddish brown. Maxillae pale to light beige. Labium pale, except for darkened anterior margin of mentum. Anterior corner of hypostomal lobe black. Head capsule with a small, inconspicuous notch located at posterior-lateral margin and usually marked by a black patch, posterior margin of head capsule trimmed in black for a varying distance between black patch and vertex; these markings remaining unchanged through remaining instars. Prothoracic shield slightly lighter than head capsule, mottled and bearing setae. Remaining thorax and abdomen pale, except for spot pigmentation at base of setae. Setae simple, primary and subprimary, and prominent; setae remaining this way through subsequent instars. Spiracles same as first instar. Suranal plate pale to lightly pigmented and bearing setae. Thoracic legs and prolegs normally developed.

Third instar (Fig. 1d).—Body length 4.4 to 6.8 mm. Head capsule width 0.48

to 0.57 mm. Head beige to light brown and mottled. Stemmata unchanged. Antennae beige to light brown. Clypeus and labrum concolorous with head capsule. Apices of mandibles reddish brown. Maxillae pale to beige. Labium pale to beige except for darkened anterior margin of mentum. Anterior corner of hypostomal lobe black. Head capsule, appendages, and markings remaining fairly constant through remaining instars. Thorax and abdomen beige to light yellow-green. Prothoracic shield pale to beige and bearing setae. A dorsal stripe present, appearing beige to light green if ingesta present. An irregular faint subdorsal stripe, reaching nearly to alpha seta, may be present but is never prominent. Pinnacula bearing setal group rho of meso- and metathorax large, black and prominent. Remaining setae usually with dark ringed papillae. A small black spot located anterior to alpha setae of abdominal segments 2 to 8. Spiracles circular, pale, and brown or darker ringed; location same as earlier instars. Suranal plate pale to lightly pigmented and bearing setae.

Fourth instar (Fig. 1e).—Body length 5.6 to 10.7 mm. Head capsule width 0.75 to 0.83 mm. Head beige to light brown and mottled. Stemmata, pigmentation of appendages, spiracles, and various cephalic markings remaining the same as in third instar. Thorax and abdomen beige to green. Prothoracic shield pale to beige and bearing setae. A green dorsal stripe present, flanked on each side by a faint whitish subdorsal stripe nearly reaching thoracic beta and abdominal alpha setae. A second subdorsal stripe, whitish but fainter, located ventrolaterally to alpha and beta setae; extending from the mesothorax to abdominal segment 9. A faint whitish subspiracular stripe extends from the prothoracic kappa group to abdominal segment 9, encompassing the kappa group of the meso- and metathorax, and reaching to the abdominal kappa groups. Setal group rho of meso- and metathorax borne on a large, black pinnaculum. Alpha and beta setae from mesothorax to abdominal segment 8 borne on slightly smaller black pinnacula. Remaining setae with papillae dark ringed. A small black spot located anterior to each alpha seta of abdominal segments 2 to 8. Suranal plate pale to beige, may be slightly mottled, bearing setae.

Fifth instar (Fig. 1f).—Body length 8.8 to 15 mm. Head capsule width 0.98 to 1.2 mm. Head beige to light brown and mottled. Stemmata, pigmentation of appendages, and various cephalic markings as in previous instar. Thorax and abdomen beige to green. Prothoracic shield pale to beige and bearing setae. A prominent green dorsal stripe visible in the living specimen; an irregular dark dorsal stripe, inconspicuous during life, visible in preserved specimens. Dorsal stripe flanked on each side by two separate whitish subdorsal stripes as in previous instar. A distinct greenish black supraspiracular stripe extends from the mesothorax to abdominal segment 9, encompassing the pinnacula bearing rho setae. A faint whitish subspiracular stripe, as seen in previous instar, is also present. Intersegmental grooves often yellow. Setae and setal groups borne upon prominent, black pinnacula as in previous instar. Remaining setae with darkly ringed papillae. Alpha setae with a dark spot located anteriorally. Spiracles circular, largely pale, and black rimmed. Suranal plate pale to beige, may be slightly mottled; bearing setae. Near the end of the ambulatory stage of this instar, after feeding has ceased, the trunk loses its green color and becomes dark beige to light orangish brown except for striped areas. Dorsal stripe becomes light to medium brown, subdorsal stripes become more beige, supraspiracular stripe appears pinkish to orangish brown with areas of darker brown interspersed, and subspiracular stripe appears light beige. Venter remains a beige color as does prothorax. Pigmentation tends to lighten to a cream color prior to pupation with only the dorsal and supraspiracular stripes being prominently visible. Overwintering, full grown larvae show similar pigmentation.

Larvae which pass through six larval instars instead of the typical five have their first three instars no different than the "typical." The fourth and fifth instars appear essentially the same as a typical fourth instar, except that their head capsules and body lengths range differently from the typical. Head capsule width for the fourth instar ranges from 0.65 to 0.71 mm; body length, 4.4 to 7.6 mm. Head capsule width for the fifth instar range from 0.85 to 1.0 mm; body length, 7.2 to 10 mm. The sixth instar has a head capsule, body length, and distinctive supraspiracular stripe comparable to the typical fifth instar.

Pupa (Fig. 1g).—Obtect, length ca. 7.0 to 8.5 mm. Impunctate, shiny, golden brown color, darkening prior to eclosion. Vertex has assumed a dorsal position, causing frons to be mostly cephalic; this arrangement contributes to the "shouldered" appearance reported for Pyraustinae pupae (Mosher, 1916). Epistomal suture and anterior tentorial pits well defined. Labrum broadly triangular, bordered caudo-laterally by large pilifers which are separated medially by narrow, chisel-shaped labial palpi. Eye-pieces large, covering easily the visible compound eye. Galea of maxillae large and prominent, extending slightly past apex of forewing. Galea bordered laterally and subproximally by spindle-shaped sclerite representing prothoracic femur; this in turn is bordered laterally by prothoracic tibia and tarsi. Tibia and tarsi extend slightly past midpoint of galea. Prothoracic leg bordered laterally by mesothoracic leg which extends nearly to distal end of galea. Antenna borders mesothoracic leg and extends nearly to apex of forewing. At the junction of antenna, eye-piece, and bases of tibiae is a small subrectangular sclerite which represents the maxillary palpus.

Pronotum distinct, subrectangular, bounded laterally by antennae. Mesonotum large; sclerite continuous, covers forewings. Metanotum smaller, hindwings largely covered by forewings. Abdomen with 8 demarcated segments. Functional spiracles present on segments 2 to 7, segment 8 with a non-functional spiracle. Male with visible phallomeres on venter of ninth segment, female with visible vulva on venter of eighth segment. Cremaster dark brown, distinct, possessing 8 hooked setae.

Adult.—Adult male and female are quite similar in appearance. [See Munroe (1976) for colored photographs of male and females.] Wing expanse of male approximately 14 to 15 mm, female approximately 15 to 16 mm. The following descriptions give liknesses and differences between sexes, except for genitalia, which are outlined by Munroe (1976).

Male.—Labial palpi porrect and prominent, cream colored scaling basally, a mixture of rust-orange and fuscous scaling distally. Proboscis well developed with cream colored scaling basally. Maxillary palpi filiform, a mixture of rust-orange and fuscous scaling. Frons rounded, anterior and lateral margins rust-orange, center fuscous; scaling in front of and between antennae primarily long, thin, rust-orange scales and some fuscous. Antennae long and filiform, scape and pedicel moderately scaled rust-orange and fuscous, flagellum with small brownish scales dorsally. Compound eye amber, sometimes appearing speckled. Ocelli dark amber and fairly prominent. Vertex with a mixture of long, thin rust-orange and fuscous scaling; rim of occiput mostly with erect, rust-orange scales.

Pronotum with a mixture of rust-orange and fuscous scales. Mesonotum and metanotum primarily fuscous with some rust-orange scaling laterally. Partagia covered with a combination of long, thin, rust-orange scales, long paddle-shaped rust-orange scales, and long, paddle-shaped fuscous scales. Forewings subtriangular, dorsal surface primarily a combination of rust and fuscous scales, and usually with at least two distinct patches of orange—one antemedially and the other postmedially, from the costal margin extending posteriorally about one third the wing's width. Termen heavily fringed, inner margin less so. Basal two thirds of ventral surface mostly orange with two fuscous patches, except for anal region which is cream colored. Distal third mostly fuscous. Hindwings subtriangular, but more rounded. Dorsal surface primarily fuscous, but with a median orange patch in the basal third and a wide, orange postmedial band which extends across wing, parallel to termen. Few rust colored scales present. Termen and inner margin fringed with fuscous scales. Basal two thirds of ventral surface orange, but with a poorly defined, fuscous antemedial band present. Distal third of wing fuscous. Frenulum present as a strong, orange colored spine. Venter of thorax and all legs covered by cream to light buff colored scales. Legs normally developed.

Dorsum of abdomen primarily fuscous, but mixed with rust and orange scales. Venter mostly cream to light buff, with increasing fuscous scaling posteriorally. First abdominal sternum with a pair of tympana. Terminal visible segment compressed and appearing somewhat oblique in profile.

Female.—Female is nearly identical to the male except dorsal surface of forewing is slightly more variegated with more orange patches which may nearly form a postmedial band; ventral aspect may have more rust-colored scales along the termen. Dorsal surface of hindwing appears to have slightly more rust scales. Ventral aspect as in male, but may have fuscous antemedial band more defined and may also have more rusty scales along termen and inner margins. Frenulum, a single spine in male, is a bifurcate spine in female. Visible terminal segment of abdomen somewhat truncated and slightly compressed. Tip of antovipositor, with its fine setae, often visible.

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Fabiola quinqueferella: An Obscure California Moth Formerly in Glyphipterigidae (Lepidoptera: Oecophoridae)

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Abstract.—*Fabiola quinqueferella* (Walsingham) is illustrated to demonstrate its affinity to other Oecophoridae and to *Fabiola* species.

Walsingham (1881) described a small colorful moth from northern California that he collected during his expedition of 1871. Superficially it resembles other moths of the genus *Glyphipterix* from California, now properly in Glyphipterigidae, so he described the new species as *Glyphipteryx* [sic] *quinqueferella* Walsingham. While studying the North American fauna of Glyphipterigidae this species was quickly noted to belong to the Oecophoridae (Heppner, 1978), most noticeably by the scaled haustellum (Glyphipterigidae all have a naked haustellum) and by male genitalia resembling other small oecophorids.

The moth appears best placed in the genus *Fabiola* (Hodges, pers. comm.) and has been transferred there in the new North American checklist (Hodges et al., 1983). This paper has been prepared to illustrate the species, especially the genitalia, and describe characters not noted by Walsingham.

Fabiola quinqueferella (Walsingham)

Glyphipteryx [sic] *quinqueferella* Walsingham, 1881:322.

Size.—6.0–7.5 mm base to apex forewing length.

Head.—Frons and vertex buff; labial palpus buff, 2nd segment nearly twice length of apical segment; antenna without pecten, ½ forewing length, buff, with ventral sensory setae in males twice length of antennal segments.

Thorax.—Buff; patagia buff; venter shining light buff; legs buff with some white on apices of each tarsal segment.

Forewing.—Elongated with rounded apex; R2 from end of cell; buff-gray ground color, with white crosswing fascia angled at basal ⅓, another to midwing at ½ wing length, angled toward basal fascia; wing base with yellow line along cubital vein, reaching first white fascia, with orange along radius and anal veins; orange between each white fascia and between midwing fascia and apical wing patch; apical ⅓ of wing with pale gray to whitish area with black and intense white scales mixed in, with white prominent between 4 black spots along tornal margin; each black spot having a small distal silvery spot; fringe around apical ⅓ of wing very long, dark gray.

Hindwing.—Uniformly gray, with darker gray fringe.

Abdomen.—Buff.

Male genitalia.—Uncus pointed, narrow; gnathos unspined, subtending tuba analis, hooklike, pointed; tegumen as wide as valva at base, narrowing to width

Figure 1. *Fabiola quinqueferella* (Walsingham), male, California.

of uncus; valva with rounded apex; sacculus coming to an upcurved free point, with broadened base; vinculum rounded, no saccus; juxta with a pair of dorsal elongated appendages and a pair of small pointed basal lobes; aedeagus curved, with small phallobase; vesica without cornuti but with small spines.

Female genitalia.—Unknown.

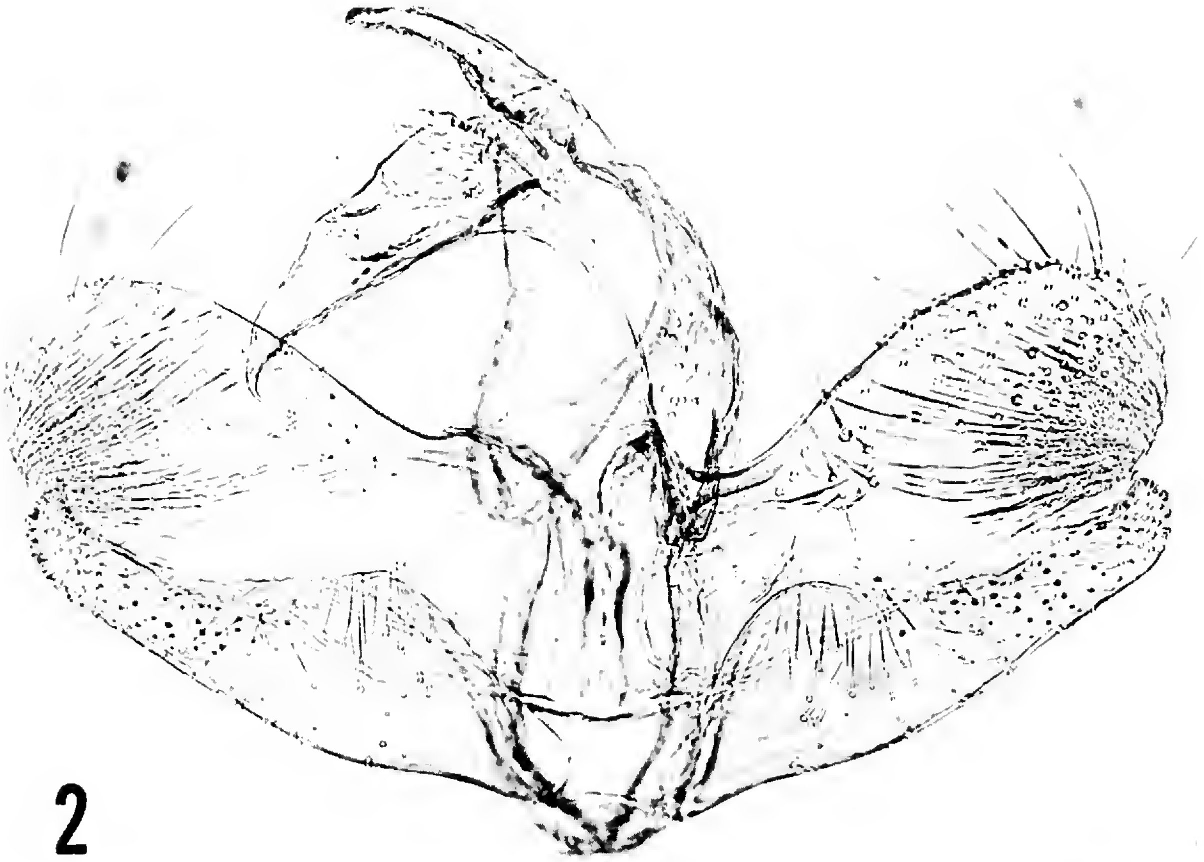
Types.—Lectotype ♂ (designated by Heppner, 1978). California: Hatchet Creek, Shasta Co., 14–17 Jul 1871, Walsingham (92020), (BMNH). Paralectotypes (7 ♂). California: Hatchet Creek, Shasta Co., 14–17 Jul 1871 (3 ♂), Walsingham (92021–92023), (BMNH); Burney Falls, Shasta Co., 18–20 Jul 1871 (2 ♂), Walsingham (92024, 92025), (BMNH); Bear Creek, Shasta Co., 27–28 Jul 1871 (1 ♂), Walsingham (92026), (BMNH); "Cal," (1 ♂), Walsingham, [no date], (USNM). Another putative syntype is without locality data but apparently collected by Walsingham (MCZ, ex Chambers Coll. [Labelled paralectotype in 1978]). Walsingham (1881) noted only 8 syntypes in his original description.

Additional specimens.—CALIFORNIA: Colusa Co.: "24" [Cache Cr., 24–25 Jun 1871] (1 ♂), Stainton Coll. 401445 (BMNH). Mariposa Co.: Yosemite Natl. Park, 30 Jun 1941 (1 ♂), R. M. Bohart (LACM), and 28 Jul 1915 (2 ♂), (ANSP). Tulare Co.: Monache Meadows, 8–14 Jul (1 ♂), (USNM). OREGON: Klamath Co.: "62" [near Summit Lk., 26 Sep 1871] (1 ♂), Walsingham (BMNH). [Walsingham field numbered specimens dated with Essig (1941) paper.]

Distribution.—Western Oregon to the southern Sierra Nevada of California.

Host.—Unknown.

Remarks.—*Fabiola quinqueferella* appears to be a primitive member of the *Fabiola* group of species on the basis of characters such as the relatively simple



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Figures 2–4. *Fabiola quinqueferella* (Walsingham). 2. Male genitalia (lectotype, California; BMNH slide 20230). 3. Aedeagus (lectotype). 4. Male genitalia (paralectotype, California; USNM slide 77105) [reduced].

genitalia and the length of setae on the antennae (similar to *Fabiola shaleriella* Chambers). The species may require a new genus but it is preferable at this time to defer any such change until the female is discovered.

The key to species of *Fabiola* in Hodges (1974) may be amended as follows to include *F. quinqueferella*:

1. Apical ⅓ of forewing white with various markings .... *quinqueferella*
   Apical ⅓ of forewing mostly black and orange, plus various markings, with some white, but not with most of area white 2
2. [remainder of key as in Hodges (1974) but with couplet numbers advanced by one].

ACKNOWLEDGMENTS

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PAN-PACIFIC ENTOMOLOGIST
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Two New Species of Idiocerine Leafhoppers from Malagasy Republic (Homoptera: Cicadellidae)[1]

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Abstract.—Two new species of idiocerine leafhoppers are described from Malagasy Republic (Madagascar). These are *Idiocerus rossi* and *Nesocerus trimaculatus.*

Two additional species can now be added to the idiocerine leafhoppers known from Malagasy Republic (Madagascar). Freytag and Knight (1966) reviewed the subfamily Idiocerinae and included 17 species. All 19 species, including the two described at this time, appear to be endemic to this island.

We thank Curtis Dunn, Academy of Natural Sciences, Philadelphia for the loan of these specimens.

***Idiocerus rossi,* NEW SPECIES**
(Figs. 1–4)

Length.—Male 3.5 mm (approximately); female unknown.

Color.—Head yellow; ocelli dark brown. Pronotum yellow; lateral margins behind eyes with brown patches; scutellum yellow. Forewings hyline; veins brown except costal veins yellow.

Male genitalia.—Pygofer short, posterior margin broadly concave, with a thin pair of internal bifurcate processes inserted on anterior margin in lateral view. Aedeagus simple, similar to *sakarahensis* but with shaft longer and a sharp lip-like projection under gonopore (best seen in lateral view). Connective as in *sakarahensis.* Style simple, apical third, in dorsal view, curved lateral.

Holotype.—Male—Madagascar, Ankarafantsika (Forest Reserve), near Marovoay, XII-1-1959, E. S. Ross, Collector. Deposited in the Academy of Natural Sciences, Philadelphia.

Etymology.—This species is named in honor of the collector, E. S. Ross, curator at the California Academy of Science.

Diagnostic features.—This species is related to *sakarahensis,* but can be separated from it by the aedeagus having a linear shaft without projections on the dorsal margin and the lip-like projection under the gonopore.

Notes.—This species is known only from the holotype. The thorax of the holotype has been damaged making it necessary to give an approximate measurement of the length of this species.

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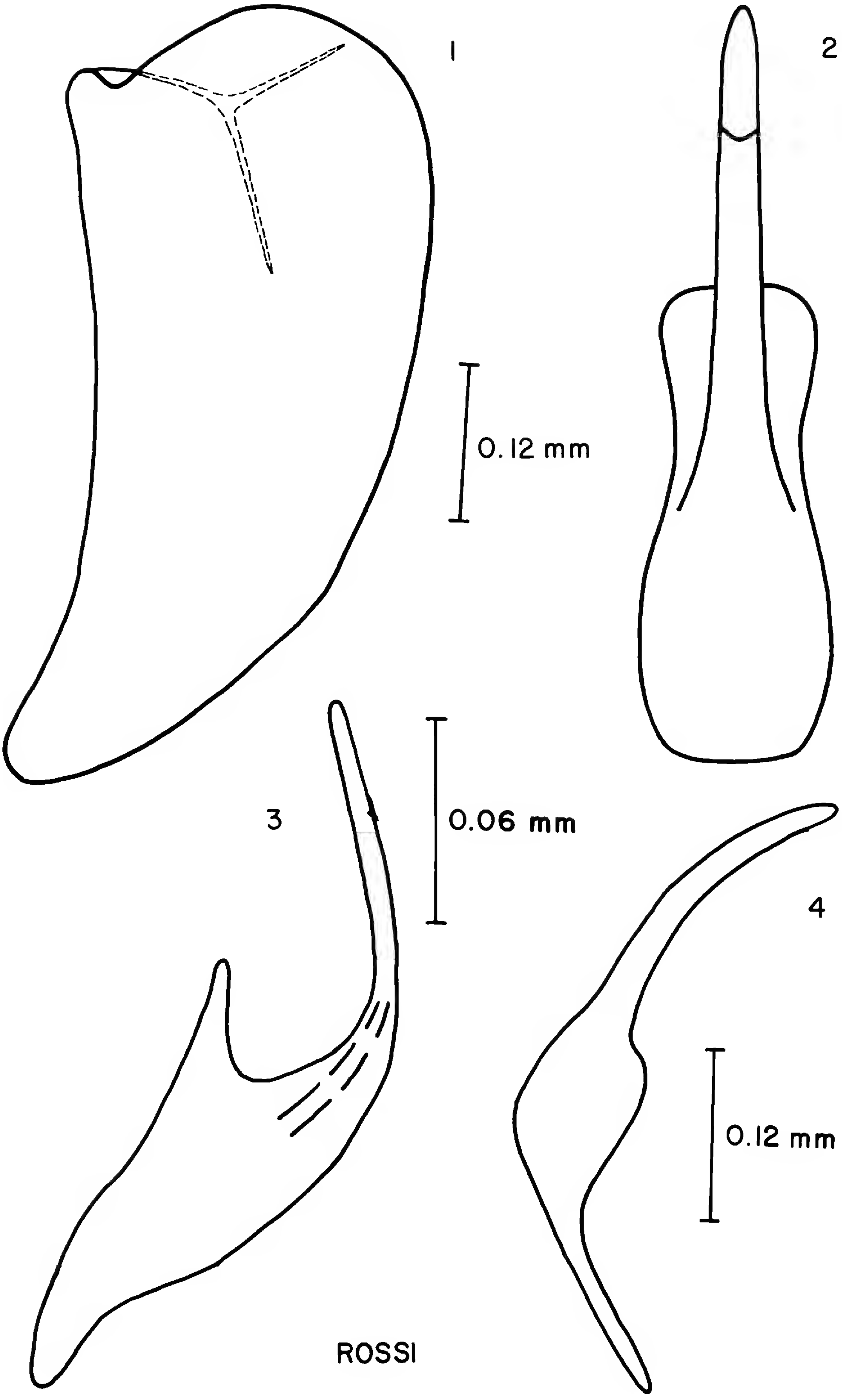
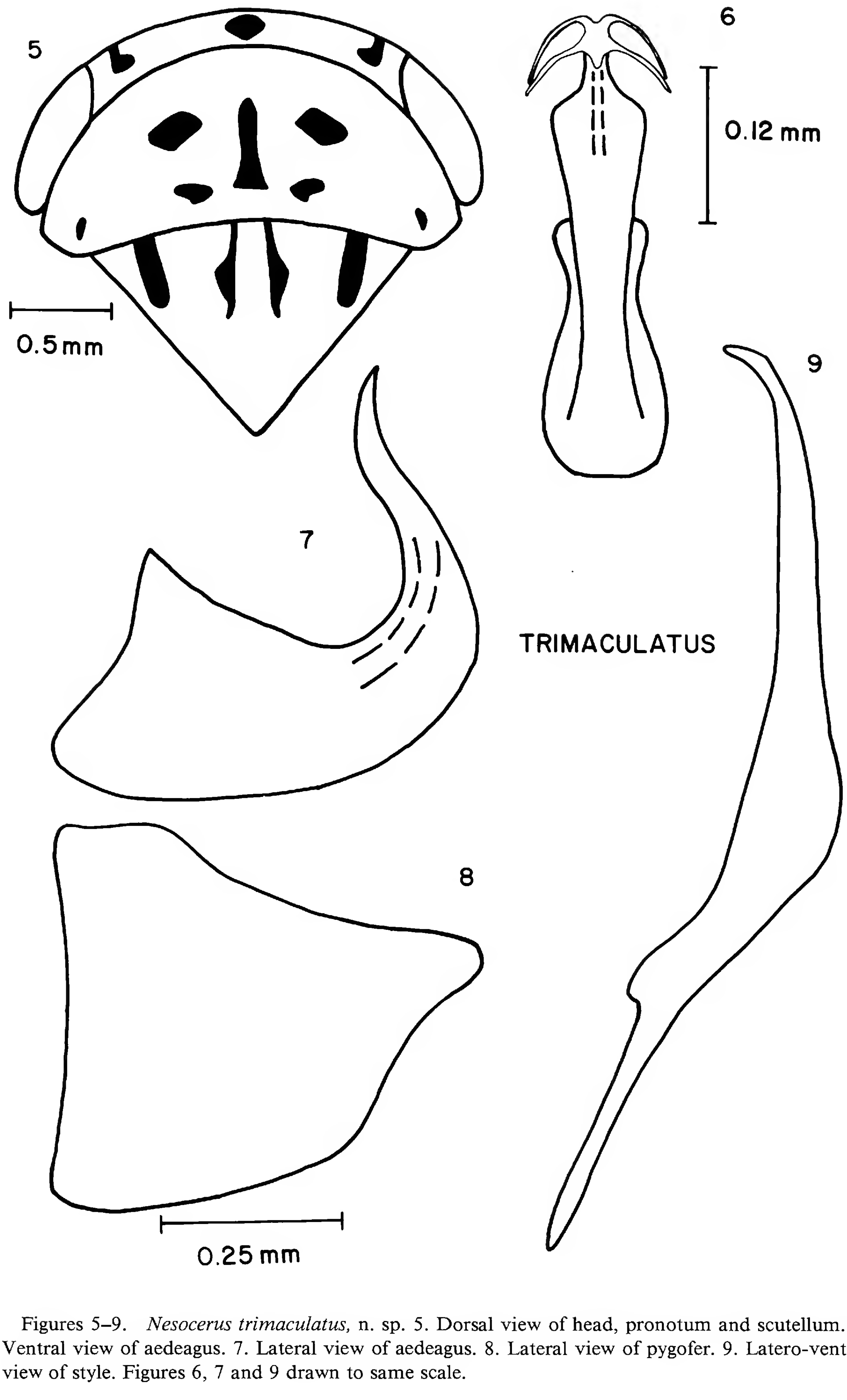
[1] The investigation reported in this paper (No. 82-7-199) is in connection with a project of the Kentucky Agricultural Experiment Station and is published with approval of the Director.



Figures 1–4. *Idiocerus rossi,* n. sp. 1. Lateral view of pygofer. 2. Ventral view of aedeagus. 3. Lateral view of aedeagus. 4. Latero-ventral view of style. Figures 2 and 3, to the same scale.



Figures 5–9. *Nesocerus trimaculatus,* n. sp. 5. Dorsal view of head, pronotum and scutellum. 6. Ventral view of aedeagus. 7. Lateral view of aedeagus. 8. Lateral view of pygofer. 9. Latero-ventral view of style. Figures 6, 7 and 9 drawn to same scale.

Nesocerus trimaculatus, New Species
(Figs. 5–9)

Structural features.—Head wider than pronotum. Forewing normal except median vein evanescent near base.

Color.—Head light yellow with 3 brown patches along anterior margin in dorsal view; face light yellow with 2 brown patches near anterior margin of postclypeus in ventral view; postclypeus with a median longitudinal brown band; brown patches circling ocelli; second antennal segment brown; postclypeus with 2 small brown spots on disc, longitudinal medial brown stripe and 2 small brown spots on lateral posterior margin. Scutellum light yellow with 4 longitudinal bands starting at anterior margin and ending near disc. Lateral edges of thorax light yellow, legs light yellow, except hindleg with brown spot on anterior-distal margin. Forewing transparent, veins brown.

Male genitalia.—Pygofer produced posterior margin along with a few setae scattered on apical half. Plates spatulate; apex bluntly rounded, macrosetae only on lateral margin. Aedeagus stout, curved dorsad in lateral view with 2 pairs of processes at apex in caudal view, processes directed dorsad. Connective broadly Y-shaped. Style linear, apex curved dorsad in lateral view.

Holotype.—Male—Madagascar, Ankarafantsika (Forest Reserve), near Marovoay, XII-1-1959, E. S. Ross, Collector. Deposited in the Academy of Natural Sciences, Philadelphia.

Etymology.—Latin, tri (three) and maculat (spotted) refers to the 3 dark brown patches on the head in dorsal view.

Diagnostic features.—This species will key to *N. duospinus* in Freytag and Knight's key to the Madagascar *Nesocerus* (1966:82). It can be separated from it by the aedeagus having 2 pairs of apical processes and the head with 3 brown patches in dorsal view.

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Nosopsyllus fasciatus Parasitizing House Mice on Southeast Farallon Island, California (Siphonaptera: Ceratophyllidae)

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Southeast Farallon Island is a small granitic island located near the edge of the continental shelf approximately 48 km WSW from the Golden Gate Bridge, San Francisco, California. Presently the island is under the jurisdiction of the San Francisco Bay National Wildlife Refuge and the 12th U.S. Coast Guard District. The Point Reyes Bird Observatory (PRBO) maintains a research station at the island with logistic support provided by the Coast Guard and the Oceanic Society. The island serves as an important sanctuary and breeding ground for 12 species of marine birds and 5 species of pinnipeds (Ainley and Lewis, 1974). Besides humans the only other land mammals presently residing on the island are house mice, *Mus musculus* Linnaeus (DeSante and Ainley, 1980). European rabbits, *Oryctolagus cuniculus* Lilljebord, exterminated from the island in 1974, had been resident beginning sometime between 1855–1876 (Pinney, 1965). Various domestic mammals including dogs, cats and mules have resided there during the past but are no longer present (DeSante and Ainley, 1980) and hoary bats, *Lasiurus cinereus* (Palisot de Beauvois), and red bats, *L. borealis* (Müller), occur in small numbers for brief periods during their fall migration (Tenaza, 1966; PRBO, unpubl.). The absence of rats, *Rattus norvegicus* (Berkenhout) and *R. rattus* (Linnaeus), (DeSante and Ainley, 1980) is an interesting aspect of the island's ecology considering the rather intense and continuous human activity since 1849 (Doughty, 1971; Shanks and Shanks, 1978).

During 23 August to 6 September 1980 I visited the island to continue studies on the marine bird flea, *Ceratophyllus pelecani* Auguston, parasitizing western gulls, *Larus occidentalis* Audubon. During this period the house mouse population was at its annual peak (R. Boekelheide, pers. comm.) and the PRBO staff biologists were snap-trapping mice inside their house in an attempt to control the rather high indoor mouse infestation. House mice were present on both the main island and West End, a smaller island to the west separated by the narrow Jordan Channel, and mice were quite active on the southern marine terrace where large numbers of western gulls had recently nested. Because of the high mouse population, the dispersed gull population (gulls were no longer territorial about their nests and most hatching year gulls were capable of flight), and mouse activity in the gull nesting area, it appeared possible that the mice were serving as fall alternative hosts for the bird fleas. There is one record of *C. pelecani* collected from *Peromyscus maniculatus elusus* Nelson and Goldman, Santa Barbara Island, Channel Islands, California (Hubbard, 1947) and this flea will readily engorge on white mice in the laboratory (Schwan, unpubl.). Therefore, during my stay on the island I examined house mice snap-trapped in the PRBO house and the nearby Coast Guard (CG) house, as well as a few I captured by hand outdoors. The results of these examinations are presented herein.

RESULTS

During 26 August–6 September 1980 I examined 48 house mice for fleas; 20 mice from the PRBO house, 18 from the CG house, and 10 from outdoors. While adult *C. pelecani* were still active in abandoned gull nests located near these houses, I found none on these mice. However, *C. pelecani* is a nest flea, spending little time on its avian host and one might not find many on mice either even though these fleas might be feeding on them. However, 26 of the 48 mice (54.2%) were infested with the northern rat flea, *Nosopsyllus fasciatus* (Bosc), a flea not previously known to occur on the island. I collected 39 *N. fasciatus* (27 males, 12 females) from the mice: flea index for all mice = 0.81, flea index for only infested mice = 1.50. One male and one female were also found in a mouse nest located under a board on the marine terrace.

The percentages of mice infested from the CG house, PRBO house and outdoors were 72.2%, 60.0% and 10.0%, respectively, while the *N. fasciatus* indices were, in the same order, 1.33, 0.70 and 0.10 fleas per mouse. These data suggest that *N. fasciatus* is more abundant on indoor mice compared to outdoor mice, although Eskey (1938) found the opposite for *N. fasciatus* infesting rats in San Francisco. The CG house, which has only occasional and short term human occupancy and no mouse control, contained mice which were more frequently infested and had a *N. fasciatus* index nearly double that found on the mice from the PRBO house. The PRBO house has continued human occupancy and mouse control and I suggest that the lower infestation rate and flea indices for PRBO house mice are probably due to a continual influx of relatively clean mice from outside.

Male mice outnumbered females 33 to 15. Forty-three of the 48 mice, weighed to the nearest 0.1 g, had a mean weight of 15.1 g (range 8.1–21.1 g) and 33 of these 43 mice (76.7%) weighed over 14 g and were therefore adult (DeLong, 1967). The mice were in good condition: they had clean pelage and no scars, most were molting and many had large fat deposits associated with their reproductive tracts, and none were infested with any mites, lice or ticks.

DISCUSSION

Prior to this study *N. fasciatus* was unknown on SE Farallon Island and the presence of an established *N. fasciatus* population on house mice in the absence of *Rattus* is interesting. For example, during November 1970 to December 1972 I trapped 253 house mice from a feral population in an annual grassland community near Hayward, Alameda Co., California (Schwan, unpubl.). No *Rattus* were present and from the house mice I collected 85 *Leptopsylla segnis* (Schönherr) (32 males and 53 females), 9 *Malaraeus telchinus* (Rothschild), (1 male and 8 females) and 1 male *Hystrichopsylla occidentalis* Holland. No *N. fasciatus* were found. The *M. telchinus* and *H. occidentalis* were primarily associated with sympatric voles, *Microtus californicus* (Peale) (Schwan, 1975). Linsdale and Davis (1956) examined 77 house mice in an area free of rats in Monterey Co., California and found no *N. fasciatus*. Other studies in the San Francisco Bay area have shown occasional light infestations of *N. fasciatus* on house mice in areas where mice and rats occur together. Miles et al. (1957) reported 9 *N. fasciatus* from 227 house mice and Stark and Miles (1962) found an unreported low number on 27 mice. In Hawaii, Haas et al. (1972) commonly found *N. fasciatus* on house mice living with *R. rattus* and *R. exulans* (Peale) in a *Eucalyptus* plantation.

N. fasciatus is a rat flea endemic to Europe and the British Isles and has a world-wide distribution due to its association with commensal rodents (Buxton, 1941; Jordan, 1948; Lewis, 1975) and it is an important plague vector among rats (Pollitzer, 1954). The species is well established throughout the United States (Benton, 1980; Prince, 1943) and was first reported from San Francisco by Fox (1908) where it occurs on *R. norvegicus* during all months of the year (Eads and Barnes, 1976). It is found throughout much of California (Prince, 1943) and has recently been collected on San Miguel Island, Channel Islands, off the southern California coast (2 females ex: *Peromyscus maniculatus streatori* Nelson and Goldman, collected 25 May 1978; B. C. Nelson, pers. comm.), an island also inhabited by roof rats. *N. fasciatus* occurs on the Hawaiian Islands (Haas et al., 1972) and has been recorded from Macquarie Island in the Subantarctic (Dunnet, 1961). Yet the species is not known to occur on *R. rattus* or *M. musculus* on the Galapagos Islands (Smit, 1970).

The time of introduction of both house mice and *N. fasciatus* to SE Farallon Island is not known. Pinney (1965) and Marshall and Nelson (1967) were the first to report house mice even occurring on the island, but mice probably reached the island many years before the 1960s. An early report of burrowing owls, *Athene cunicularia* (Bonaparte) nesting on the island (Dawson, 1911) and reported sightings of this owl back to 1887 (Bryant, 1888) may suggest the presence of mice before 1900. Burrowing owl pellets collected on the island during March 1980 contained skeletal remains of house mice (PRBO, unpubl. journal, 17 March 1980) but burrowing owls are known to include many prey items, including insects, in their diet (Bent, 1938). Therefore, past nesting of these owls does not necessarily prove the presence of mice at those times.

Regarding the introduction of *N. fasciatus,* this flea may have arrived on house mice, most likely from San Francisco, where Fox (1908) reported this flea primarily from rats but also small numbers from mice. Lewis (1967) stated that "*N. fasciatus* appears to be an unspecialized species of flea capable of colonizing new, unpopulated areas with relative ease" and "being an adaptable species, an expansion of the population in one locality may involve the transfer to a different, though related, host." However, house mice generally carry few fleas and Worth (1950), although experimenting with *Xenopsylla cheopis* (Rothschild), concluded that house mice would unlikely participate significantly to the dispersal of rat fleas. Another possible route of introduction, although remote, could have involved an infested avian predator, flying from the mainland, as discussed by Jellison (1939) regarding the role of predatory birds in the dispersal of fleas and plague. However, I believe the presence of *N. fasciatus* on the island indicates past unsuccessful introductions of *R. norvegicus* or *R. rattus.* As mentioned earlier, the absence of rats is interesting in spite of much human disturbance to the island, such disturbance even being reflected by the high percentage of exotic plant species (Coulter, 1971). One possible explanation is that rats were exterminated many years ago during the unsuccessful poisoning campaigns to control rabbits.

In conclusion, the flea *Nosopsyllus fasciatus* is established as a house mouse flea on SE Farallon Island and its presence suggests previous unsuccessful introductions of rats to the island. *N. fasciatus* is the fourth species of flea now known to occur on the island, the others being *C. pelecani,* a nest flea primarily of gulls and cormorants, *Actenopsylla suavis* Jordan & Rothschild, a nest flea of Cassin's auklets, and *Dasypsyllus gallinulae perpinnatus* (Baker), a nest flea of passerine birds.

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Rainfall, Resources, and Dispersal in Southern Populations of *Euphydryas editha* (Lepidoptera: Nymphalidae)

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While the dispersal capacity of an insect species probably changes little from one generation to another, its actual dispersal or vagility may vary considerably. This is well documented for insects which have migratory generations, such as locusts, aphids, and butterflies, but remains virtually undocumented in non-migratory species. One exception is the butterfly, *Euphydryas editha.* Individuals of this species were originally shown to be extremely sedentary (Ehrlich, 1965), but in some populations the mean dispersal distance of individuals was recently observed to change dramatically from one generation to the next. These changes in vagility appeared to be influenced by the availability of oviposition plants and adult nectar resources; significantly greater vagility occurred in drier years when those resources were sparse (White and Levin, 1981).

However, subsequent field observations of four *E. editha* populations in Southern California indicate that the determinants of vagility are more complicated. In 1977 these populations exploded in size and mass dispersal was observed. Here we discuss how weather and butterfly population size interact to determine host plant availability and butterfly population dynamics. Additionally, we consider the biogeographic and genetic consequences of dramatic population fluctuations in *E. editha,* and the mechanisms by which both the butterflies and their host plants respond to environmental stress.

LIFE HISTORY

Euphydryas editha populations in San Diego County usually fly in a four to eight week period, starting as early as mid-January and ending as late as the end of April, depending on the timing of winter rainfall. Eggs hatch about ten days after oviposition and about two weeks later larvae enter an obligatory fourth instar diapause. Diapause terminates after winter rainfall when larval host plants are again available. Postdiapause larvae then feed through another four instars, pupate, and emerge as adults to complete the life cycle. The temporal proximity of the postdiapause larval feeding period to the oviposition and prediapause larval feeding periods is key to understanding year-to-year changes in host plant densities and in butterfly dispersal.

OBSERVATIONS

During the spring of 1977 rainfall preceding the flight of *E. editha* in the mesa grasslands of San Diego County and northern Baja California was just above the long-term average (11.48 cm versus average 11.15 cm, November–January; NOAA

Climatological Data). Based on the hypothesis that normal rainfall would provide adequate plant resources, we predicted limited adult butterfly movements. Instead, in an early and extended flight period, February through April, colonies exhibited local population explosions and very high rates of dispersal. Several San Diego area populations studied by our group for almost a decade (Ehrlich et al., 1975; Singer and Ehrlich, 1979) increased nearly two orders of magnitude, to hundreds of thousands of individuals at each of four population centers: Lower Otay (LO), Upper Otay (UO), Brown's Field (BF) on Otay Mesa, and La Pressa Rodriquez (LPR) near Tijuana.

Although butterflies were extremely abundant, there was no apparent scarcity of nectar. Flowers most commonly visited (*Eriogonum fasciculatum* Bentham, *Vigueria laciniata* Gray, *Linanthus dianthiflorus* (Bentham) Greene, and *Dichelostemma pulchellum* Heller) were available in large numbers. Thus, adult movements induced by a lack of proximate nectar sources, such as those observed by Gilbert and Singer (1973), seemed unlikely. However, the larval host plants, *Plantago insularis* Eastwood and *P. hookeriana* F. and M., were scarce or absent. Nearly eight hours spent searching for these normally abundant plants resulted in only a few dozen being found at UO and BF, and none at either LPR or LO. On the basis of this search we estimate that the portion of the plant crop consumed by postdiapause larvae was more than 99%, considerably higher than the maximum of 80% previously reported (White, 1974). Defoliation of this degree results in significant larval starvation and competition for host plant resources. Nonetheless, enough food was apparently available to allow emergence of very large numbers of adults. The very nearly total defoliation of larval host plants produced a scarcity of oviposition sites, and this elicited movements far in excess of any previously recorded for either sex (White and Levin, 1981). Egg-laden females were captured several kilometers north of LO and UO in unsuitable chaparral habitat and similar distances west, over barley fields and other inappropriate habitats lacking host plants. At LO the flight observed of both sexes was directional, away from the population centers described by White and Levin (1981).

Determinants of Vagility

Given these latest observations, we can now attempt a more comprehensive model to explain generation-to-generation changes in vagility in this species. Figure 1 illustrates how factors acting on butterfly host plants determine adult population dynamics. Dry winters result in adult *Euphydryas editha* that exhibit increased vagility, because: 1) nectar plant quantity and quality are locally reduced, 2) fewer suitable oviposition plants are available and these senesce earlier, so females must fly farther to oviposit, and 3) postdiapause larvae defoliate many of these plants before adult females emerge to oviposit. When a wet year is followed by a dry year dispersal is intensified; and, the greater the difference in rainfall from one year to the next, the greater the change in dispersal. This is because the larger the difference in rainfall, the greater will be the imbalance in the densities of the emerging adult population and the available oviposition plants. When defoliation by postdiapause larvae is particularly extreme, competition for limited oviposition plants may become intense for those individuals who become adults. In the more usual course of events, however, postdiapause larval starvation is

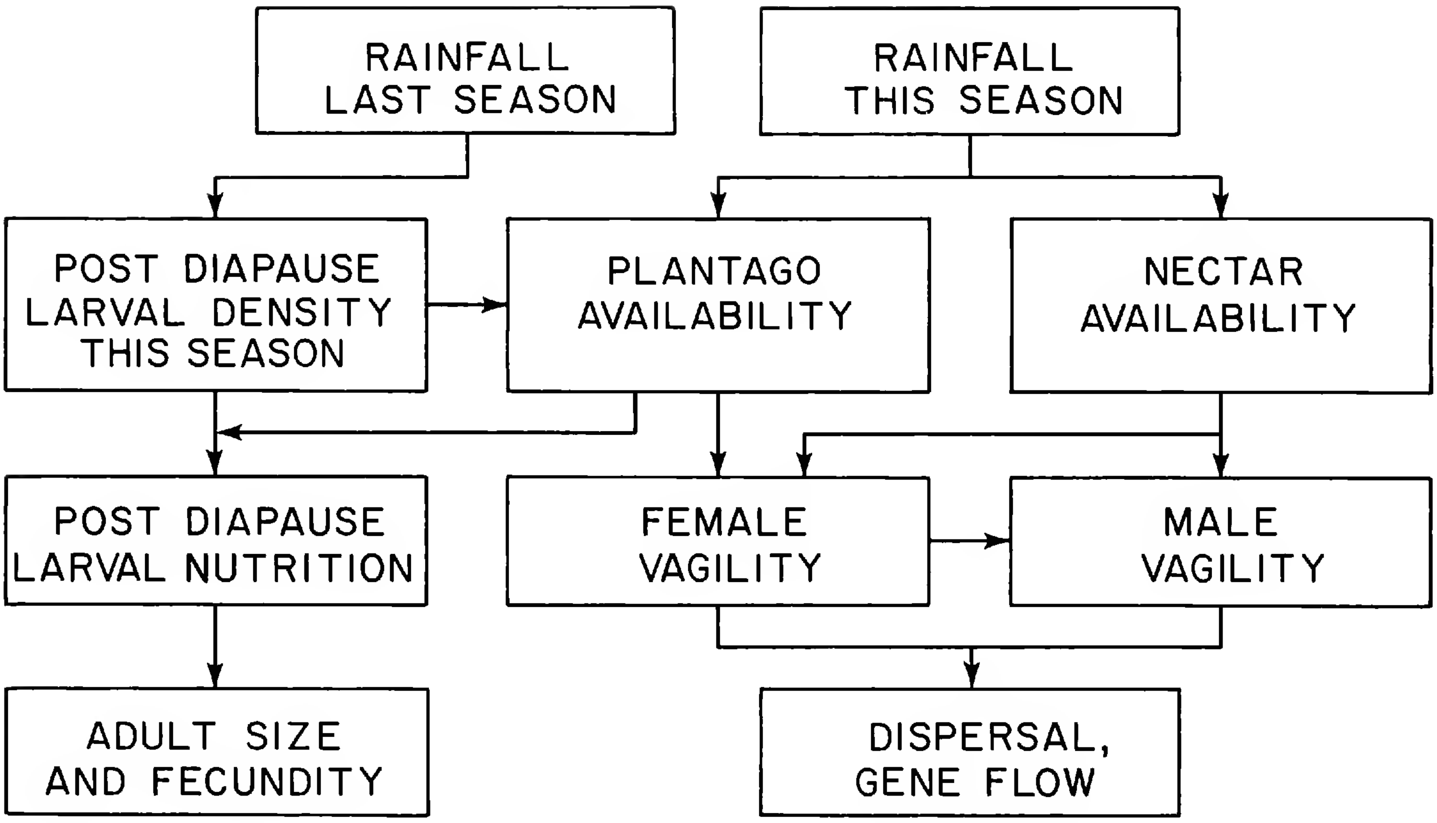

Figure 1. Flow chart of the influence of rainfall on host plant availability, larval survival, fecundity of adults, and gene flow. Discussion in text.

minimal, adult resources and oviposition plants are abundant, and adults are sedentary (this is what White and Levin observed in 1973).

Even without a decline in rainfall, consecutive years of average or better rainfall apparently result in such large population build-ups that postdiapause larvae almost totally defoliate the *Plantago* crop regardless of its abundance. This is what seems to have occurred in 1977. Whether larval food-stress predisposes adults to migrate is not known, but the presence of nectar appears not to inhibit emigration under these circumstances. These populations of butterflies are thus regulated by rainfall (which determines plant crop density) in a largely density-independent manner most years. But, intermittent generations are subject to severe competition, hence are regulated in a density-dependent manner.

ADAPTATIONS TO STRESS IN PLANTS AND BUTTERFLIES

The long-term status of larger local populations of *Plantago* and *Euphydryas* in Southern California appears to be little affected by host plant defoliation, larval starvation, and adult dispersal. Though we observed essentially total defoliation of *Plantago* in 1977, so that no seed was set, the autumn rains that year produced large standing crops from the seed bank remaining in the soil from previous years. In February of 1978, an average of 19 plants per square decimeter were counted in 15 randomly selected plots (range: 0–67) at LO. We have observed similar phenomena in Northern California where *Euphydryas* use annual larval host plants, which nearly disappeared due to drought rather than to defoliation, forcing small *E. editha* populations to extinction (Ehrlich et al., 1980).

Three characteristics of *Euphydryas editha,* particularly well developed in the *wrighti* subspecies, seem to be key to its survival in this relatively unpredictable environment. First, adult size shows a positive correlation with rainfall and is greatest when rainfall-dependent host plant density and quality are high (White and Levin, 1981; Murphy et al., in prep.). In seasons of poor host plant conditions, larvae pupate small, rather than feeding to some "optimum" size. Though smaller adult females produce fewer eggs in such years, offspring are provided sufficient time to reach diapause before host plants senesce. Second, postdiapause larvae experiencing food-stress have been observed to re-enter diapause (Singer and Ehrlich, 1979). This may explain why in 1978 the adult population was of moderate size: larvae from 1976 re-entered diapause in 1977 to emerge successfully in 1978. Third, emergence from diapause may be controlled more by rainfall and host plant availability than by time of year, and appears to be less obligatory than in other subspecies such as Northern California's *E. editha bayensis.* Abundant host plant crops are used whenever available, even when they occur out of season due to unusual rainfall. The sizes of fall-flying generations, such as the one reported for November 1936, may resemble those of normal February–March generations (Fred Thorne, pers. comm.). The pool of diapausing larvae is thus replenished whenever rainfall is substantial, rather than only in years with good winter rainfall.

BIOGEOGRAPHIC AND GENETIC CONSEQUENCES OF MASS DISPERSAL

Clearly important in the immigration-extinction dynamics of Southern California *Euphydryas editha* is the role of migrants moving into unoccupied sites during these infrequent population explosions. Populations of *E. e. wrighti* have long been known to vanish for years, then to suddenly reappear (Orsak, 1977; J. W. Johnson, pers. comm.). We suspect that in many years rainfall, and therefore host plants, are insufficient to support populations in many small, topographically homogeneous or otherwise marginal habitats and that local population extinction is likely common there. Between population outbreaks, populations may survive only in the largest, most diverse habitats. During consecutive years of adequate rainfall these populations increase in size and exhaust host plant availability which leads to mass dispersal. Larger populations then act as sources of migrants to uninhabited areas, which due to adequate rainfall in these years support sufficient plant resources to make establishment or re-establishment of populations possible. The largest, most persistent populations thus support the long-term existence of many other populations.

This extinction/recolonization dynamic has implications for conservation efforts aimed at this species (Murphy and Ehrlich, 1980). (The *wrighti* subspecies has been placed on several review lists for potential endangered status.) The extirpation of a single, large reservoir population of *wrighti* may effectively deny other habitats necessary migrants, creating a ripple effect of irreversible long-term extinctions. We suspect that just such a circumstance has eliminated *Euphydryas editha wrighti* from Orange County and much of coastal San Diego County, and now threatens populations in Riverside and inland San Diego Counties in California.

The role of infrequent episodes of mass dispersal in affecting gene flow between *Euphydryas editha* populations is not so clear. There is a lack of any significant genetic difference among populations at UO, LO, and BF (McKechnie et al., 1975; C. E. Holdren, pers. comm.). In most years the migration rates among these populations seem to be very low, probably less than that necessary to keep the frequencies of selectively neutral alleles the same (Lewontin, 1974). It is tempting, therefore, to ascribe the observed genetic similarities to population explosions of the sort seen in 1977. However, the environmental conditions that result in increased dispersal make reproduction nearly impossible for migrants arriving at occupied population sites. Hence, while adult movements are necessary for gene flow to occur, they are not equivalent to gene flow in the case of established populations.

CONCLUSIONS

After extensive study of several populations of *Euphydryas,* movement patterns appeared to be characteristic of local populations and determined by local resource distribution (Gilbert and Singer, 1973). Further research showed that for one population, year-to-year changes in rainfall produce changes in resource availability, which in turn result in changes in vagility (White and Levin, 1981). Our current understanding contains an additional element: prior build-up of insect population numbers may cause resource depletion resulting in host plant scarcity even in years of favorable weather. Thus the dynamic history of a population can have a significant effect on dispersal patterns of its individuals, and on the overall distribution of the organism.

ACKNOWLEDGMENTS

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A New Grasshopper of the Genus *Eumorsea* from Baja California, Mexico (Orthoptera: Eumastacidae)

Marius Descamps

Muséum national d'Histoire naturelle, 45 rue Buffon, 75005, Paris.

The genus *Eumorsea* Hebard is currently known only from the state of Arizona from which two species have been described: *E. balli* Hebard, 1935 (Huachuca Mts., Glen Oaks) and *E. pinaleno* Rehn and Grant, 1959 (Pinaleno Mts.). Among the Eumastacoidea sent to me for study from Baja California, Mexico, was a third species described below.

At present, the three known species are easily differentiated by the form of the sub-genital plate of the female.

1. Fastigium of vertex with latero-apical angles very broadly rounded, anterior margin curved outward (Fig. 6) 2
   Fastigium of vertex with latero-apical angles less broadly rounded, anterior margin incurved or sub-rectangular (Fig. 4); female sub-genital plate apically broadly rounded (Fig. 3) ....*E. truncaticeps,* n. sp.
2(1). Apex of female sub-genital plate triangular with two strong shoulders laterally (Fig. 1) .... *E. balli* Hebard
   Apex of female sub-genital plate with tongue-shaped process (Fig. 2).. *E. pinaleno* Rehn and Grant

***Eumorsea truncaticeps,* New Species**

Holotype.—Female: Mexico, Baja California Norte, Sierra San Pedro Martir National Park, 4.8 km E of park entrance on road from Hwy. 1 (2316 m), 28-VII-1978, D. B. Weissman and D. C. Lightfoot. Holotype (in alcohol) in California Academy of Sciences, No. 14190.

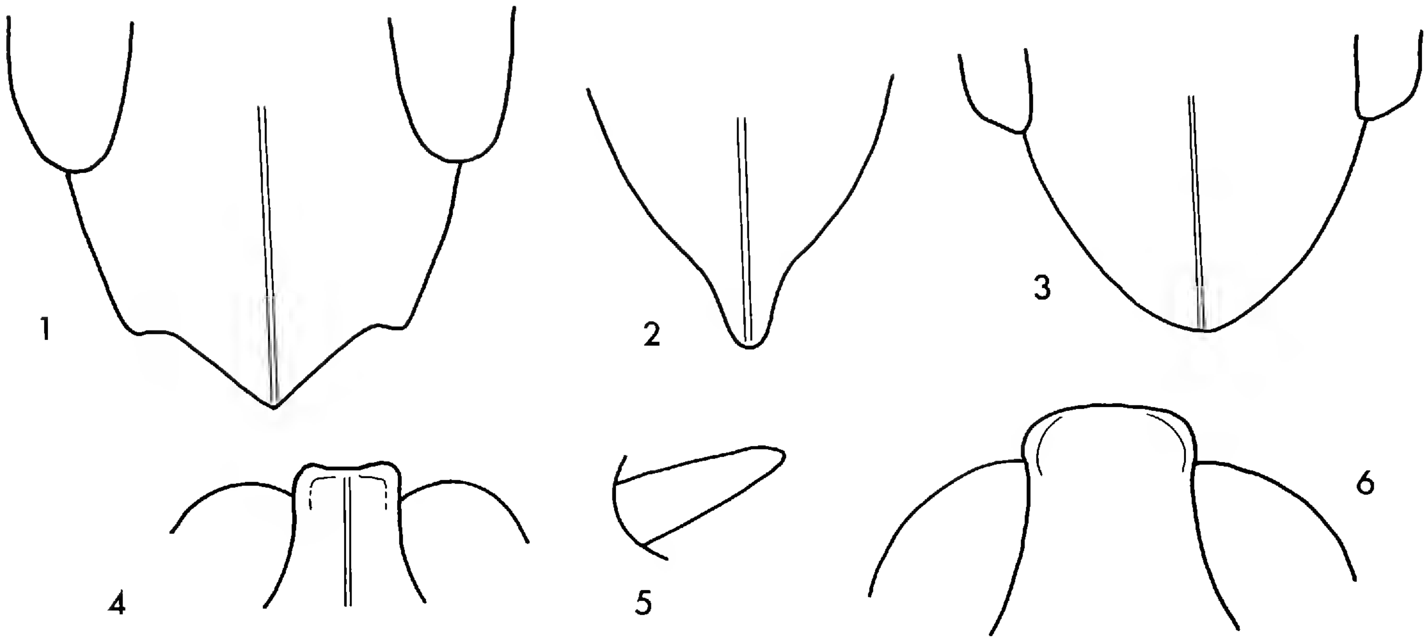
Size relatively small. Fastigium of vertex (Fig. 4) short, slightly convex, anterior edge sinuate, gently incurved, and forming a narrowly rounded 90° angle with lateral edges which are parallel and straight, with a fine median carinule. Length of the head from end of fastigium to occipital suture distinctly shorter than length of pronotum on median line.

Pronotal disc bounded by distinct fine carinules, sinuate, broken, divergent caudad in anterior two-thirds, then convergent to caudal margin; metanotum with lateral carinae strong and sharp, convergent caudad. Median carina narrow and distinct.

Posterior femur with dorsal carina ending in a rather strong spine.

Subgenital plate well developed posteriorly, edges evenly convex, apex broadly rounded. Ventral valves of ovipositor small, external margin with two well-marked teeth, internal margin with one postbasal tooth.

Color in preserved specimens generally dark brown mottled with black, in life somewhat lighter and greyer, matching granite substrate. Lateral lobes of pronotum with irregular black band extending across meso- and metanotum, ventro-



Figures 1–6. 1–3. Female subgenital plate of *Eumorsea*. 1. *E. balli*. 2. *E. pinaleno*. 3. *E. truncaticeps*. 4–5. *E. truncaticeps*. 4. Fastigium of vertex, female, dorsal view. 5. Male cercus in profile. 6. *E. balli*, fastigium of vertex, female, dorsal view.

posterior angle marked by a light triangle; first and second abdominal tergites without black marks; other tergites with lateral black marks forming a broken band; femora, tibiae and tarsi with dark and light rings, more or less distinct in individual specimens.

Allotype.—Male: Mexico, Baja California Norte, Sierra San Pedro Martir National Park, 4.8 km E of park entrance on road from Hwy. 1 (2316 m), 28-VII-1978, D. B. Weissman and D. C. Lightfoot. Holotype (in alcohol) in California Academy of Sciences, No. 14190.

Cercus thick, slightly incurved, length about 2.5 times basal width (Fig. 5).

	Pronotum	Posterior femur
1 ♂	1.8 mm	7.5 mm
2 ♀	2.0–2.4 mm	10.0–10.2 mm

Records.—MEXICO: Baja California Norte, Sierra San Pedro Martir National Park, 4.8 km E of park entrance on road from Hwy. 1 (2316 m), 28-VII-1978, D. B. Weissman and D. C. Lightfoot, 1 ♂ allotype, 1 ♀ holotype (both in alcohol), 5 ♀ paratypes (pinned); 0.8 km W (outside) of entrance to Sierra San Pedro Martir National Park, 20-VII-1977, D. Weissman, 1 ♀ paratype (pinned). Types deposited in California Academy of Sciences, San Francisco; University of Michigan Museum of Zoology, Ann Arbor; and Academy of Natural Sciences, Philadelphia.

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PAN-PACIFIC ENTOMOLOGIST
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Scientific Note

Association of *Mydas xanthopterus* (Loew) (Diptera: Mydidae) and *Pepsis formosa* Say (Hymenoptera: Pompilidae) in the Chiricahua Mountains of Southeastern Arizona

During mid-July of 1980, the adults of *Mydas xanthopterus* (Loew) were collected in association with *Pepsis formosa* Say in Pinery Canyon 25 km E of Portal, Cochise County, Arizona, USA. Geographically, *M. xanthopterus* is sympatric with *Pepsis* species distributed from southeastern Arizona to the trans-Pecos region of western Texas (Cole, 1969, The flies of western North America, p. 181). Males and females of *M. xanthopterus,* which resemble red-winged *Pepsis* species and are considered possible Batesian mimics by Cole (Ibid.), were collected sympatrically with *P. formosa* from the yellowish-white blossoms of squaw bush (*Rhus* sp.) (plants 0.5–2.0 m high) along Pinery Creek in the Chiricahua Mountains. In flight, *M. xanthopterus* was mistaken for *P. formosa.* Both species fly along a direct flight path with the fore legs extended forward beyond the head, the middle and hind legs directed rearward beside the abdomen, and with all tarsi curved upward. Prior to alighting, *P. formosa* would characteristically fly from side to side in a horizontal plane as individuals approached within ca. 0.5 m of the blossoms. Adults of *M. xanthopterus* did not exhibit any of these lateral movements before landing. Either males or females would normally approach a group of blossoms at the top of bushes, descend slowly, alight and begin nectar feeding. The largest of the *M. xanthopterus* collected was equivalent in size to a medium sized female or large male *Pepsis.* Males of *M. xanthopterus* were typically smaller than females.

Though we did not quantify our collections, both *M. xanthopterus* and *P. formosa* (including perhaps other *Pepsis* species not collected) appeared to be equally abundant. In three hours of intensive collecting along Pinery Creek, the authors took 9 specimens (5 ♂, 4 ♀) of the mydaid, including one female of *M. abdominalis* Adams, and several *P. formosa.* Specimens were identified by comparing our material to that deposited in the insect repository at the University of California, Davis (courtesy of R. O. Schuster). A small series of *M. xanthopterus* has been placed in the museum at U. C. Davis.

The authors wish to thank Dr. D. Clark of Arizona State University for identifying the *Rhus* collected from Pinery Canyon and Mr. R. O. Schuster of the Department of Entomology, University of California, Davis, who gave us permission to use the identified specimens deposited in the U. C. Davis museum as an aid towards the identification of *M. xanthopterus* and *P. formosa.*

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Scientific Note

Tibicen Cicada (Homoptera: Cicadidae) Associated With A Potted Ornamental Palm Tree

The purpose of this note is to call attention to what appears to be a feeding association between a nymph of the cicada *Tibicen canicularis* (Harris) (Homoptera: Cicadidae) and the roots of a potted ornamental palm tree, *Chamaedorea elegans* Martius (Dwarf Date Palm), in a Milwaukee, Wisconsin household. Although actual feeding by the nymph was not observed, other observations suggest a feeding relationship with the potted plant. This tentative conclusion is of particular interest since there are not many records of nymphal feeding associations for North American cicadas such as the widespread *T. canicularis* (Beamer, 1928, Univ. Kans. Sci. Bull., 18:155–263; Moore, 1966, Pap. Mich. Acad. Sci. Arts and Lett., 51:75–96).

On 6 April 1981 a male *Tibicen* emerged from a hole in the soil of a potted *C. elegans* kept throughout the winter in the living room of a Milwaukee residence. This palm tree was about 0.75 m tall and kept in a large plastic pot outfitted with a series of ¾-inch diameter holes in the bottom. The previous summer the palm was kept out-of-doors for about 2 months, on a stone patio, and the remaining time on a gravel bed along one side of the house and adjacent to several small rosebushes. While out of doors, the basic pot was enclosed inside a large redwood decorator pot, outfitted with a single ¾-inch hole in the center of the bottom. This arrangement blocked all but one of the several holes in the basic pot during this period. The plant was purchased in the spring of 1979 from a local ornamental plant dealer who related that the palms were grown from seeds in Del Ray Beach, near Miami, Florida. The soil of the potted plant was never completely replaced, and for the small amounts that were replaced from time to time, "sterile" potting soil purchased from a local vendor was always used. At the farm site in Florida, it takes about a year for the palm to grow to a meter, and the plants are then trucked north in paper containers with the soil.

The nymphal cast and adult cicada were sent to Dr. Thomas E. Moore who determined them tentatively as *T. canicularis.* As the cicada was still teneral when it was preserved, conclusive species identification could not be confirmed. The emergence hole in the pot was very close to the base of the palm (Fig. 1) but because the soil had been disturbed, it was not possible to make a plaster-of-paris cast of the nymph's burrow to confirm feeding on the plant's roots. The palm was left undisturbed for several weeks to see if other cicadas emerged, and none did; then the plant was dug up and a thorough check made of the soil and roots. No other nymphs were found.

Suspecting that the nymph might have accidentally or deliberately crawled up into the pot through the single unobstructed bottom hole while the plant was out-of-doors in the previous summer, I reasoned that the warmth of the house in the winter accelerated the development of the nymph, thereby causing the adult to emerge much earlier than it normally would outside. In this region, *T. canicularis* usually begins emerging in early July (T. E. Moore, pers. comm.). One piece of valuable data, therefore, would be the discovery of other nymphal casts of this cicada species in the yard during the summer months of 1981. If found, they would add credence to the association between the cicada and potted palm being from a nymph present in the yard the previous summer. But none were found when checks were made in late August. The yard contains one Seedless Mountain Ash tree about 10 years old, a few lilac bushes and rosebushes. Since *T. canicularis* females commonly lay eggs in the dead, pithy stems of shrubs such as rosebushes and lilacs within three feet of the soil (T. E. Moore, pers. comm.), and the potted plant was placed near these bushes the previous summer, I suspected that if any nymphs were present, they would turn up near these bushes, some of which are between 7 and 13 years old. T. E. Moore (pers. comm.) suspects a 10-year life cycle for this cicada in this region. Beamer (op. cit.) reared *T. canicularis auriferei* in Kansas to the beginning of the fourth instar in three years, and determined that fifth instar nymphs require an undetermined period lasting more than one year to complete development.

Based upon the above observations, I conclude that this cicada was probably introduced into the potted palm in Florida where these ornamentals are grown out-of-doors. The nymph, in moving through the soil, either entered the pot or else became associated with the palm if it was grown in free soil (both methods are used). During the approximately two-year period in the Milwaukee household, the nymph probably fed upon the roots of the palm, only to then have an accelerated emergence prompted by the warmth of the house and "long-day" cues from artificial lights. In my experience in the Milwaukee area, *T. canicularis* tends to emerge in clusters in that several nymphal casts are usually found together under a tree or bush in the course of a summer. Scattered, single individuals are encountered far less frequently. But T. E. Moore has noted at two sites in Michigan (Ann Arbor area) that the same study sites produce no nymphal casts in some years while many in others, even though adults are heard singing in the area every year. Tentatively, the complete absence of nymphal casts from the yard in the summer following the one in which the plant was kept out-of-doors is circumstantial evidence against the numph being from a local population there. *Tibicen canicularis* occurs in Florida (T. E. Moore, pers. comm.).

ACKNOWLEDGMENTS

I thank Dr. Thomas E. Moore, Museum of Zoology, The University of Michigan, for determining the cicada, discussion of the observations, and reviewing the manuscript. Dr. Natalie W. Uhl of the L. H. Bailey Hortorium, Cornell University, acting in the stead of the late Dr. Harold C. Moore, determined the palm tree. Mr. Mark Schafer of Flower City in Milwaukee provided information on the source of the palm. Finally, very special thanks to the Pousha family for alerting me of the cicada emergence in their living room, and for allowing numerous trips to their home for observations. The cicada and its nymphal cast are deposited in the collections of the Milwaukee Public Museum.

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Scientific Note

Pachodynerus californicus (Saussure) New to the U.S. (Hymenoptera: Eumenidae)

On April 1, 1978 at Deep Canyon, Boyd Desert Research Institute, Palm Desert, Riverside Co., California, I collected *Pachodynerus californicus* (Saussure) visiting *Encelia farinosa* Gray. This species has previously been collected from Baja California Norte but this is the first United States record. Deep Canyon is more than 80 miles north of the nearest Baja site. It is unlikely that it would migrate that distance and a small population probably exists in Deep Canyon.

Pachodynerus californicus is a robust wasp approximately 13 mm long, and 4 mm wide, mostly black with 2 pale yellow stripes on the gaster and pale yellow markings on the clypeus, propodeum and upper mesopleuron. It probably nests in pre-existing cavities in stems and twigs and in abandoned mud-dauber nests. Caterpillars are probably used as prey (Krombein, K. et al., 1979., Cat. Hymen. Amer. North of Mexico, 2:1499).

Pachodynerus, a member of the Vespoid family Eumenidae, is a small genus with only 3 species known previously from America North of Mexico. *P. erynnis* (Lepeletier) occurs in the southeast; *P. astraeus* (Cameron) is found from southwestern Texas to southern California and *P. nasidens* (Latreille) is found in southern Arizona, Texas, Florida and Hawaii.

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Proceedings

FOUR HUNDRED AND TWENTIETH MEETING

The 420th meeting was held Friday, 21 January 1983, at 8:15 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 17 December 1982 were read and accepted. Three persons were elected as members of the Society: Mr. Randall J. Mitchell as student member, and Dr. Peter R. Atsatt and Mr. Charles D. Hunter as regular members.

Dr. Smith reported on the meeting of the executive board which decided that the 1983 editorial board would consist of an executive editor, several assistant editors, and a secretary.

Dr. Smith also pointed out that the sixtieth volume of *The Pan-Pacific Entomologist* is due in 1984 and suggested that a special commemorative volume be published.

Mr. Gary A. Freed, a graphic artist and member of the Society, offered for sale t-shirts which bear the Society's logo. Dr. Vincent D. Roth announced the recent publication of his *Handbook for Spider Identification* and offered it for sale.

Dr. David H. Kavanaugh introduced Dr. Roth, resident director of the Southwestern Research Station, Portal, Arizona. Mr. John A. Skinner introduced four persons from the University of California, Davis.

Dr. Smith reported that researchers, in a recent article in *Science,* demonstrated that the stabilimentum of spiders acts as a signal for birds and insects to avoid the web. He also reported on two groups of fossil myriapods, the Euthycarcinida which were aquatic and the Arthropleurida.

The featured speaker Dr. Richard Karban, University of California, Davis, presented "Ecology of the Periodical Cicadas (Homoptera)." His slide-illustrated lecture reported on the natural history and the effect of density on reproductive success of some periodical cicadas of eastern North America.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 39 persons was present, of which 28 signed as members and 11 as guests.—Vincent F. Lee, Secretary.

FOUR HUNDRED AND TWENTY-FIRST MEETING

The 421st meeting was held Friday, 18 February 1983, at 8:05 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 21 January 1983 were read and accepted. Two persons were elected as members of the Society: Mr. Larry D. Corpus as student member, and Dr. Jacqueline L. Robertson as regular member.

Dr. Smith reported that the Society will have to face some serious decisions regarding financing a paid secretary to the editor since the present officers of the Society who are employed by the California Academy of Sciences cannot afford to carry more responsibilities for the Society.

Several guests from faraway places such as Germany and New York were introduced or introduced themselves.

Mr. Vincent F. Lee gave a note on the Biological Institute of Tropical America (or BIOTA) and solicited donations for this organization. He also announced that Dr. David B. Weissman will be conducting a research cruise this summer to several islands in the Gulf of California and along the Pacific Coast of Baja California. Dr. Smith noted the great proliferation of an eriophyid mite, introduced from South America, on fuchsias in San Francisco and offered the formula of a mixture to control the infestation.

The featured speaker Dr. Edward S. Ross, Department of Entomology, California Academy of Sciences, presented "Insect Diversity in an Amazonian Forest." His well-illustrated slide lecture reported primarily on a recent trip to Explorer's Inn along the Tambopata River of Peru, with additional slides from his previous trips to other Amazonian areas.

The social hour was held in the Goethe Room following adjournment of the meeting.

A total of 98 persons was present, of which 30 signed as members and 44 as guests.—Vincent F. Lee, Secretary.

FOUR HUNDRED AND TWENTY-SECOND MEETING

The 422nd meeting was held Friday, 18 March 1983, at 8:10 p.m., in the Goethe Room, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 18 February 1983 were read, corrected, and accepted. Dr. Philippe de Wailly was elected as a regular member of the Society.

Dr. Smith announced that Dr. Paul H. Arnaud Jr. had volunteered to be the interim editor of *The Pan-Pacific Entomologist.* Mr. Steve Engle introduced himself as a new guest of the Society. Mr. Vincent F. Lee announced that the Department of Entomology of the California Academy of Sciences has used hard-bottomed insect trays for sale. Dr. David H. Kavanaugh showed slides of his trip to the Steens Mountain, Oregon last year.

The featured speaker Dr. Rollin E. Coville, Division of Entomology and Parasitology, University of California, Berkeley, presented "Nesting Biology and Behavior of *Trypoxylon* Spider Wasps (Hymenoptera: Sphecidae)." His slide-illustrated lecture reported primarily on his research in Costa Rica. Special mention was made of the nesting biology and enemies of the wasps.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 40 persons was present, of which 25 signed as members and 13 as guests.—Vincent F. Lee, Secretary.

FOUR HUNDRED AND TWENTY-THIRD MEETING

The 423rd meeting was held Friday, 15 April 1983, at 8:05 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 18 March 1983 were read and accepted. Mr. David A. Rider was elected as a student member of the Society.

Dr. David H. Kavanaugh introduced Dr. Larry E. Watrous and Dr. Craig Dietrick. Dr. Smith gave an update on the status of *The Pan-Pacific Entomologist.* Mr. Vincent F. Lee announced again that the Department of Entomology of the California Academy of Sciences has used hard-bottomed insect trays for sale. Dr. William E. Ferguson noted the migration of painted lady butterflies in the Borrego Desert of Southern California. Dr. Smith summarized recent fossil finds of Dr. Jarmilla Kukalova-Peck.

The featured speaker Mr. Charles P. Hansen, San Mateo County Mosquito Abatement District, presented "Canine Heartworm in the San Francisco Bay Area." His slide presentation reported on the occurrence, detection, and spread of canine heartworm by mosquitoes in dogs and coyotes.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 20 persons was present, of which 13 signed as members and 7 as guests.—Vincent F. Lee, Secretary.

FOUR HUNDRED AND TWENTY-FOURTH MEETING

The 424th meeting was held Friday, 20 May 1983, at 8:05 p.m., in the Goethe Room, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 15 April 1983 were read and accepted. Mr. Roy R. Snelling and Dr. David B. Weissman were elected as regular members of the Society.

Dr. Smith announced that Dr. Robert S. Lane had kindly volunteered to replace Dr. Paul H. Arnaud Jr., now interim editor of *The Pan-Pacific Entomologist,* on the Publications Committee. He will complete Dr. Arnaud's term through 1985. Dr. Smith commented on some changes in editorial policy, and Dr. Arnaud summarized the current status of the journal.

Dr. David H. Kavanaugh introduced Dr. Rob E. Roughley, and Mr. Gary W. Ulrich introduced Mr. Michael Pitcairn. Dr. Kavanaugh announced the existence of the National Science Foundation's Long Term Ecological Network (LTEN) sites which systematists might be interested in sampling. Dr. Smith mentioned that the American Association for the Advancement of Science will be meeting in San Francisco in 1984. He suggested that the Society participate in a joint meeting with the Academy at these meetings. He also gave further details on *Monura,* a fossil machilid of phylogenetic significance.

The featured speaker Dr. Hugh Dingle, University of California, Davis, presented "Ecology and Evolution of Insect Migration." He demonstrated how migration and diapause are interrelated in some insects of the temperate regions. Examples of migration in the monarch, *Oncopeltus, Spodoptera,* and others were discussed.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 37 persons was present, of which 26 signed as members and 11 as guests.—Vincent F. Lee, Secretary.

FOUR HUNDRED AND TWENTY-FIFTH MEETING

The 425th meeting was held Friday, 21 October 1983, at 8:10 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 20 May 1983 were read and accepted. Twenty-four persons were proposed and elected as new members: Mr. Mark A. Barnby, Mr. Ryan Church, Mr. Anthony J. Galluccio, and Ms. Leslie B. Weeks as student members; and Dr. Richard L. Brown, Mr. Jim Cope, Mr. David K. Faulkner, Dr. George R. Ferguson, Dr. Paul H. Freytag, Dr. Dan Gerling, Mr. Robert R. Hansen, Mr. Lawrence R. Hummer, Dr. Urless N. Lanham, Dr. William B. Muchmore, Dr. John L. Neff, Dr. Mark F. O'Brien, Mr. Carl A. Olson, Dr. George R. Roemhild, Ms. Adrienne E. Roth, Dr. Tom G. Schwan, Dr. Todd E. Shelly, Dr. Alexander Sokoloff, Dr. Gary M. Stonedahl, and Dr. Donald B. Thomas Jr. as regular members.

Dr. Smith announced that a new membership category, sponsoring member, was recently created by the Publications Committee, and Mr. Vincent F. Lee read the names of the members who kindly elected this category for 1984: Dr. Phillip A. Adams, Mr. Robert P. Allen, Dr. Richard M. Bohart, Mr. and Mrs. Robert Buickerood, Dr. George R. Ferguson, Mr. Wayne C. Fields Jr., Dr. John G. Franclemont, Dr. Cornelius B. Philip, Mr. David B. Scott, and Dr. David B. Weissman. He also mentioned a donation from Dr. David M. Gordon. Dr. Smith announced that the estate of Dr. Charles P. Alexander bequeathed a large sum of money for the publication of *The Pan-Pacific Entomologist.* He also gave an account of a dinner honoring Dr. Richard M. Bohart held on 28 September at Hs. Lordship's Restaurant in Berkeley where two leather-bound copies of the special volume of our journal (volume 59) in his honor were presented to Dr. Bohart and his wife Margaret on the occasion of his seventieth birthday. Dr. Arnaud summarized the current status of the journal. Dr. Smith also announced that the XVII International Congress of Entomology will be held 20–26 August 1984 in Hamburg, Federal Republic of Germany. Dr. Paul H. Arnaud Jr. announced a special price of Memoir 4 of the Society publications by the late Dr. Robert L. Usinger, *Autobiography of an Entomologist.*

Dr. Ronald E. Stecker showed two excellent slides of Dr. Bohart taken several years apart. Dr. Kirby W. Brown showed slides of lepidopteran eggs taken with a microscope and camera. Dr. Thomas S. Briggs passed around a live ricinuleid, a rare arachnid, collected when he attended the IX International Congress of Arachnology in Panama this past August. Dr. Smith exhibited recent publications on Carboniferous arthropods from the Burgess Shale of Canada and summarized the unique and unusual features about them.

The featured speaker Mr. Martin Galindo-Ramirez, University of California, Santa Cruz, presented "Population Genetics and Spider Biogeography." He showed results of his research using gel electrophoresis on *Bothriocyrtum* tarantulas and how these tie in with field studies of their natural distributions. He also reported on his on-going research with this technique on *Lutica* spiders of sand-dunes of southern California and Baja California and speculated on the biogeographical distributions of them in California.

The social hour was held in the entomology conference following adjournment of the meeting.

A total of 42 persons was present, of which 27 signed as members and 15 as guests.—Vincent F. Lee, Secretary.

FOUR HUNDRED AND TWENTY-SIXTH MEETING

The 426th meeting was held Friday, 18 November 1983, at 8:05 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 21 October 1983 were read and accepted. Six persons were proposed and elected as new members: Mr. Michael F. Day, Mr. Lawrence E. Serpa, and Ms. Sally M. Swales as student members; and Mr. Peter Ghormley, Dr. Glenn E. Haas, and Dr. Frank W. Merickel as regular members.

Dr. Smith called on the audience for volunteers to serve on the program, membership, and publication committees of the Society for 1984. He also announced that the Society should chair a section of the meetings of the Pacific Branch of the American Association for the Advancement of Science in June 1984 in San Francisco and asked for volunteers. Mr. Vincent F. Lee read these additional names of members who elected the sponsoring member category for 1984: Dr. Richard K. Allen, Dr. William F. Barr, Dr. Donald J. Burdick, Dr. Leopoldo E. Caltagirone, Dr. Kenneth W. Cooper, Dr. J. Gordon and Alice Edwards, Dr. Theodore W. Fisher, Dr. E. Eric Grissell, Dr. Kenneth S. Hagen, Dr. Alice S. Hunter, Mr. Johannes L. Joos, Mr. Robert L. Langston, Dr. Robert J. Lyon, Mr. Gordon A. Marsh, Mr. David G. Marqua, Dr. Woodrow W. Middlekauff, Mr. Robert B. Miller, Mr. Calvert E. Norland, Mr. Harry W. Oswald, Dr. Robert W. L. Potts, Dr. Jacqueline L. Robertson, Ms. Leslie S. Saul, Dr. Harvey I. Scudder, Dr. Terry N. Seeno, Mr. Frank E. Skinner, and Mr. Baldomero Villegas. He also mentioned the following persons who gave generous donations to the Society: Mr. John C. Downey, Dr. Norville M. Downie, Dr. Edward S. Ross, and Mr. Stephen R. Scott.

Mr. Alan I. Kaplan announced that the Northern California Spider Society has for sale t-shirts bearing his society's name and a beautifully executed silk screen of a spider. Dr. Smith commented on the recent findings of gigantic fossil arthropods, notably eurypterids, scorpions, trilobites, millipedes, and spiders and posed questions for speculation on how these organisms are able to function, given their sizes.

The featured speaker Dr. Edward S. Ross, California Academy of Sciences, presented "Entomological Encounters in China, Malaya, and Sumatra." He showed slides and lectured on his trip to these areas in the summer this year with a tour group in China and on his own in the other countries. He talked about the structure and insect associates of *Rafflesia,* Earth's largest flower.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 92 persons was present, of which 44 signed as members and 35 as guests.—Vincent F. Lee, Secretary.

FOUR HUNDRED AND TWENTY-SEVENTH MEETING

The 427th meeting was held Friday, 16 December 1983, at 8:15 p.m., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Dr. Edward L. Smith presiding.

The minutes of the meeting held 18 November 1983 were read and accepted. Ms. Carol Evkhanian was proposed and elected as a regular member.

Dr. Smith called for reports from the standing committees. Dr. Wojciech J. Pulawski, Treasurer, announced that the Society's finances are in excellent condition, especially after receiving the Charles P. Alexander bequest. Mr. Vincent F. Lee, a member of the membership committee, gave a breakdown of the 1983 membership. Dr. John E. Hafernik Jr., chairperson of the nominating committee, read the slate of officers proposed for 1984: Dr. Harvey I. Scudder as president, Dr. J. Gordon Edwards as president-elect, Dr. Wojciech J. Pulawski as treasurer, and Mr. Vincent F. Lee as secretary. Dr. Smith called for and received no additional nominees from the audience. The nominees were unanimously elected to office. Dr. Paul H. Arnaud Jr. summarized the report of the auditing committee and reported that the accountant Mr. H. Vannoy Davis found the accounts in good order.

Dr. Smith gave further details on the Society's participation in the meetings of the Pacific Branch of the American Association for the Advancement of Science in June 1984. He issued a call for papers and suggested that abstracts be published in the October 1984 issue. He also suggested that articles in *The Pan-Pacific Entomologist* should have an author's abstract and keywords before each article. He then handed the gavel over to Dr. Scudder, the new president for 1984. Mr. Lee announced that this meeting has approval for the State of California Agricultural Pest Control Adviser continuing education accreditation and asked those persons who wish to receive credit to sign the sign-up sheet. He then read additional names of members who elected to be sponsoring members for 1984: Mr. Eric M. Fisher, Dr. John E. Hafernik Jr., Mr. Charles E. Kennett, Mr. Dennis M. Kubly, Dr. Robert L. Mangan, Dr. Richard L. Penrose, Dr. Evert I. Schlinger, and Drs. Marius S. Wasbauer and Joanne Slansky. On behalf of the Society, he thanked Dr. James W. Tilden and William M. Upholt, both Life Members, who gave generous donations to the Society. Dr. Woodrow W. Middlekauff introduced Dr. David C. F. Rentz, a member of the Society, who was visiting from the CSIRO, Canberra City, Australia. Dr. Scudder announced titles of the talks for the January and Febuary meetings.

The featured speaker Dr. Edward L. Smith, California Academy of Sciences, gave the presidential address, "Sawfly Galls: How Hymenoptera-Symphyta Provision Their Larvae with Plant Tumors." He showed slides and lectured on gall formation by these insects, with excellent photographs of microtomic sections under different lighting techniques.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 24 persons was present, of which 20 signed as members and 4 as guests.—Vincent F. Lee, Secretary.

PACIFIC COAST ENTOMOLOGICAL SOCIETY

STATEMENT OF INCOME, EXPENDITURES AND CHANGES IN FUND BALANCES

Years Ended September 30, 1983 and 1982

	1983	1982
Income		
Dues and subscriptions	$10,037	$10,078
Reprints and miscellaneous	6,504	6,046
Sales of Memoirs	226	256
Interest	2,509	5,727
Dividends, American Telephone & Telegraph Company	468	432
Increase (Decrease) in value of capital stock of American Telephone & Telegraph Company	590	(150)
	$20,334	$22,389
C. P. Alexander bequest	29,732	
	$50,066	$22,389
Expenditures		
Publication costs—Pan-Pacific Entomologist	$10,262	$ 6,418
Reprints, postage and miscellaneous	694	5,039
	$10,956	$11,457
Increase in fund balances	$39,110	$10,932
Fund balances October 1, 1982 and 1981	45,885	34,953
Fund balances September 30, 1983 and 1982	$84,995	$45,885

STATEMENT OF ASSETS, September 30, 1983 and 1982

	1983	1982
Cash in bank		
Commercial account	$ 3,385	$12,023
Savings accounts & certificates of deposit		
General fund	54,995	9,909
Memoir fund	21,415	19,229
Total cash in bank	$79,795	$41,161
Undeposited receipts	0	114
Investment in 80 shares of American Telephone & Telegraph Co. common stock (Life Membership and Fall Funds), at market value	5,200	4,610
	$84,995	$45,885

See accompanying notes to the financial statements.

PACIFIC COAST ENTOMOLOGICAL SOCIETY

NOTES TO THE FINANCIAL STATEMENTS

Year Ended September 30, 1983

Summary of significant accounting policies.

Accounting Method: Income and expenses are recorded by using the cash basis of accounting. *Marketable Securities:* American Telephone & Telegraph Co. common stock is carried at market value. Increases and decreases in value are reflected in income. *Income Tax:* The Society is exempt from Federal income and California franchise tax. *Accounts Receivable:* As of September 30, 1983, accounts receivable aggregated $3,617. *Accounts Payable:* As of September 30, 1983, there was no material amount of unpaid bills.

As Chairman of the Auditing Committee, and in accordance with its bylaws, I have reviewed the financial records of the Society. During the course of this review nothing was noted which indicated any material inaccuracy in the foregoing statements.

H. Vannoy Davis
Chairman of the Auditing Committee

PAN-PACIFIC ENTOMOLOGIST
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The Pan-Pacific Entomologist

Index to Volume 60

(New taxa in boldface)

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The Pan-Pacific Entomologist

Contents for Volume 60

THE PAN-PACIFIC ENTOMOLOGIST

Information for Contributors

Members are invited to submit manuscripts on the systematic and biological phases of entomology, including short notes or articles on insect taxonomy, morphology, ecology, behavior, life history, and distribution. Non-members may submit manuscripts for publication, but they should read the information below regarding editing and administrative charges. Manuscripts of less than a printed page will be published as space is available, in Scientific Notes. All manuscripts will be reviewed before acceptance. Manuscripts for publication, proofs, and all editorial matters should be addressed to the editor.

General. — The metric system is to be used exclusively in manuscripts, except when citing label data on type material, or in direct quotations when cited as such. Equivalents in other systems may be placed in parentheses following the metric, *i.e.* "1370 m (4500 ft) elevation".

Typing. — **Two copies** of each manuscript must be submitted (original and one xerox copy or two xerox copies are suitable). All manuscripts must be **typewritten, double-spaced** throughout, with ample margins, and be on bond paper or an equivalent weight. **Carbon copies** or copies on paper larger than 8½ × 11 inches are not acceptable.

Underscore only where *italics* are intended in the body of the text. **Number all pages** consecutively and put authors name on each sheet. References to **footnotes** in text should be numbered consecutively. Footnotes **must** be typed on a separate sheet.

Manuscripts with extensive corrections or revisions will be returned to the author for retyping.

First Page. — The page preceding the text of the manuscript must include (1) the complete title, (2) the order and family in parentheses, (3) the author's name or names, (4) the institution with city and state or the author's home city and state if not affiliated (5) the complete name and address to which proof is to be sent.

Names and descriptions of organisms. — The first mention of a plant or animal should include the full scientific name with the author of a zoological name *not* abbreviated. Do not abbreviate generic names. Descriptions of taxa should be in telegraphic style. The International Code of Zoological Nomenclature must be followed.

Tables. — Tables are expensive and should be kept to a minimum. Each table should be prepared as a line drawing *or* typed on a separate page with heading at top and footnotes below. Number tables with Arabic numerals. Number footnotes consecutively for each table. Use only horizontal rules. Extensive use of tabular material requiring typesetting may result in increased charges to the author.

Illustrations. — No extra charge is made for line drawings or halftones. Submit only photographs on glossy paper and original drawings. Authors *must* plan their illustrations for reduction to the dimension of the printed page (117 × 181 mm; 4⅝ × 7⅛ inches). If possible, allowance should be made for the legend to be placed beneath the illustration. Photographs should not be less than the width of the printed page. Photographs should be mounted on stiff card stock, and bear the illustration number on the face.

Loose photographs or drawings which need mounting and/or numbering are not acceptable. Photographs to be placed together should be trimmed and abut when mounted. Drawings should be in India Ink, or equivalent, and at least twice as large as the printed illustration. Excessively large illustrations are awkward to handle and may be damaged in transit. It is recommended that a metric scale be placed on the drawing or the magnification of the *printed* illustration be stated in the legend where applicable. Arrange figures to use space efficiently. Lettering should reduce to no less than 1 mm. *On the back of each illustration* should be stated (1) the title of the paper, (2) the author's complete name and address, and (3) whether he wishes the illustration returned to him. Illustrations not specifically requested will be destroyed. **Improperly prepared illustrations will be returned to the author for correction prior to acceptance of the manuscript.**

Figure legends. — Legends should be typewritten double-spaced on separate pages headed EXPLANATION OF FIGURES and placed following LITERATURE CITED. Do not attach legends to illustrations.

References. — All citations in text, e.g., Essig (1926) or (Essig 1958), must be listed alphabetically under LITERATURE CITED in the following format:

Essig, E. O. 1926. A butterfly migration. Pan-Pac. Entomol., 2:211–212.
Essig, E. O. 1958. Insects and mites of western North America. Rev. ed. The Macmillan Co., New York, 1050 pp.

Abbreviations for titles of journals should follow a recent volume of *Serial Sources for the Biosis Data Base*, BioSciences Information Service. For **Scientific Notes** the citations to articles will appear within the text, i.e. . . . "Essig (1926, Pan-Pac. Entomol., 2:211–212) noted . . .".

Proofs, reprints, and abstracts. — Proofs and forms for the abstract and reprint order will be sent to authors. Changes in proof will be charged to the author.

Editing and administrative charges. — Papers by members of the Pacific Coast Entomological Society are charged at the rate of $30.00 per page. Members without institutional or grant funds may apply for a society grant to cover a maximum of one-half of these charges. Non-members will be charged at the rate of $60.00 per page. Editing and administrative charges are in addition to the charge for reprints and do not include the possible charges for author's changes after the manuscript has been sent to the printer.

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OF THE
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MEMOIRS OF THE PACIFIC COAST ENTOMOLOGICAL SOCIETY.

Volume 1. *The Sucking Lice* by G. F. Ferris. 320 pages. Published October 1951. Price $10.00 (plus $1.00 postage and handling).*

Volume 2. *The Spider Mite Family Tetranychidae* by A. Earl Pritchard and Edward W. Baker. 472 pages. Published July 1955. Price $10.00 (plus $1.25 postage and handling).*

Volume 3. *Revisionary Studies in the Nearctic Decticinae* by David C. Rentz and James D. Birchim. 173 pages. Published July 1968. Price $4.00 (plus $0.75 postage and handling).*

Volume 4. *Autobiography of an Entomologist* by Robert L. Usinger. 343 pages. Published August 1972. SPECIAL PRICE $5.00 (plus $1.00 tax, postage, and handling for California orders, $0.70 postage and handling for non-California U.S. orders, or $1.70 for foreign orders). No members discount at this special price.

Volume 5. *Revision of the Millipede Family Andrognathidae in the Nearctic Region* by Michael R. Gardner. 61 pages. Published January 21, 1975. Price $3.00 (plus $0.75 postage and handling).*

*(Add 6% sales tax on all California orders (residents of Alameda, Contra Costa, San Francisco, Santa Clara and Santa Cruz counties add 6½%). Members of the Society will receive a 20% discount on the price of the memoirs.)

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