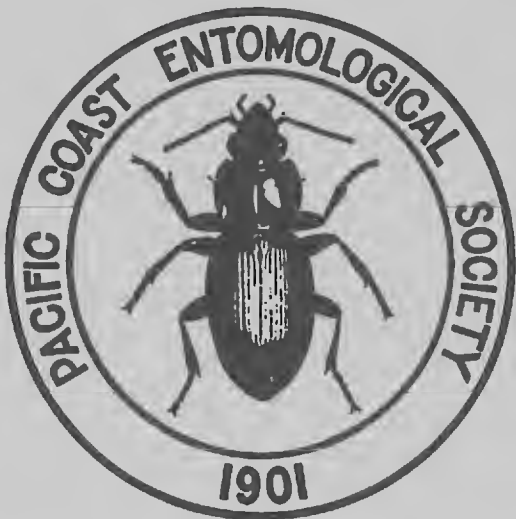


THE
PAN-PACIFIC ENTOMOLOGIST



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Delusory Cleptoparasitosis: Delusions of Arthropod Infestation in the Home

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Abstract.—We describe two cases where individuals believed that their homes were infected by nonexistent arthropods. These delusions of cleptoparasitosis (nest parasitism) share many of the more dramatic symptoms associated with imagined bodily infestation (delusory parasitosis). These symptoms may precede delusory parasitosis and may be encountered by entomologists and pest control professionals who are not usually involved with public health problems.

The term “delusory parasitosis” refers to a mental disorder in which an individual has an unwarranted belief that insects or mites are infesting his or her body (Waldron, 1962; Ebeling, 1975), i.e., literally a “delusion of parasitosis.” This condition is distinct from “entomophobia” or an exaggerated fear of real insects and from “illusions of parasitosis” (Waldron, 1972) where environmental factors such as dust or static electricity are the true sources of physical discomfort attributed erroneously to arthropod infestation.

Persons suffering from delusory parasitosis generally believe that their environment is infested. Items cited by these individuals as sources of the arthropods thought responsible for bodily infestation include automobiles, pieces of furniture, and articles of clothing (B. Keh, pers. comm. and 1983).

In a recent review, Keh (1983) presents a thorough discussion of delusory parasitosis from the point of view of a public health entomologist. However, neither his review nor other references on the subject describe cases where individuals imagine arthropod infestations of their living quarters without the accompanying more dramatic delusion of bodily infestation. Public health entomologists probably encounter such complainants, but would refer them to a pest control professional without investigation unless health problems were mentioned (Keh, pers. comm.). The delusory nature of the complaint would therefore probably not be documented by pest control personnel or entomologists interested in structural pests or public health entomologists. In an effort to correct this situation, we describe two cases which illustrate our extension of the concept of delusory parasitosis to include phenomena that we believe are best described in new terminology as “delusions of cleptoparasitosis” (nest parasitism).

CASE HISTORIES

The first instance was encountered by JKG in California in 1976 as an employee of a pest control company. A middle-aged female resident of a condominium complex receiving monthly pest control service began calling daily, complaining of insect infestation in her rugs and throughout her unit, and requesting immediate service.

Technicians responded to her request several times and chemically treated her condominium unit. Each time, the woman expressed her anger at the supposed inadequacy of the previous treatments and tearfully revealed details of personal problems to the technicians. After several weeks, the pest control company refused to respond to her repeated requests, despite complaints from the concerned manager of the complex that the company was contractually obligated to respond to all requests for service, whatever their basis.

The second case, which prompted this report, was encountered by us in California in 1985. Despite assurances from several pest control companies and private consultants, the male complainant was absolutely convinced that his home, which was to go to his wife as part of a separation agreement, was infested by wood-destroying insects. Old insect tunnels (varnished over) in a picture frame and in a large cabinet were attributed by him to recent insect tunneling activity, and knots falling out of a new redwood fence were thought to be eaten from within. A small decorative box made from an undetermined hardwood also exhibited small tunnels. This box had been stored in the freezer in an attempt to kill any resident insects. Because these tunnels did not contain boring materials and had a dark stain associated with them, we determined that they had been excavated by ambrosia beetles (probably family Scolytidae or Platypodidae) when the tree was cut.

The tenant also provided us with samples of damaged wood and of insects, determined to be the common dermestid beetle *Anthrenus verbasci* (L.). This wood was a 1 × 4 inch Douglas fir board which had been broken in half. Several of the fractures (break lines) in the board had been marked for special attention as suspected insect tunnels. One of the tenant's friends had taken one of the pieces to his home to observe further the imagined insect activity in the fracture zone. Wood technologists determined that the wood had not been subject to decay but exhibited an unusually large-sized early wood with large diameter tracheids.

Although dermestids and other pests of stored food products can damage wood when an extensive infestation is present (Grace, 1985), only three specimens were collected by the homeowner, two of them outside the structure. *A. verbasci* is a common detritivore and has not been reported to damage wood.

DISCUSSION

These two cases have several elements in common besides the conviction of the complainants that their homes were infested by apparently nonexistent insects. Both individuals were living alone at the time of the complaint, and volunteered details of recent emotionally disturbing personal problems. The husband of the woman in the first case had recently separated from her and she complained of having little contact with her grown son. In the second instance, the male complainant volunteered that he was involved in upsetting separation proceedings. Emotional trauma, particularly from marital problems, is reported to be characteristic of delusory parasitosis (cf. Ebeling, 1975; Keh, 1983).

If there is an emotional basis for the delusion of home infestation, it may be very difficult for the entomological investigator to play a role in directing afflicted individuals to sources of psychological counseling. In instances of imagined bodily invasion, entomologists and pest control professionals are sometimes able to communicate with the physician(s) that the victim has contacted. Physicians are certainly in a better position to help these individuals obtain treatment for

psychological problems. When there has been no medical complaint, the entomological investigator appears to have little choice but to determine whether or not arthropods are present. If this conclusion is unacceptable to the affected individual, he or she may be advised to consult another professional. However, the complainant likely will resist recommendations for psychological counseling.

In the 1985 case we have described, our protocol was to inspect the premises and "damaged" wood, and identify the insect samples provided to us. During our telephone conversations and the inspection by DLW of the complainant's home, no mention was made of insects biting or parasitizing him. Several weeks after our initial contacts with the complainant, he then began to claim that insects were burrowing into his skin, a typical expression of delusory parasitosis. In an unusual development (B. Keh and Professor R. S. Lane, pers. comm.), a male friend of the complainant, who did not live in the house, expressed the same symptoms. We then referred both men to Professor Lane, a medical entomologist. After being shown samples which appeared to be skin scrapings, he interviewed both men and determined that no parasitic arthropods were present. Apparently, these two persons from separate homes were reinforcing each other's mental condition and anxiety over the perceived problem. Finally, we encouraged both complainants to seek medical (not necessarily psychological) advice for their problems.

Our conclusions in this case were not acceptable to the complainants. They continued to call and visit us without appointments and their manner towards us became increasingly demanding and hostile. At the request of campus police, we refused to engage in further conversation with the complainants and notified them that any further contact would constitute harassment.

We do not know how often delusions of cleptoparasitosis are encountered by entomologists and pest control professionals, since published reports involve only imagined bodily infestations (cf. Keh, 1983). This may reflect the fact that medical and public health investigators, who are familiar with the syndrome of delusory parasitosis, are not usually contacted by individuals suffering from the delusion of infested premises alone. This delusion could represent a different manifestation of emotional problems similar to those associated with delusions of bodily infestation. However, our experience in the 1985 case described here suggests that this complaint may simply precede expression of the more dramatic symptoms of delusory parasitosis. Contact with the complainant in the 1976 case was interrupted before further symptoms could be observed.

ACKNOWLEDGMENTS

We are grateful to R. P. Akers for establishing contact with the complainant in the 1985 case and providing technical assistance; R. S. Lane for analyzing the complaints of bodily infestation; R. S. Beal, Jr. (Emeritus, Northern Arizona University, Flagstaff, Arizona) for dermestid species determinations; and W. A. Dost (Head, Wood Building Research Center, Richmond, California) for wood examination. We thank B. A. Barr, L. W. Barclay, M. A. Hoy, W. C. Schaupp, and A. R. Weinhold for describing their interactions with the complainants. G. W. Frankie, B. Keh and R. S. Lane reviewed drafts of the manuscript and provided pertinent information. R. P. Akers, J. W. Fox and L. D. Merrill also read early drafts of the manuscript and offered helpful suggestions.

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**Asian Biting Fly Studies VI:
Records and New Species of Oriental Haematopotini (Diptera:
Tabanidae)
from Nepal, Thailand, Laos and Cambodia**

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The adult Oriental Haematopotini have been documented by Stone and Philip (1974) to a point where it would seem little could be added to our knowledge of the tribe without extensive specialized collecting. Nevertheless, the Oriental Region continues to yield new records and new species in this unusual complex which has radiated throughout the Indian and Malayan subregions into an impressive list of closely related forms, several of which have been implicated as disease vectors. In these two subregions only two genera are involved, *Hippocentroides* Philip, 1961 and *Haematopota* Meigen, 1803; the former apparently includes two species, one of which is amply represented in this study. Based on the study by Stone and Philip, *Haematopota* includes 160 species, 5 nomina dubia and two nomina nuda. Studies by Thompson (1977) and Burger (1981) have added two species to this total.

From observations made in the present study, but requiring further examination, the generic characterization of *Haematopota* should include statements on 1: the form of the spermathecae which are not inflated apically and 2: the structure of the spermathecal ducts which are much more membranous, longer (may reach into the third abdominal segment) and more inflated than those of tabanine genera.

The following study of the distribution of 15 species of Oriental *Haematopota* includes descriptions of five new species, one each from Cambodia, Laos and Thailand and two from Nepal.

1. *Hippocentroides desmotes* Philip, 1961

1961. Philip, Indian J. Ent.21(2):82-88,f.

1974. Stone and Philip, USDA Tech. Bull. 1489:28,f, figs. 1,1a,122.

1976. Matsumura and Takahasi, Japanese J. Sanit. Zool.27(3):297,f.

In 1912, Brunetti described a unique male *Haematopota* from Dehra Dun, India. The dark wing with six very narrow incomplete hyaline transverse bands was distinct compared with all other Asian species of that genus.

Philip (1961:82) described a female tabanid with six complete transverse pale wing bands from Bengal, India. He placed it in a new monotypic genus *Hippocentroides* with the genotype *H. desmotes*. In 1974, Stone and Philip reviewed the Haematopotini and transferred the Brunetti species *striatipennis* to *Hippocentroides*.

Matsumura and Takahasi (1976:297) reported a single female of *desmotes* from Nepal. Although stating that it is a "small blackish" species, the description given by them refers to its dark brown appearance and it is particularly interesting to note that they report no abdominal pattern at all.

During 1956-57, in dense lowland jungle of southern Nepal, I took a series of

tabanids with the distinctive wing pattern of transverse bands. Specimens were taken both north and south of the Siwalik Hills. Comparison of this material with the type of *desmotes* shows differences in color and setal pattern. The integument of the Nepalese specimens is darker than the reddish-brown of Philip's specimen. The distal margin of the first four abdominal segments of the specimens from Nepal is fringed with silvery setae. These setae are underlain on the first two tergites by silvery pollinosity and laterally on the third and fourth segments. By contrast, *desmotes* has yellowish setae, reduced pollinose and setal markings on the second tergite and no markings on the third or fourth abdominal tergites. Philip described other differences in the head and wing patterns in addition to which I note a size range of 6.5 to 8.5mm.

The question arises as to the relationship of the population from southern Nepal to *striatipennis* and *desmotes*. Based on adult anatomical and pattern characteristics, it is unlikely that these forms represent three distinct species. Owing to lack of material from western India, it is not possible at this time to determine whether the type of *desmotes*, or my Nepalese material, or both, represent the female of the Brunetti species. My personal interpretation is that all these specimens could represent a single population bearing the specific name *striatipennis*. The fine condition of my material may be responsible for the apparent variation of color and pattern from the two described forms. Indeed, Stone and Philip were convinced that one of my specimens from Nepal was conspecific with *desmotes*. For the present, I will follow their conclusion that the Nepal sample represents the westernmost population of *desmotes*.

Records.—NEPAL, Amlekhganj, 19 July 1956,f; 8 July 1956,9f(Shannon trap, 500m.); 14 July 1957,f; Chisapani, 4 July 1957,2f (EIC and Ghan Sham).

2. *Haematopota abacis* Philip, 1960

1960b. *Chrysozona abacis* Philip, Fed. Malaya Inst. med. Res. St.29:29,f.

1963. *Haematopota obscurata* Philip, Pacific Insects 5:529,f,m.

1974. Stone and Philip, *ibid*:30,f,m,synonymy, figs. 50,173,174.

Record.—THAILAND, Chiangmai Province, Doi Sutep, 1000m., 8 August 1959.

This specimen was taken at the wat on Doi Sutep. Its external characteristics agree well with the description of *abacis* by Stone and Philip; their notation in regard to the dorsal margin of the subcallus, "upper margin nearly straight," is more accurate than their figure; also, the interantennal spot is wider than shown in that figure.

3. *Haematopota albofasciatipennis* Brunetti, 1912

1912. Brunetti, Indian Mus. Rec. 7(5):458,m.

1974. Stone and Philip, *ibid*:41,f,figs.68,194.

1976. Matsumura and Takahasi, *ibid*:299,f, as *H. albofasciatipennis*.

A series of twenty-nine female specimens of this species shows the following differences from the descriptions by Stone and Philip (1974) and Matsumura and Takahasi (1976): frons of the specimens from north of the Siwalik Hills (Hetaura and Chisapani) with gray to brownish pollinosity with vertexal area browner, the median spot present or absent and either set off by light pollinosity or not; with a ring, or partial ring, or virtually no silvery pollinosity around the lateral frontal spots which

are subquadrate; basal callus shiny dark brown; face immediately below antennae slightly darker than remainder and gena. Stone and Philip describe the w/h of the frons as subequal; my material differs with a w/h of $3/2$. Scutellar stripes indistinct. Foretibia with basal third white; midtibia with two white bands more or less distinctly divided, the basitarsus white with a narrow dark distal band; hindtibia with at least one distinct white band, a second poorly defined band also present, basitarsus as for midleg. Abdominal sternites dark with narrow light posterior margins.

Specimens from Mile 4, north of Amlekhganj and on the southern slope of the Siwalik Hills, appear even lighter brown than other specimens. Scutal stripes are not evident or are hardly developed. Basal callus brown to dark red-brown with a dark median line from the point of the basal callus onto the blackish-gray pollinose frons. The hindtibial white mark may be reduced to a single distinct basal band or with the median white band reduced and best developed on the median aspect; the basitarsus of both the mid and hindlegs is dark apically. Specimens from Amlekhganj show variation similar to that of the material from Mile 4. The wing of the material from north of the Siwaliks is proportionally broader and with a more broadly rounded anal area than that from the southern slope. Limited dissections show variances in the form of the spermathecae, those from Hetaura appearing much less sclerotized and with reduced pigmentation. Both forms have medianly enlarged spermathecal ducts.

Records. — NEPAL, Rapti Valley, Hetaura, 520m., 14 April 1956, 12f; Chisapani, 4 July 1957, 2f. Amlekhganj, 520m., 6 June, f; 14 June, f; 19 June 1956, 2f; 5 July 1957 (500m.), 7f. Mile 4, 560m., 5 July 1957, 3f. Some specimens were taken by hand net, but those from Hetaura and two from Amlekhganj were taken in a Shannon trap and one was taken at a light in Amlekhganj.

4. *Haematopota assamensis* Ricardo, 1911

1911. Ricardo, Indian Mus. Rec. 4(9):343, f.

1974. Stone and Philip, *ibid*:50, f, figs. 17, 138.

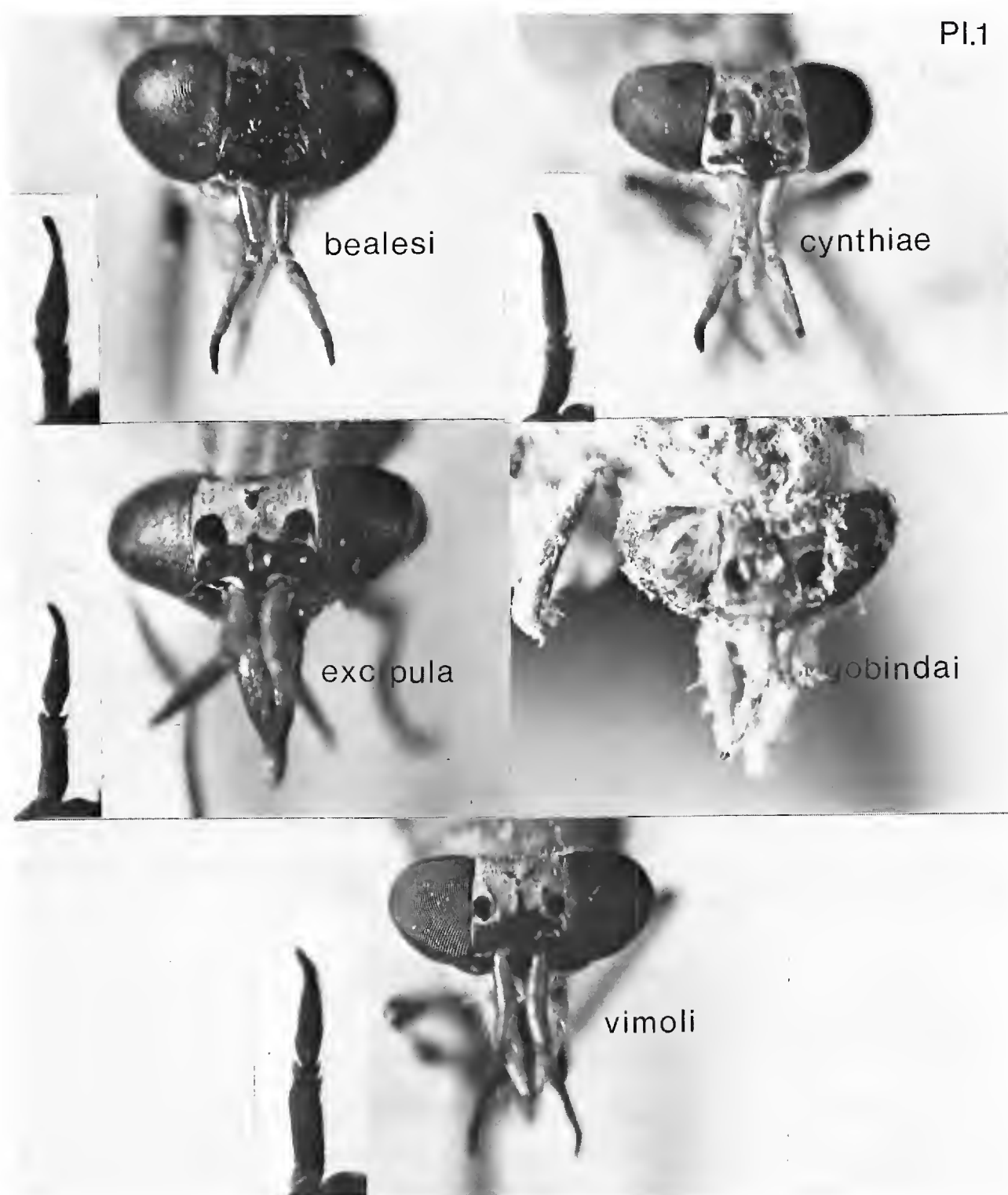
Records. — NEPAL, Amlekhganj, 15 April 1956, f; 18 May 1957, f.

The fly taken in April was on a cow in an open pasture area. These records extend the range of this species 600 miles westward from Assam.

5. *Haematopota bealesi* Coher, NEW SPECIES

A unique specimen from Laos not clearly related to any Oriental species known to me with the exception perhaps of *H. tenasserimi* Szilady, 1926.

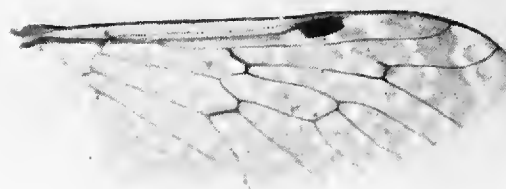
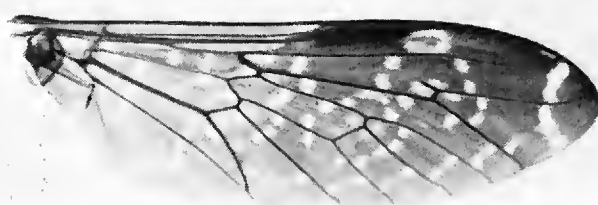
Female. — 8mm. Head: Frons (Pl. 1) width/height subequal, with a large black pollinose subtrapezoidal area, emarginate at dorsal margin where apex of vertex intrudes, less so at ventral margin, vertexal area lighter with short black setae and some shorter pilosity which produces silvery reflections; callus dark red-brown with a dome-shaped margin intruding into the frontal pattern; subcallus wide, somewhat lighter color than the callus, cleft and with narrow lateral projections which are widened apically; face whitish pollinose with brownish subtriangular areas below each antenna and with a median brownish longitudinal stripe that reaches their confluence; parafacials whitish pollinose; beard white; antenna (Pl. 1) with scape narrow and slightly shorter than the flagellomere; apex of style narrowly dark; palpus light brown with dark setae. Eye: (Pl. 1) globose, particularly as compared to other species. Thorax: scutum dark with black setae dominant on central disc and towards



Pl. 1. Head, showing frons and antenna of *Haematopota bealesi*, *H. cynthiae*, *H. excipula*, *H. gobindai* and *H. vimola*.

the median anterior margin, golden setae dominant on lateral margins, posteriorly and onto anterior scutellum which is otherwise dark with black setae. Wing: (Pl. 2) with a broad apical hyaline band in which there is an isolated spot intersecting the upper branch of the third vein. Halter: stem and knob whitish. Legs: dark brown with white of lighter markings as follows: basal five-sixth of foretibia whitish; basal half of mid femur lighter brown-yellow; midtibia with two narrow yellowish rings, one of which is about one-third the distance from the base, the second about one-third the distance from the apex; hind femur somewhat lighter; hind tibia with a narrow sub-basal whitish ring and a similar incomplete ring about two-thirds the distance from the base. Abdomen: tergites dark brown with very narrow light pollinose

Pl. 2

bealesicynthiaeexcipulagobindaivimoliPl. 2. Wings of *Haematopota bealesi*, *H. cynthiae*, *H. excipula*, *H. gobindai* and *H. vimola*.

posterior margins on TII-TVI, TI-TII with grayish lateral pollinosity; SI-SIII and anterior SIV more reddish brown, SII-SVI with a hint of a lighter posterior margin.

Holotype female.—LAOS, Vientiane-Pak San Rd., 80 miles E., 21 June 1959 (P. F. Beales). In the collection of the California Academy of Sciences.

H. bealesi is most closely related to *H. tenasserimi* but is easily separable from that species on the basis of the extent of the pollinose area of its frons and the subequal w/h of the frons, the proportions of the antennal segments, and the pattern of the apical hyaline area of the wing.

It gives me great pleasure to name this species for Dr. Peter F. Beales, W.H.O., who helped to collect many of the specimens in this study and who obliged me by collecting material during trips he made to Laos and Cambodia.

6. *Haematopota bicolor* Stone and Philip, 1974

1974. Stone and Philip, *ibid*: 57, f, figs. 41, 165.

Records. — NEPAL, Amlekhganj, 1956, 520m., 6 June, 2f; 14 June, f; 16 June, f; 29 July, 2f; 30 July, f; 14 Aug., 5f; 28 Sept., f. 500m., 8 July, 2f; 13 July, 3f; 29 Aug. 1957, 2f; Baridamar, 6 Aug. 1956, 2f.

These lowland forms of *bicolor* do not appear different from the boreal populations reported from Assam and northcentral Nepal. However, one specimen taken 8 August at Amlekhganj is longer by 2mm. and with a wider abdomen than the remainder of the series; its wing markings in aggregate are the most different of the entire series, but, its variations appear in other combinations in other specimens.

7. *Haematopota cilipes* Bigot, 1890

1890. Bigot. Paris Mus. d'Hist. Nat. Nouvelle Arch. (3)2:205, f.

1974. Stone and Philip, *ibid*: 74, f, figs. 7, 128.

The five specimens taken in southern Thailand not only differ in some details from the description given by Stone and Philip but also differ from each other. The principal variations occur as follows: frontal callus with dorsal median point varying in shape to as much as a broad rectangular area; frontal spots of four specimens more subquadrate than the figure of Stone and Philip and with at least some light brown pollinosity marginally; median frontal spot small and light-colored on four specimens; scutal stripes developed only on the anterior margin of the scutum; scutal and scutellar setae golden yellow; posterior scutellar crescents fused medially on some specimens; mid and hind tibial bands not always well-defined and may appear as a single long light band; two of the specimens with a narrow median diagonal dark stripe through the subapical hyaline band of the wing.

Records. — THAILAND, Trang Province (no data), f; Lamor Vill. #3, 8 June 1960, f; Chong, 15 June 1960, 3f.

The place of capture for all the specimens with full data, places this as a jungle inhabiting species.

8. *Haematopota cynthiae* Coher, NEW SPECIES

Female. — 7mm. Head: Frons (Pl. 1) width/height 6/5, clothed with gray pollinosity, subcircular lateral spots black, separated by half their diameter from the callus and surrounded by whitish pollinosity with a sparse but noticeable tuft of white setae below each; vertex gray pollinose, apical vertexal spot with white pollinosity below and a narrow median white pollinose line above; callus red-brown with a strongly bowed dorsal margin; subcallus cleft, dark brown; face white pollinose; parafacials with a small dark comma-shaped lateral mark; beardless; antenna (Pl. 1) with scape/flagellomere 5/6, scape yellowish and slightly thicker than the width of the widest part of the flagellomere which is brownish and narrow, style dark brown; palpus dark cream-colored with brownish setae. Thorax: median gray scutellar stripe short and narrow, sublateral gray stripes longer and broader, disc with short golden setae intermixed with brown setae; scutellar setae brown; pleura whitish pollinose. Wing: (Pl. 2) much like *albofasciatipennis* but with apical hyaline band intruding into the apex of the marginal cell; hind margin broadly hyaline including the anal region, joined or not to subapical hyaline transverse band. Halter: cream-colored stem and brown knob. Legs: brown with white markings as follows: foreleg dark brown,

foretibia with front surface two-thirds white, reduced obliquely to one-third of lateral surface; midleg light brown with basal four-fifths of tibia white and basitarsus white except for narrow distal brown ring, tarsal segments showing basal white; hind leg light brown with basal third of tibia diffuse whitish, basitarsus white with a narrow distal dark ring, tarsal segments with basal white. Abdomen: TII-TVI with submedian rows of white pollinose spots within a more diffuse lateral white pollinose area and with light-colored setae; TIII-TVI with a narrowly lighter posterior margin; sternites darkening posteriorly, SII-SVI with narrow lighter posterior margins, setae light-colored.

Holotype female. — NEPAL, 520m., Rapti Valley, Hetaura, 14 April 1956. In the collection of the California Academy of Sciences.

Paratopotype. — female with the same data.

Both specimens were taken flying with *albofasciatipennis*. To the eye, they are more robust and larger and the wings are not as deeply infuscated. The lateral frontal spots are smaller and rounder and surrounded by silvery pollinosity. The pattern of the vertexal area is reduced and silvery pollinosity lies below the median spot and continues as a faint median vertexal line. The scutal pattern of stripes is strongly developed. TIII-TVI show well-developed submedian light spots. The subapical spot of the wing is much longer and somewhat broader and the hind margin of the wing is at least twice as broadly hyaline.

This sibling of *albofasciatipennis*, flying with that species, is easily separated from its 'twin' by the form of the frontal black spots, the length of the subapical hyaline band and the wide posterior hyaline band on the posterior margin of the wing. I take great pleasure in naming this species for my wife, also a twin.

9. *Haematopota excipula* Coher, NEW SPECIES

Female. — 9.5mm. Head: Frons (Pl. 1) width/height 2/1, with brownish to silvery pollinosity, subcircular lateral black pollinose spots touch or nearly touch callus and eyes, spots in some light show small light-colored setae around each as well as around the smaller median dark spot from which there is a median vertexal pollinose line; vertexal area not clearly defined by pattern; callus dark brown, dorsal margin horizontal with a small median triangular projection; subcallus dark brown and cleft; face silvery pollinose with a small black spot below each antennal base; parafacials with an extensive black pollinose area which touches eyes; beardless; antenna (Pl. 1) with scape about four-fifths as long as flagellomere and narrower than the greatest width of the flagellomere, light brown; flagellomere brown, narrow, style slightly darker; palpus cream-colored with brown setae. Thorax: with a narrow median longitudinal silvery pollinose stripe to center of disc; submedian stripes shorter and followed by a silvery spot, setae brown with smaller scattered golden setae; posterior margin of disc silvery pollinose; scutellum silvery pollinose along anterior margin and median area, fine brown scutellar setae; pleura silvery pollinose. Wing: (Pl. 2) pattern slightly variable in marginal cell, paratype with a broader rosette; in anal region of paratype, hyaline stripes connected by a longitudinal hyaline stripe. Halter: with stem and apical third of knob cream-colored, basal two-thirds of knob brownish. Legs: dark brown, forecoxa with basal half silvery pollinose; forefemur laterally silvery pollinose; foretibia with basal fourth lighter; midfemur with basal two-thirds lighter; midtibia with a narrow light ring and two other indistinct rings; midbasitarsus lighter except at apex; basal two-fifths of hindtibia lighter and a hint of

subapical light ring; basal portion of hind tarsus lighter. Abdomen: dark brown with scattered golden setae, TII-TV with posterior margins silvery pollinose, TII with a median T-shaped pollinose pattern; TIII-TVII with submedian elongated silvery pollinose spots; sternites dark brown.

Holotype female. —CAMBODIA, Kbal Trach, 12 May 1958 (P. F. Beales). In the collection of the California Academy of Sciences.

Paratopotype. —slightly damaged female with the same data.

This species is most closely related *H. biroi* Szilady, 1926 from which it may be distinguished by its larger size, its well-defined parafacial spots, differences in the apical hyaline spots of the wing and its lack of median light markings on any but the second abdominal tergite.

10. *Haematopota gobindai* Coher, NEW SPECIES

Although much of this specimen is obscured by fungus, it clearly represents a new taxon which I take pleasure in naming for a close companion and co-worker for over two years in the Nepal terai, Gobinda Prasad Joshi.

Female. —8.5mm. Head: Frons (Pl.1) with width/height 2/1 and with large oval lateral black pollinose spots which do not touch margins of eyes or callus; callus brownish yellow with a broad dorsal median triangle; subcallus reddish brown; antenna with scape about four-fifths as long as flagellomere and as wide as widest part of flagellomere and more yellowish than light brown flagellomere; style dark brown. Thorax, legs and abdomen cannot be characterized. Wing: (Pl. 2).

Holotype female. —NEPAL, Neghauri, 9 April 1957 (G. P. Joshi), at light. In the collection of the California Academy of Sciences.

This species appears, based on wing characteristics, to be most closely related to *H. punctifera* Bigot, 1891. It may be told from that species by its larger size, the w/h proportion of the frons and the shape and pattern of the wing, particularly the included dark spot within the wide apical hyaline band and the hyaline areas of all posterior margin cells.

11. *Haematopota howarthi* Stone and Philip, 1974

1974. Stone and Philip, *ibid*: 111,f,m, figs.4, 125.

This species has been recorded from Laos.

Records. —LAOS, Vientiane-Pak San Rd., 40 miles E., 21 June 1959,f; same data, 80 miles E.,f, (P. F. Beales).

12. *Haematopota pachycera* Bigot, 1890

1890. Bigot, *Paris Mus. d'Hist. Nat. Nouv. Arch.*(3), 2:206,f.

1974. Stone and Philip, *ibid*: 155,f, figs.23,147.

Variation in the shape of the flagellomere of the antenna, the vertexal pattern and its setation, the tomentum and setae of the scutellum as well as the wing pattern may indicate that there is a complex of species involved rather than the wide variation I presently attribute to this species.

The flagellomere is variously shaped and may either taper distally or be widened following a taper. The vertex is somewhat variable in the extent of its pattern and setation and the scutellar pattern is variable to the extent reported by Stone and Philip. Although basically similar, the wing pattern is highly variable.

Records.—THAILAND, Chiangmai Province, 1959, Sarapee, 6 July,f; 30 July,2f; Chompu, 27 July,f; Nong Quai, 23 Sept.,f; Trang Province, Lamor, Vill. #4, 18 April 1960,f; 10 May 1960,f; Bang Mark, 29 April 1959,f. LAOS, 1959, Vientiane-Pak San Rd., 21 June, 40 miles E.,f; 21 June, 80 miles E.,f; Pak San-Pak Dang Rd., 21 June,f.

13. *Haematopota singularis* Ricardo, 1911

1911. Ricardo, Rec. Indian Mus.4:339,f, fig.

1963. Philip, Pacific Ins.5(3):530,f, fig.; as *H. s. vietnamensis*.

1974. Stone and Philip, *ibid*:176,f,synonymy, figs.9,131.

My specimens show the following variations from those described by Ricardo and by Stone and Philip. Paired frontal spots large and subquadrate, surrounded by a ring of lighter pollinosity; median spot with a longitudinal light line of pollinosity running onto the vertexal area and also anteriorly on one specimen, plus a broad m-like marking of light pollinosity reaching to the paired frontal spots; eye margins with light pollinosity; callus dark brown; apex of scape plus pedicel dark. Thorax with the light areas and stripes silvery; pleura with two dark bands, one extending from the wing base to the spiracle, the second extending from the wing base around the sternites and including the base of the forecoxa. Wing with extensive brown markings in the oblique stripe of one specimen; halter light at apex. Legs with midbasitarsus definitely lighter-colored except at tip; hindfemur densely clothed with dark hairs along the entire length of dorsal and ventral surface; hind basitarsus quite swollen. Abdomen with TVI and TVII with a pair of submedian light spots, those on TVII much larger. Spermathecae narrow, pigmented and sclerotized, each with the terminal portion differently shaped, one strongly and broadly narrowed, a second narrowed less close to the tip and a third rounded.

Record.—CAMBODIA, Kbal Trach, 12 May 1958,3f.

These three specimens, one of which is lacking head and abdomen, are noted as being taken on carabao. The laterally split abdomen of one is due to engorgement with blood, a condition not uncommon in other field caught flies. This is the first record of this species in Cambodia.

14. *Haematopota splendens* Schuurmans Stekhoven, 1929

1929. Schuurmans Stekhoven, Treubia 6(Suppl.):95,f.

1974. Stone and Philip, *ibid*:179,f,m, figs.48,171.

Record.—THAILAND, Pattalung Province, Khouw Pup Pah, 26 June 1960.

Taken flying with *vimoli*. Dr. Philip has kindly supplied me with a copy of the data on the Thai collection of this species. Unfortunately, I have no better luck in deciphering the cryptic data than he did. However, it is interesting to note that the specimen was taken at 5500' on 7 April, 1939.

15. *Haematopota vimoli* Coher, NEW SPECIES

Female.—8.5–9.5mm. Head: Frons (Pl. 1) width/height about 2/1, pollinosity variable, silvery to silvery-black to brownish-black and with brown setae; vertexal area usually darker; lateral dark spots subcircular and variably surrounded by lighter-colored pollinosity which forms a line running posteriorly through the median line of the vertex; callus red-brown, with dorsal margin variable in shape; subcallar

area black medially and cleft; face medianly black pollinose and large lateral black pollinose triangles on the parafacials; beard white; antenna (Pl. 1) with scape slightly longer than flagellomere, style brownish; palpus brown with whitish pollinosity. Thorax: scutum with anterior narrowly silvery, disc and scutellum brown with golden setae; pleura whitish pollinose. Wing: (Pl. 2) much like *H. helviventer*. Halter: light stem and dark knob. Legs: dark brown with white markings as follows, basal third of foretibia, basal four-fifths of midtibia and barely so on base of basitarsus, basal two-thirds of hindtibia. Abdomen: TI-TVI dark brown with posterior margin of TII entirely or partly light-colored and a narrow pollinose triangle projecting two-thirds of way to anterior margin, clothed with golden setation particularly at posterior margin of each segment; SI-SVI whitish with a darker median patch on SIII-SVI.

Holotype female.—THAILAND, Trang Province, Chong, 15 June 1960, Shannon trap. In the collection of the California Academy of Sciences.

Paratopotypes.—All taken in Shannon trap. 1960: 10 May,f; 15 June,7f; 29 June,4f; Paratype: Pattalung Province, Khouw Pup Pah, 26 June 1960,f.

T. vimoli is clearly related to *T. spenceri* Stone and Philip, 1974 and *T. helviventer* Stone and Philip, 1974 but is clearly separable based on the w/h of the frons which is wider than high, the presence of large black parafacial spots and the form of the long, slim flagellomere of the very narrow antenna.

This jungle species is named for Dr. Vimol Notananda of Chiangmai, Thailand, who so graciously supported my activities in that country.

It is of interest to note that certain species were taken flying at the same time and place with other tabanids. The following listing is noted:

H. albofasciatipennis with *Tabanus adhabarensis* and *Chrysops dispar* on 4 July 1957 north of the Siwalik Hills and with *T. albosetosus* and *T. nepalensis* on 5 July 1957 south of the Siwalik Hills, Nepal.

H. bicolor with *T. albosetosus* on 6 June 1956, with *T. jucundus* on 16 June 1956, with *T. subcallosus*, *T. teraiensis*, *T. jacobarius* and *T. nepalensis* on 30 July 1956, with *T. jacobarius* on 8 July 1956 and 29 August 1957, all in Amlekhganj, Nepal.

H. cilipes with *T. aurilineatus* on 8 June 1960 in Trang Province, Thailand.

H. pachycera with *T. konis* on 27 July 1959 in Chiangmai Province and with *T. brunipennis* on 29 April 1959 in Trang Province, Thailand.

H. vimoli with *T. hybridus*, *T. subhybridus*, *T. brunnicolor*, *T. caduceus*, *T. griseipalpis*, *T. macdonaldi*, *C. dispar* and *C. fixissimus* on 15 June 1960; with *H. splendens* on 26 June 1960; with *T. hybridus* and *T. subhybridus* on 29 June 1960. All records from Trang Province, Thailand.

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A Taxonomic Study of Nearctic *Meromyzobia* Ashmead, 1900 (Hymenoptera: Encyrtidae)

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Abstract.—The Nearctic species of *Meromyzobia* Ashmead, 1900, are reviewed. A generic diagnosis is provided and some important morphological characters are discussed. *Desantisella* Subba Rao is synonymized with *Meromyzobia* (New Synonymy). *Meromyzobia americana* Ashmead, based on a male, and *M. flavicincta* Ashmead, based on a female, are synonymized (New Synonymy), with *flavicincta* recognized as the valid name. A Lectotype is designated for *Ericydnus maculipennis* Ashmead, the type-species of *Meromyzobia*. Descriptive notes are given for *M. flavicincta*, *M. bifasciata*, and *M. maculipennis*. Four New Species are described (*M. deserticola*, *M. melanosoma*, *M. pedicelata*, and *M. texana*).

INTRODUCTION

The following taxonomic notes are part of a review of the Nearctic Encyrtidae and are published here in response to requests for identifications of material by several workers interested in ecological aspects of insects associated with salt marsh grasses (*Spartina* spp.) in Florida. I do not consider this a revision because fewer than 150 specimens are involved. Detailed phylogenetical notes on the relationship of *Meromyzobia* to other encyrtids will be published elsewhere (Gordh, in prep.).

Meromyzobia was characterized by Ashmead (1900) for a loosely described assemblage of species, most of which had been placed in other genera in earlier publications. Ashmead (1900) recognized six species in *Meromyzobia* from North America and these have been carried in subsequent catalogs without taxonomic study (Muesebeck et al., 1951; Peck, 1963; Gordh, 1979). Elsewhere, species referable to *Meromyzobia* have been taken only in South America. DeSantis (1968, 1972) has described *M. gripha* from a male taken near Buenos Aires, and *M. flavipes* from a female taken near Loreto (Misiones). DeSantis' (1979) Catalog of Neotropical Chalcidoidea (except Brazil) only includes these two species. Subba Rao (1971) described *Desantisella brasiliensis* from two females taken at Nova Teutonia, Brazil, and *D. plaumanni* from a male taken at the same locality. *Desantisella* is synonymized with *Meromyzobia* (New Synonymy). Explanation of this synonymy is given below. Otherwise, treatment of the South American species awaits collection of more material.

Meromyzobia DIAGNOSIS

Female.—Body moderately large (usually 1.50–3.25 mm. long), sometimes elongate, sometimes robust. Coloration predominantly pale with weak to moderate metallic reflections over various parts of the body. Head hypognathous to

subopisthognathous; in dorsal aspect with anterior margin broadly rounded and continuous with compound eye margins laterad; vertexal margin broadly rounded, medial margins of compound eyes parallel, posterior margins not contiguous with posterior margin of head. Ocelli not close-set but centrally located on vertex; angle formed by anterior ocellus greater than 90 degrees; lateral ocellus about one diameter from medial margin of compound eye. Frontovertex moderately wide, about 0.4–0.5 times as wide as head, weakly reticulate, sometimes shallowly and very sparsely punctate. Head in frontal aspect transversely oval with toruli closest, near ventral margin of compound eyes; scrobal impressions very shallow, short, and poorly developed; malar sulcus complete and well formed. Antennae with scape cylindrical in cross section or weakly compressed but not expanded ventrad; first two funicular segments anelliform, distal four funicular segments not modified; club not large or well differentiated, septa sometimes difficult to distinguish in point mounted specimens. Mandible with one tooth and a broad truncation or with three equal-sized teeth. Maxillary palpus four-segmented; labial palpus three-segmented.

Mesosoma with incomplete, short, straight parapsidal sutures; axillae meeting mesad; propodeum smooth, sloping posteriad and with two medial, longitudinal, subexocuticular carinae or lines of propodeal reinforcement. Wings macropterous, frequently conspicuously fuscous, females sometimes brachypterous. Middle tibial spur large, robust, and frequently enlarged distad.

Metasoma as large or larger than mesosoma; pygostyli near midline to apical one-third of metasoma, ovipositor and gonostyli usually not strongly exerted, sometimes exerted up to one-fifth length of metasoma. Seventh sternum from basal to apical one-third of metasoma.

Male.—Typically smaller than the female with antennal flagellar segments enlarged. Body coloration resembles female. Body parts similar in shape to female (including frontovertex). Males macropterous with hyaline wings. Ocelli not larger than female ocelli.

DISCUSSION

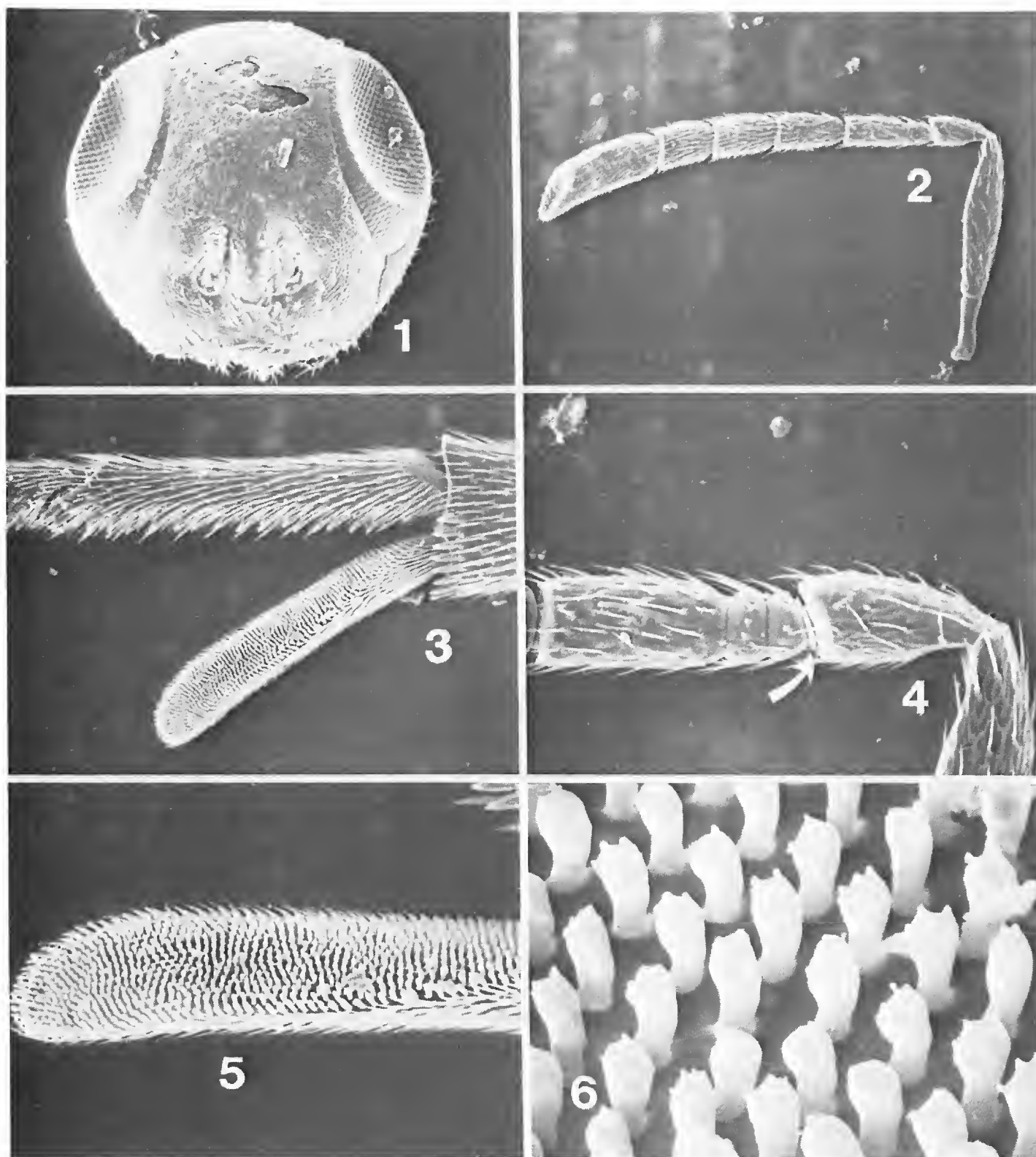
The correct systematic placement of *Meromyzobia* remains vague. Ashmead (1900) summarized early attempts at higher classification of the Encyrtidae and provided the modern concept upon which encyrtids were classified for more than 50 years. In his schema, *Meromyzobia* was assigned to the Ectromini, a Tribe characterized by species with bidentate mandibles, a large (frequently plowshare-shaped) seventh sternum, and a rather long marginal vein. *Meromyzobia* clearly does not possess the essential features of the Ectromini. Mercet (1921) abandoned the Tribal classification of Ashmead in favor of Subfamilies (the Encyrtinae and Arrhenophaginae with 12 “groups” in the former), but did not place *Meromyzobia* because it did not occur on the Iberian Peninsula. The genus was not treated by Erdos and Novicky (1955) for similar reasons. Hoffer (1955) provided a formal attempt at reorganizing encyrtid genera into Tribes. He did not consider *Meromyzobia*, but his reappraisal of the Mirini Ashmead has been shown to have merit and it is here that *Meromyzobia* belongs. Trjapitzin (1973A, B) reorganized the Encyrtidae and modified the concept of Subtribes within the group (corrected to Miraini). *Meromyzobia* was placed in the Subtribe Mayridiina by Trjapitzin and Gordh (1978), but was listed Incertae Sedis by Gordh (1979). Placement by Trjapitzin and Gordh is taken as correct pending further study.

I have not had the opportunity to study the holotype of *Desantisella brasiliensis* Subba Rao, which should be in the British Museum. However, the extensive description of that species and diagnosis by Subba Rao (1971) leave no doubt that *Desantisella* is synonymous with *Meromyzobia*. The shape of the middle tibial spur clearly fits within the concept of *Meromyzobia* as understood here. Other characters regarded as diagnostic for *Desantisella* are within the range of variation expressed by *Meromyzobia*.

Biologically, *Meromyzobia* appears diverse and does not fit the pattern of most Miraini which, according to Trjapitzin (1973B), are primary and secondary parasites of coccoids. Tachikawa (1978) reports *Meromyzobia* as parasitic on undetermined Orthoptera eggs. *Meromyzobia pedicelata* New Species was undoubtedly reared from Orthoptera eggs. The host plant was *Tripsacum laxum* Nash (Gramineae). *Meromyzobia melanosoma* New Species has been repeatedly taken in association with *Spartina* spp. (Gramineae) along the eastern seaboard of the United States. *Meromyzobia maculipennis* has been taken from the puparia of *Anthracophaga ingrata* (Williston), a chloropid. This fly was described from material taken by F. M. Webster, who also collected the parasite. The host plant for the chloropid was *Muhlenbergia mexicana* (L.) Trin. (Williston 1983). *Meromyzobia flavicincta* was taken from unidentified galls on *Aristida gyrans* Chapman (Gramineae). *Meromyzobia deserticola* New Species has been taken from *Hilaria rigida* (Thurb.) (Gramineae). *Meromyzobia texana* New Species has been reared in association with the pseudococcoid *Antonina graminis* (Maskell), an introduced pest of pasture, turf, and lawn grasses. Subba Rao (1971) does not mention the biology of *Desantisella*, but Noyes (1980) indicates its species are hyperparasites of Chamaemyiidae attacking Aclerididae. Thus, overwhelming circumstantial evidence suggests that *Meromyzobia* should be considered a New World genus of Miraini with an ecological preference for grasses.

Morphologically, *Meromyzobia* has several interesting features which may not be appreciated from the following taxonomic treatment, but which have importance in higher classification of this large and difficult group. Thus, sexual dimorphism should be studied carefully because it will prove helpful in understanding relationships. Most groups of encyrtids express dimorphism in antennal conformation, ocellar size and triangle shape, frontovertex size and shape, body size and coloration, and wing size and coloration. Species of *Meromyzobia* express very weak sexual dimorphism in head and antennal characters. The curious reduction of FI and FII of the antenna is a synapomorphy shared by males and females. Additionally, the vestigial ring segments are evident in several species (Figs. 4, 22, 35). Also of note is the lack of sexual dimorphism in ocellar size or arrangement.

Meromyzobia may be added to the number of genera in which mandible dentition is not constant. Most species are tridentate but the type-species and several others have one tooth and a broad truncation. The functional significance of this character and its character states must be considered before the character is considered of more than specific importance. I suspect that tooth shape and number is correlated with the context in which development occurs. The mandible shape of one tooth and a broad truncation is functionally adapted to facilitate the parasite emerging from galls. Gall wall architecture differs among plants but basically consists of a matrix of fibers. I hypothesize that the anterior, short, mandibular tooth grasps the gall fibers and loosens them from their position in the matrix. Subsequently, the conspicuous



Figures 1-6. 1. *Meromyzobia maculipennis*, female head, frontal aspect. 2. *M. maculipennis*, female antenna, lateral aspect. 3. *M. maculipennis*, female middle tibial spur and basitarsus. 4. *M. maculipennis*, female antennal pedicel, anellus (arrow), Funicular I-III. 5. *M. maculipennis*, female middle tibial spur, medial aspect. 6. *M. maculipennis*, female middle tibial spur setae on medial surface.

truncations (which form a broad line of contact when mandibles are opposed) engage the loose fibers which are then pulled free of the gall wall. A line of contact formed by the truncations is functionally more efficient for engaging the loose fibers than mandibular teeth in the form of conical projections. The line or truncated surface of contact is nearest to the liberated gall fibers and engages long and short fibers with equal facility. In comparison, conical mandibular teeth are less efficient because they contact gall material only near the apex of the teeth and therefore can engage short fibers over a limited portion of the potential surface area available for fiber engagement. A partial explanation for tridentate and truncate mandibles in

Meromyzobia may lie in host associations and the matrix being processed by the mandibles in emerging from pupal containment.

Parapsidal sutures are present in all species but constitute a plesiomorphous character. Female brachyptery is seen in more than one species but males of all species for which they are known are macropterous. The macropterous female wing is sometimes infumated, but the male wing is invariably hyaline. This dimorphism appears to be a plesiomorphy. In at least one species we see associated with the wing development a concomittant reorganization of thoracic sclerites consistent with a non-ecologically proximate wing reduction condition. (That is, wing reduction in encyrtids can be in response to at least two types of conditions. Environmentally induced brachyptery is a response to immediate conditions and seen in genera such as *Cheiloneurus* where individuals of a species may be macropterous or brachypterous depending on the time of the year, host, or both. Non-environmentally mandated brachyptery is manifested in species which undergo radical reorganization of thoracic sclerites to include elongation and enlargement of the pronotum at the expense of the mesoscutum and scutellum. The different conditions imply different levels of genetic control and complexity, and therefore should be evaluated as different characters, not character states.)

The middle tibial spur is perhaps the most important structural character used in defining *Meromyzobia*. Within the genus the character ranges from typically encyrtid to balloon-like and inflated distally. The extreme condition seems best expressed in South American forms. In North American *Meromyzobia*, the spur holds different forms of cuticular ornamentation. In all species examined, the outer surface appears pubescent. Light microscopy shows this pubescence as seta-like. However, SEM shows the pubescence is composed of trichode-shaped acanthae, not the characteristic trichogen-tormogen formation (Figs. 12, 13). In contrast, the medial surface of all species studied have the classic seta-in-a-socket (Fig. 37). The seta is modified in all species studied, but owing to the nature of the material examined (old) and its availability (borrowed and in limited numbers), a thorough study could not be made. Differences indicated under each species are taken as species specific. The setae range from short and rather straight (Fig. 6) to long and curved (Figs. 15, 31). Most species display a seta which is longitudinally depressed or spoon-shaped along one face (Figs. 6, 15, 31) with the apical surface tined (Figs. 6, 15, 31). At least one species displays setae which are hyphae-like and not spoon-shaped or apically tined (Fig. 37). In other respects, the morphology of *Meromyzobia* is not remarkable.

A KEY TO THE NEARCTIC SPECIES OF *Meromyzobia* ASHMEAD

- 1 (A). Males 2
- (B). Females 8
- 2 (A). Mandible with one tooth and a broad truncation; body robust; middle tibial spur distally lobate; scutellum elongate, nearly three times as long as median length of propodeum; subexocuticular propodeal carinae widely separated and parallel ..*Meromyzobia maculipennis* (Ashmead)
- (B). Mandible with three teeth or other characters variable or not in the combination above 3

- 3 (A). Body not strongly dorsoventrally flattened and/or body predominantly pale colored or reddish brown 4
- (B). Body rather conspicuously dorsoventrally flattened; body predominantly dark colored with some weak metallic reflections ... 5
- 4 (A). Parapsidal sutures transverse (Fig. 33), not oblique to primary axis of body; head viewed in dorsal aspect with posterior margins of compound eyes nearly contiguous with posterior margin of head at one point; propodeum pale ... *Meromyzobia texana* (New Species)
- (B). Parapsidal sutures not transverse (Fig. 8) oblique to primary axis of body; posterior margin of compound eyes separated from posterior margin of head by at least two ocellar diameters; propodeum reddish brown *Meromyzobia flava* (Ashmead)
- 5 (A). Body large (ca. 3.5 mm); femora and tibiae all dark ... *Meromyzobia melanosoma* (New Species)
- (B). Body relatively small (ca. 2.5 mm); femora and tibiae not all dark 6
- 6 (A). Pronotum about as long as median length of mesoscutum; head subopisthognathous *Meromyzobia deserticola* (New Species)
- (B). Pronotum shorter than median length of mesoscutum; head hypognathous 7
- 7 (A). Frontoververtex < 0.50 times as wide as head; with shallow setigerous punctures; body reddish brown *Meromyzobia flavicincta* (Ashmead)
- (B). Frontoververtex > 0.50 times as wide as head; without shallow setigerous punctures; body predominantly pale colored .. *Meromyzobia flava* (Ashmead)
- 8 (A). Metasoma in lateral aspect with gonostyli and ovipositor projecting well beyond apex of metasoma, at least 0.5 times length of middle tibial spur 9
- (B). Metasoma in lateral aspect with gonostyli and ovipositor considerably shorter, not projecting conspicuously beyond apex of metasoma (Note: some distortion may give the impression of weak exertion, but gonostylus never as long as 0.5 times middle tibial spur length) . 10
- 9 (A). Metasoma slightly shorter than mesosoma; forewing with one fuscous spot posterior of marginal and stigmal veins; axilla yellow or pale colored; propodeum brownish with subexocuticular longitudinal carinae evident and parallel; mesopleuron pale *Meromyzobia unifasciata* (Ashmead)
- (B). Metasoma clearly longer than mesosoma (Figs. 17, 18); forewing with two fuscous clouds separated by a hyaline stripe; propodeum nearly black or if somewhat more pale and subexocuticular carinae visible, then they diverge posteriad; mesopleuron dark brown or black *Meromyzobia melanosoma* (New Species)
- 10 (A). Mandible with one tooth and broad truncation; macropterous; subexocuticular propodeal carinae parallel or nearly so 11
- (B). Mandible tridentate; macropterous or brachypterous; subcuticular propodeal carinae diverging posteriad 13
- 11 (A). Pedicel elongate; propodeum with elevated median cuticular carina; pronotum less than 0.35 times medial length of mesoscutum *Meromyzobia pedicellata* (New Species)

- (B). Pedicel normal; propodeum medially smooth, without carinae; pronotum at least 0.40 times as long as median length of mesoscutum 12
- 12 (A). Pronotum 0.5 times as long as medial length of mesoscutum; scutellum about 1.10 times longer than wide; frontoververtex 0.45 times as wide as head *Meromyzobia bifasciata* (Ashmead)
- (B). Pronotum about 0.45 times medial length of mesoscutum; scutellum about 1.25 times longer than wide; frontoververtex 0.42 times as wide as head *Meromyzobia maculipennis*
- 13 (A). Macropterous; forewing weakly infuscated beneath marginal vein; parapsidal sutures transverse (Fig. 33), not oblique to primary axis of body; propodeum with incomplete, weak, median longitudinal carina *Meromyzobia texana* (New Species)
- (B). Brachypterous; forewing infuscation obscure; parapsidal sutures oblique to primary axis of body; propodeum medially polished and without longitudinal carina 14
- 14 (A). Body predominantly pale colored; pronotal median length considerably longer than mesoscutum, but posterior margin transverse or nearly so, clearly not forming a broad, inverted "V"; mesosoma flattened; gonostyli concealed or not exerted *Meromyzobia deserticola* (New Species)
- (B). Body predominantly dark reddish-brown; pronotal median length shorter than mesoscutum with posterior margin forming a very broad, inverted "V"; mesosoma not conspicuously flattened; gonostyli slightly exerted *Meromyzobia flavicineta* (Ashmead)

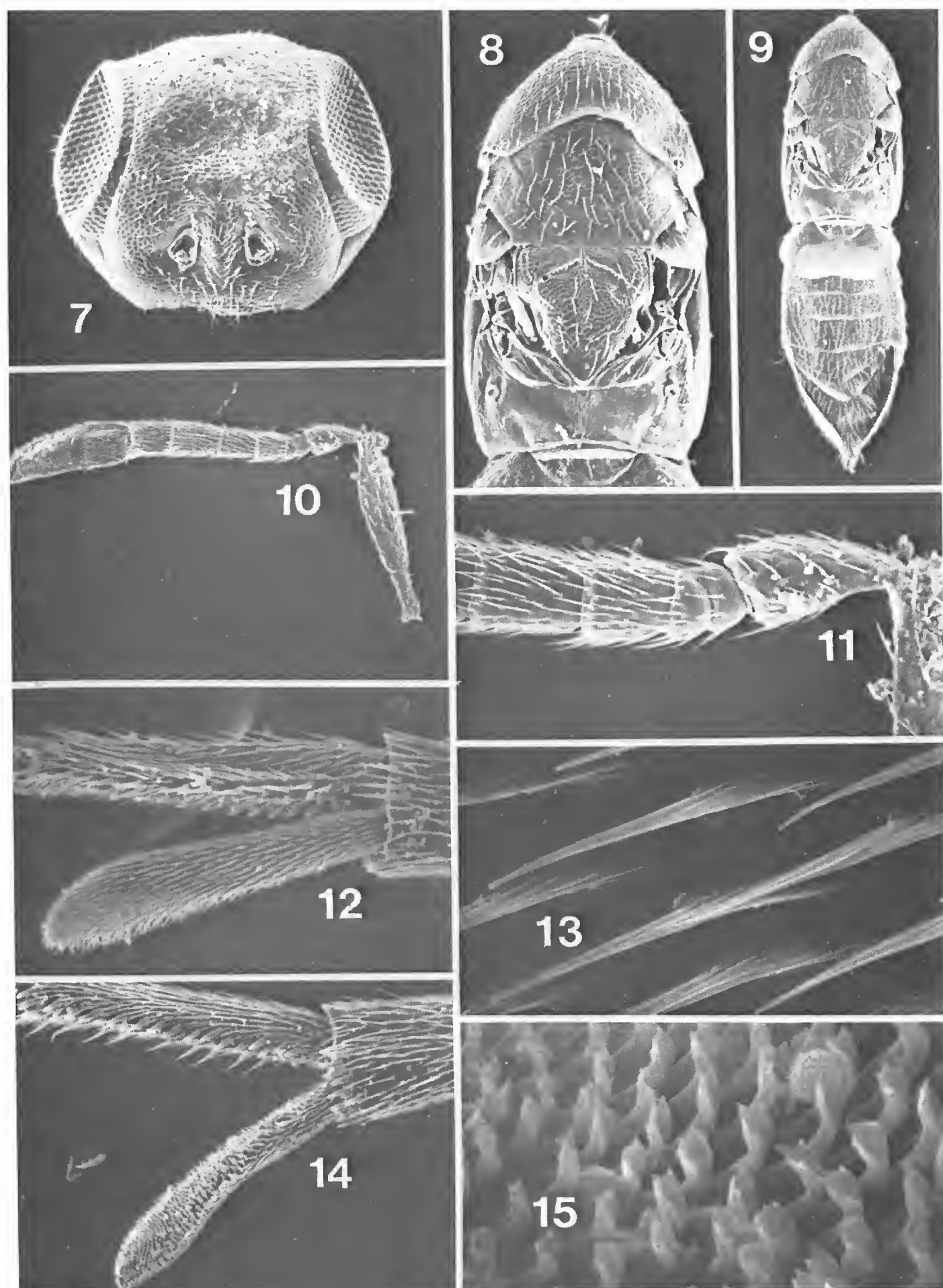
The following comments are included under names previously recognized as valid.

Meromyzobia americana (Ashmead). 1888. Entomol. Amer. 41:16. Male.

This species was based on a male specimen taken in Florida. It has not been recovered or reported (except catalog entries) since its description. The original description is misleading because it states that the scutellum of the holotype is "large, highly convex and finely grooved." In fact, the scutellum is of normal size for a male, not robust, and narrowly and longitudinally reticulate along postero-medial 0.60 with the pattern larger elsewhere; apex polished. Similarly, the pedicel is not unusually small, but rather the flagellar segments are disproportionately large. Otherwise, the description is accurate. Additional characters include: Frontoververtex 0.48 times as wide as head; surface reticulate with scattered, shallow, setigerous punctations. Middle tibial spur not enlarged distad. Propodeum with two distantly separated, longitudinal carinae.

Comparison of the holotype with the type of *M. flava* suggests that they are similar, although colored very differently. The specimens resemble one another in the shape of the head, configuration of the antenna, scrobal cavity, size and shape of the mesopleuron. Both bear a non-dilated middle tibial spur. The frontoververtex: headwidth ratio is 0.53 for *M. flava*, and scuteller sculpture patterns are different. Synonymy is not implemented here because too few specimens are available for study, and the holotypes are not in perfect condition for comparison.

I feel confident that the male described as *americana* is conspecific with the female described as *flavicincta* (New Synonymy). Both were taken from the same locality



Figures 7–15. 7. *M. flavicincta*, female head, frontal aspect. 8. *M. flavicincta*, female mesosoma (arrow to parapsidal suture). 9. *M. flavicincta*, female mesosoma and metasoma. 10. *M. flavicincta*, female antenna, lateral aspect. 11. *M. flavicincta*, female antennal pedicel, anellus, Funicular I–IV. 12. *M. flavicincta*, female middle tibial spur and basitarsus, lateral aspect. 13. *M. flavicincta*, female middle tibial spur acanthae. 14. *M. flavicincta*, female middle tibial spur, medial aspect. 15. *M. flavicincta*, female middle tibial spur setae on medial surface.

and described in the same publication. The dimorphism expressed in this species is identical to that found in *M. deserticola* New Species, including female aptery and male macroptery. As first revisor, I select *Meromyzobia flavicincta* as the valid name because the type is based on the female sex and I regard this sex as more important in encyrtid classification.

Meromyzobia bifasciata (Ashmead). 1890. Bul. Colo. Biol. Assoc. 1:28,46. Female.

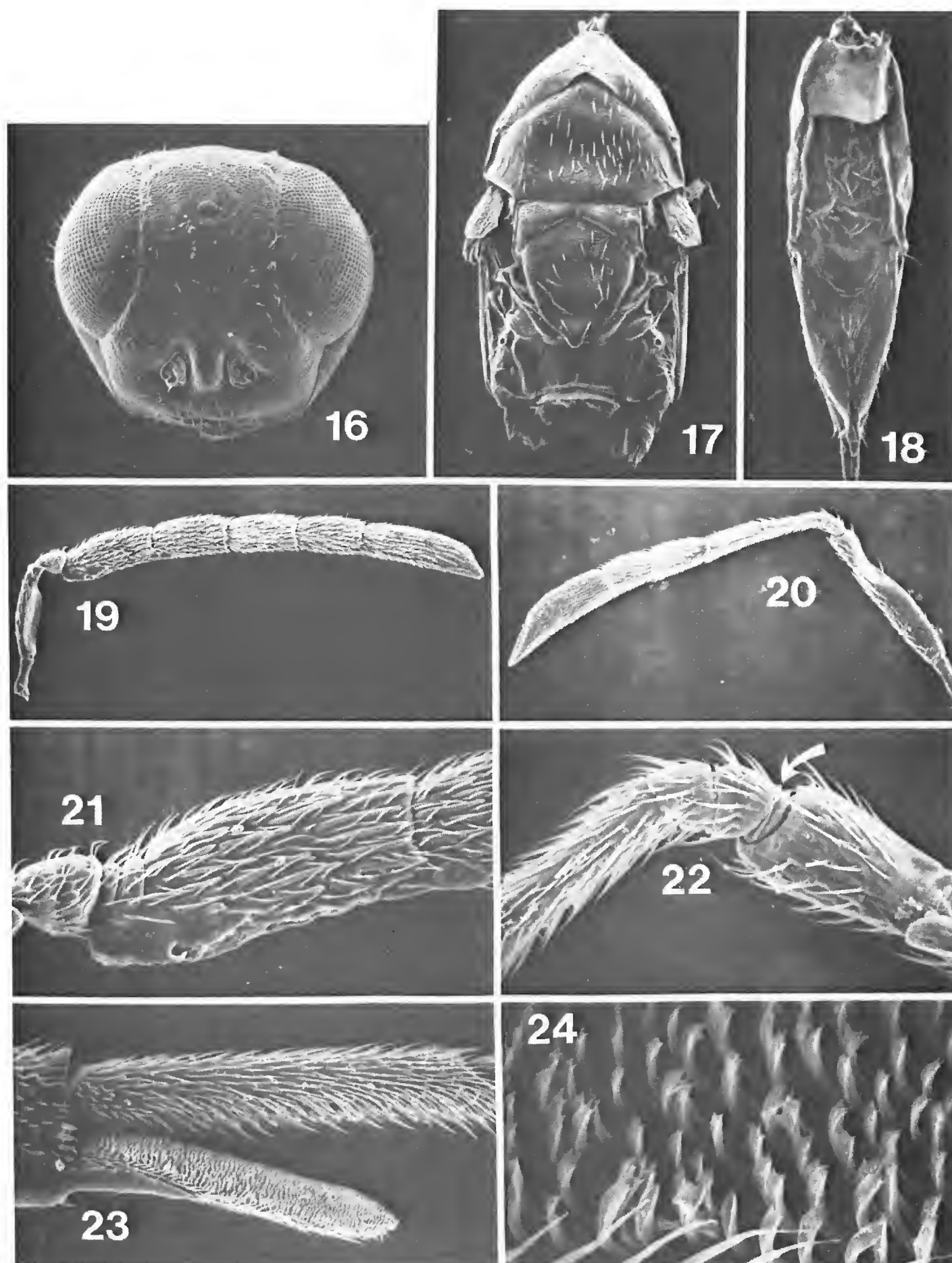
This species was based on one female taken at West Mountain Valley, Colorado, by T. D. A. Cockerell and originally placed in *Homalotylus*. The point-mounted holotype stands in the USNM collection (Type-number 4720), and lacks the club of one antenna and all flagellar segments of the other antenna. The description was based primarily on coloration, the precise nature of which cannot now be confirmed. Two points in error are corrected here; the body length is 2.32 mm, not 2.20 as indicated by Ashmead, and the frontovertex is not closely punctate with a few larger punctures but rather minutely reticulate with scattered, shallow, setigerous punctures. Characters here considered important, but not included in the original description include: frontovertex 0.45 times as wide as head, mesosoma robust, pronotum 0.5 times as long as medial length of mesoscutum, posterior margin forming broad, inverted “V”; scutellum about 1.10 times wider than long, posterior 0.30 polished and flattened. Forewing macropterous with extensive infuscation. Middle tibial spur lobate distad. Metasoma with gonostyli and ovipositor very slightly exserted, pygostyli and posterior margin of seventh sternum near midline of metasoma.

I am not convinced that *bifasciata* is distinct from *maculipennis* as I can find no reliable structural characters to differentiate them. The former is represented in the USNM collection by the holotype only; the latter is represented by the “type” and fewer than ten specimens identified by earlier workers. This material is in poor condition and many characters are difficult to observe or measure. They are probably synonyms, but synonymizing them seems more appropriate when more and better curated material is available for study. Characters used to separate females in the key may be an artifact of small sample size and poor preservation.

Meromyzobia deserticola, New Species

Female.—1.86 mm long. Body predominantly pale yellow with following parts darker: posterior $\frac{2}{3}$ of mesopleuron, lateral $\frac{3}{4}$ propodeum, metasomal terga IV–V reddish brown. Antennal scape concolorous with head, remaining segments uniformly darker. Basal $\frac{2}{3}$ tegula white, remainder dusky, prepectus nearly transparent. Fore and hind coxae yellow, hind coxa with vestiture of conspicuous white setae. Middle coxa dusky; pretarsi dusky. Hind femur reddish brown, basal $\frac{1}{5}$ tibia white, remainder reddish brown; pretarsi dusky, remaining tarsomeres nearly white. Wings hyaline.

Head subopisthognathous, in dorsal aspect with frontovertex 0.46 times as wide as head, 0.75 times as long as head. Ocelli small, forming a very broad, obtuse triangle with lateral ocellus about one diameter from medial margin of compound eye. Posterior margin of head very broadly rounded; head in frontal aspect 1.27 times wider than long; vertex weakly arched above imaginary line continuous between lateral margins of compound eyes. Ventral margin of head broadly arched. Head in lateral aspect 1.7 times longer than wide. Compound eye with minute setae,



Figures 16–24. 16. *M. melanosoma* NEW SPECIES. Female head, frontal aspect. 17. *M. melanosoma*, female mesosoma. 18. *M. melanosoma*, female metasoma. 19. *M. melanosoma*, male antenna, medial aspect. 20. *M. melanosoma*, female antenna, medial aspect. 21. *M. melanosoma*, male antennal pedicel, Funicular I–III. 22. *M. melanosoma*, female antennal pedicel, anellus (arrow), Funicular I–III. 23. *M. melanosoma*, female middle tibial spur and basitarsus, medial aspect. 24. *M. melanosoma*, middle tibial spur setae on medial surface.

posterior margin of eye diverging from posterior margin of head ventrad. Malar sulcus complete and conspicuous. Entire surface of head minutely reticulate with moderate vestiture of pale, short setae. Antenna as illustrated (Fig. 39). Mandible tridentate.

Thoracic notum flattened. Pronotum campanulate, as wide as long; mesoscutum 0.5 times as long as pronotum, 0.83 times as long as scutellum. Parapsidal sutures difficult to discern, but short, straight, oblique to primary axis of body and subparallel to lateral margin of mesoscutum. Propodeum 0.65 times as long as scutellum, median portion with two subparallel, subsurface carinae which diverge posteriad. Mesopleuron smooth, 2.82 times longer than wide. Middle tibial spur enlarged but apically tapered, not pointed. Wings micropterous.

Metasoma 1.15 times as long as mesosoma; pygostyli at apical 0.64 of metasoma. Ovipositor and gonostyli not exerted; gonostyli broad and apically rounded. Seventh sternum at basal 0.33 of metasoma; posterior margin medially incised. Tergum I as long as following three terga combined, reticulate; sculptural pattern less pronounced on terga II–VII; all terga with moderate vestiture of conspicuous pale setae.

Male. — 1.44 mm long. Habitus as female, differing in that posterior aspect of head reddish brown, anterior aspect more pale; axillae black, remainder of mesosoma and metasoma reddish brown. Antenna concolorous with forecoxa; hind femur dusky; fore and middle femora and tibiae yellow; basal half of hind tibia nearly white; apical half nearly yellow. Tarsomeres 1–3 white, tarsomere 4, pretarsi dusky. Wings hyaline, macropterous. Ocelli larger than female. Antenna as illustrated (Fig. 38). Wings macropterous (Fig. 40), projecting beyond apex of metasoma. Thoracic notal sculpture not as bold as female.

Described from six females and three males taken at Seeley, CA, 25 March 1965 on *Hilaria rigida* (Thurb.) (Gramineae) by R. A. Flock and J. Pineda. Holotype female, allotype male, and paratypes deposited in USNM collection.

Meromyzobia deserticola most nearly resembles *M. flavicincta* and may be distinguished from that and other species based on characters given in the key.

Meromyzobia flava Ashmead, 1900. Proc. U.S. Natl. Mus. 22:350. Male.

According to the original description and USNM type-catalog, this species was based on a male taken in the District of Columbia. It has not been recovered elsewhere or at a later time. The holotype is point mounted and stands in the USNM collection (Type-number 4723) and bears a label reading "Arlington, VA." The original description is not particularly accurate or informative. Study of the specimen shows that it is morphologically similar to *M. americana*. Characters incorrect or not included in the original description include body length 1.46 mm, head yellow with three darker spots each anterior of an ocellus, forewing slightly infuscated beneath marginal vein. Frontoververtex 0.53 times as wide as head, without scattered setigerous punctures.

Meromyzobia flavicincta (Ashmead), 1888. Entomol. Amer. 4:17. Female.

This species was described from one female taken at Jacksonville, Florida. The intact holotype is mounted on a card and deposited in the USNM collection. The brief description is not particularly informative or accurate and descriptive notes are provided here. The specimen is 1.90 mm long (0.75 in, not 0.80 as stated in the

original description). The coloration is not as the description but the life-like color cannot be accurately given owing to the age of the specimen. Based on a specimen I identify as *M. flavicincta*, the head, pronotum, and mesoscutum appear tan, antenna somewhat darker; axilla, scutellum, propodeum, mesopleuron dark reddish brown; metasoma predominantly dark with pale yellow with transverse band near base. Coxae, tibia, femora dusky; tarsomeres white, pretarsus dusky.

Head as shown (Fig. 7); antenna (Figs. 10, 11) not particularly short or slender. Frontovortex 0.48 times as wide as head, reticulate with several shallow setigerous punctures. Pronotum 0.75 times as long as medial length of mesoscutum; posterior margin forming broad, inverted "V." Parapsidal sutures distinct, but incomplete (Fig. 8). Wings brachypterous but projecting slightly beyond posterior margin of propodeum; distal margin of wing weakly infuscated. Propodeum with subcuticular carinae diverging posteriad. Middle spur distally lobate. Ovipositor and gonostyli very slightly exerted beyond apex of metasoma (Fig. 9). Mesopleuron 1.66 times longer than wide; surface very weakly reticulate. Middle tibial spur (Figs. 12–15) enlarged distad; pubescence on outer surface composed of elongate acanthae (Figs. 12, 13); medial-surface setae long, curved, apically tined (Figs. 14, 15).

Although the female is brachypterous, I consider it conspecific with the male described by Ashmead as *Prionomastix americana* as noted above. The shape of the head in male and female is similar and the relative length of the pronotum to the other components of the thorax are identical. The propodeum is the same size, shape, and has two subcuticular, longitudinal carinae which diverge posteriad. The middle tibial spur in both sexes is large, robust, but apically pointed in the male and enlarged in the female. The parapsidal sutures are similarly developed in the male and female. Both specimens were taken at Jacksonville, Florida, probably about the same time as judged from the identically printed locality labels and curiously constructed microscopic card mounts. Neither specimen pin carries supplemental collection information. The USNM type-catalog number 4721 indicates that specimen came from the Ashmead collection and was taken from Florida. Type-catalog number 4719 carries the entry for *americana*. It also reports that specimen is from the Ashmead collection, taken from Florida without a specified locality, and erroneously logs the sex of the specimen as a male. Nevertheless, the synonymy proposed here is taken as correct and the male is nearly identical with the male described as *flava*, but synonymy is not implemented. Five female specimens taken at Miami, Florida, from gall on *Aristida gyrans* also stood in the USNM collection appear conspecific with the holotype.

Meromyzobia maculipennis (Ashmead), 1893. Bul. Ohio Agr. Exp. Sta., Tech. Ser. 1:162–163.

Understanding the concept of this species is important for several reasons. Originally described by Ashmead as *Ericydnus maculipennis*, it was based on several specimens which Ashmead considered as males. The type-series was of indeterminate size and reared from *Chlorops ingratus* Williston (= *Anthracophaga ingrata*) by F. M. Webster in Ohio. A holotype was not designated. In the USNM collection is one specimen in the type-collection with labels which read: "Columbus O," "F. M. Webster," "Type 4722 USNM" and "*Ericydnus maculipennis* Ashm." The last label carries the word "Ashm." twice and a male symbol which has been replaced with a female symbol. This label is in Ashmead's handwriting whereas the

other three labels are typeset. The specimen on the pin is a male. Four other specimens in the collection carry handwritten labels "5272° Par: on *Chlorops*." At least two of these specimens are females. The number on the latter three pins is a Webster Number, but that card entry is missing from the Webster Number Catalog in the USNM. The USNM type catalog entry indicates that three specimens were received from Webster, which with published information and information on the collection labels suggests that the card mounts with the handwritten labels are part of the type-series used by Ashmead to describe the species. Study of all four specimens shows them to be conspecific. To complicate matters a microscope slide with fragments is labeled "*Meromyzobia maculipennis* Ashmead ♂ ♀ types" in the handwriting of A. A. Girault. Under the circumstances the specimen in the type-collection has been remounted on a larger card (owing to its precarious position) with a leg and forewing remaining on the original point. It has been labeled LECTOTYPE. The remaining specimens have been labeled as *Meromyzobia maculipennis*, but not designated paralectotypes.

The original description of *maculipennis* is misleading in many respects. Specimens range in size from 2.30–2.65 mm in length, not 3.0–3.1 as reported by Ashmead. Antennal segments (Figs. 2, 4) are not subfiliform as noted in the original description, but rather females bear the characteristic two anelliform funicular segments and the male apparently does as well, although this cannot be confirmed from the specimens available for study. Other characters not mentioned by Ashmead in the original description, but important in recognizing this species include: mandible with one tooth and a broad truncation; head (Fig. 1) with frontovertex 0.42 times as wide as head, reticulate with a few scattered, shallow, setigerous punctures. Pronotum 0.43 times as long as medial length of scutellum; posterior margin forming a broad, inverted "V" of an angle more than 90 degrees. Scutellum 1.25 times longer than wide, predominantly reticulate with apical 0.30 polished and flattened. Middle tibial spur (Figs. 3, 5, 6) large with setae on medial surface short, straight, apically tined. Ovipositor and gonostyli not exerted or very slightly exerted (due to distortion of metasoma after death). Stylus less than half as long as middle tibial spur. Pygostyli and posterior margin of seventh sternum near an imaginary transverse line bisecting metasoma.

Subba Rao (1971) apparently had not seen *Meromyzobia maculipennis* when he characterized *Desantisella*. This genus was proposed for two South American species, *brasilensis* and *plaumanni*. *Desantisella* is coincident with *Meromyzobia* in all salient features, including head shape, antennal configuration, wing coloration, shape, and venation, and size of the middle tibial spur. Other characters, including the three toothed mandible, fall within the scope of variation expressed for other species included in the genus. *Desantisella* here is recognized as a junior synonym of *Meromyzobia* (New Synonymy).

***Meromyzobia melanosoma*, NEW SPECIES**

Female.—3.72 mm long. Body elongate (Figs. 17, 18) macropterous with wing projecting near apex of metasoma but not beyond distal portion of gonostyli. Body predominantly dark brown to black. Head reddish brown, pronotum dusky; anteromedial portion of mesoscutum dark brown, remainder yellow; anterior half of tegula yellow, posterior half dusky; axillae, scutellum, propodeum black; mesopleuron dark brown; metasomal tergum I anterolaterally dusky, remainder

weakly yellow; remainder of metasoma brown; gonostyli contrastingly pale brown. Antenna somewhat darker than head. Forewing predominantly fuscous with clouds over wing blade. Coxae, femora, tibiae concolorous with mesopleuron; fore tarsomeres brown; middle tibial spur, tarsomeres 1–3 of middle and hind leg white; tarsomere 4 and pretarsus of middle and hind leg dusky.

Head hypoganthous, in dorsal aspect with frontovertex 0.42 times as wide as head and 0.85 times medial head length; frontovertex minutely reticulate, setigerous punctures very shallow and sparse, nearly absent. Ocelli forming a large triangle whose anterior angle exceeds 90 degrees; lateral ocellus less than one diameter from medial margin of compound eye, about four diameters from occipital margin. Occipital margin broadly rounded. Head in lateral aspect about 0.51 times taller than wide; malar sulcus conspicuous and complete; compound eye with scattered minute setae, posterior margin diverging from posterior margin of head ventrad. Head in frontal aspect (Fig. 16) 1.06 wider than long, with toruli close-set, separated by less than torular width; interantennal prominence weak and broadly rounded; scrobal impression weakly developed, nearly absent (Fig. 16). Mandible tridentate. Maxillary palpus four-segmented; labial palpus three segmented. Antenna as illustrated (Figs. 20, 22).

Mesosoma rather elongate (Fig. 17) but shorter than metasoma (Fig. 18). Pronotum weakly, minutely reticulate; with moderate vestiture of darkened setae; medial length 0.31 times as long as medial length of mesoscutum; posterior margin forming an angle of about 110 degrees. Mesoscutum with reticulate polygonal sculptural pattern somewhat larger than pronotal pattern but similar vestiture of setae; parapsidal sutures incomplete but converging posteriad. Axillae reticulate, broadly joined mesad; mesoscutellum 1.22 times longer than wide, predominantly reticulate with apex polished; mesopleuron 2.13 times longer than wide; predominantly reticulate but pattern minutely and longitudinal reticulate anteriad and expanding in size and diminishing in boldness posteriad; posterodorsal margin polished. Coxae with conspicuous vestiture of long pale setae on the ventral-facing surface. Middle tibial spur shorter than basitarsus (Fig. 23) with rather long, curved, apically tined and compressed setae along medial surface (Fig. 24).

Metasoma lanceolate (Fig. 18), 1.60 times longer than mesosoma. Terga weakly reticulate. Syntergum apically pointed and projecting over base of gonostyli. Gonostyli slightly shorter than middle tibial spur (0.92), apically broadly rounded. Pygostyli near midline of metasoma. Apical sternum terminating near basal third of metasoma.

Male.—2.32 mm long. Similar to female habitus, coloration, and sculpture; differing in the following features: frontovertex 0.28 times as wide as head; 0.92 times as head medial width. Antenna as illustrated (Figs. 19, 21).

Material Examined.—Holotype, Female. FLORIDA, Levy Co., 1 Female 16.iii.75; 1 FE 30.iii.75; 1 male, 1 female 25.iv.1975; 1 male 13.iv.1975; 1 female 23.xi.1975; 2 females, 2 males 9.xi.1975; 8 females, 1 male 7.xii.1975; 4 females, 1 male 11.i.1976; 1 female, 1 male 8.ii.1976; 2 males 16.ii.1976, all specimens taken on *Spartina alterniflora* Lois. (E. E. Grissell). GEORGIA, Sapela Island: 1 female 17.v.1963 (E. P. Odum), 1 female, 3 males on *Spartina* (H. Kale), 3 males 9.x.1963 on *Spartina* (E. P. Odum), on *Spartina*. NORTH CAROLINA, Cartaret Co., Newport R., 1 female 14.xi.1959 (L. V. Davis) on *Spartina alterniflora*; 3 females 15.i.1960 on *Spartina alterniflora* (L. V. Davis) NEW JERSEY, Atlantic Co.,

Oceanville, 6 females, 5 males, 9.viii.1950 (no collector specified); 4 females, 4 males, 31.viii.1959 (no collector specified).

FLORIDA, Wakulla Co., 12.vi.1980 on *Spartina alterniflora*, 6 females, (P. D. Stiling); 8.vi.1980 on *Spartina alterniflora*, 6 females (P. D. Stiling); 8.vi.1980 on *Spartina alterniflora*, 3 females, 1 male (P. D. Stiling). All material deposited in U.S. National Museum collection.

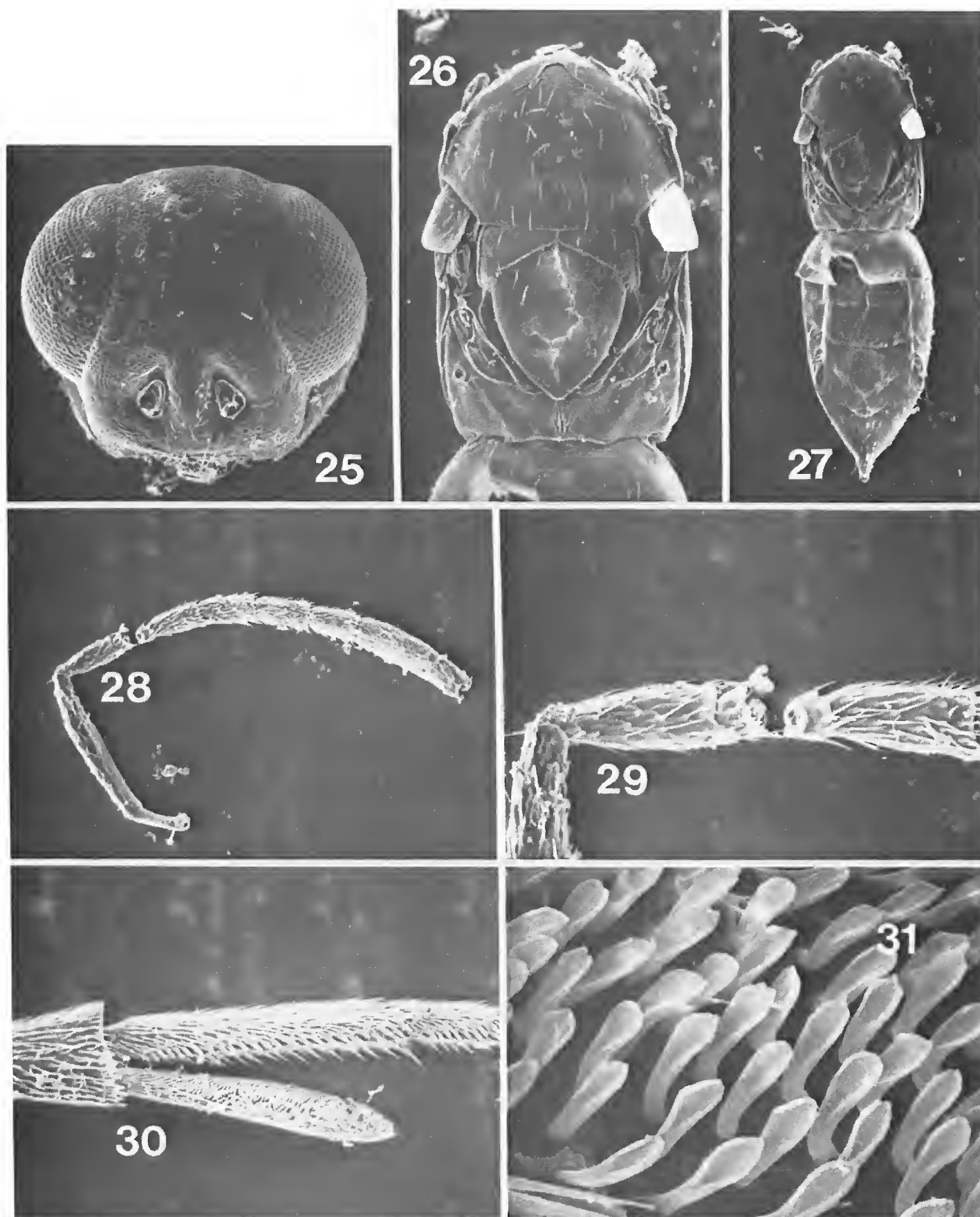
Meromyzobia melanosoma most nearly resembles *M. unifasciata* based on the three-toothed mandible, exerted ovipositor and gonostyli; apically lobate middle tibial spur, and seventh sternum which terminates near the basal one-third of the metasoma. The new species differs from *unifasciata* most conspicuously in the elongate metasoma which is clearly longer than the mesosoma, the body coloration, and the forewing with two large fuscous areas separated by a hyaline stripe. The male of *unifasciata* remains unknown, and the species remains known only from the holotype. The species here called *melanosoma* appears widespread in Atlantic Coastal situations and taken frequently with the salt marsh grass *Spartina alterniflora*. The holotype and other specimens taken by P. D. Stiling were reared from fly puparia (Stiling numbers 628C, 628D).

Meromyzobia pedicelata, NEW SPECIES

Female.—2.30 mm long. Head predominantly pale brown; intertorular projection, clypeus tan. Anterior face of pronotum reddish brown, posterior one-third tan; mesoscutum predominantly brown; region posteriad of parapsidal sutures tan. Axilla, scutellum, propodeum dark reddish brown; anterior half of tegula nearly white, posterior half dark reddish brown; mesopleuron pale brown. Anterior half of first metasomal tergum yellow, posterior half of first and second through sixth terga reddish brown; posterior margin of fifth and sixth terga nearly black, each forming a conspicuous "V." Basal terga pale yellow; distal portion of seventh sternum brown. Antenna tan. Coxae and trochanters yellow or nearly so; fore and middle femora tan; hind femur dark brown or nearly black; fore and middle tibiae dusky; hind tibia with basal one-third tan, distal two-thirds concolorous with hind femur; middle tibial spur yellow; tarsomeres dusky with pretarsi somewhat darker in certain plays of light. Forewing hyaline with a large fuscous cloud posteriad of marginal and stigmal veins which expands toward remigium and which is interrupted by a pale, transverse line corresponding roughly to a cubital vein; hind wing hyaline. Gonostyli white or nearly so.

Head in dorsal aspect with frontovertex 0.50 times as wide as head; head in frontal aspect (Fig. 25) minute and weakly reticulate with several scattered, shallow, setigerous punctures; lateral ocellus less than one diameter from medial margin of compound eye; posterior-most margin of compound eye less than one ocellar diameter from vertexal margin. Antenna as illustrated (Figs. 28, 29). Mandible with one tooth and a broad truncation.

Pronotum about 0.33 times as long as medial length of mesoscutum. Mesoscutum weakly and uniformly reticulate (Fig. 26), nearly polished; sculptural pattern nearly identical on axillae and scutellum. Scutellum as long as wide, rather robust. Mesopleuron polished with very weak reticulate sculpture along anterior margin, 1.7 times longer than wide. Propodeum with a complete, well developed, longitudinal median carina; subcuticular carinae parallel. Middle tibial spur slightly longer than

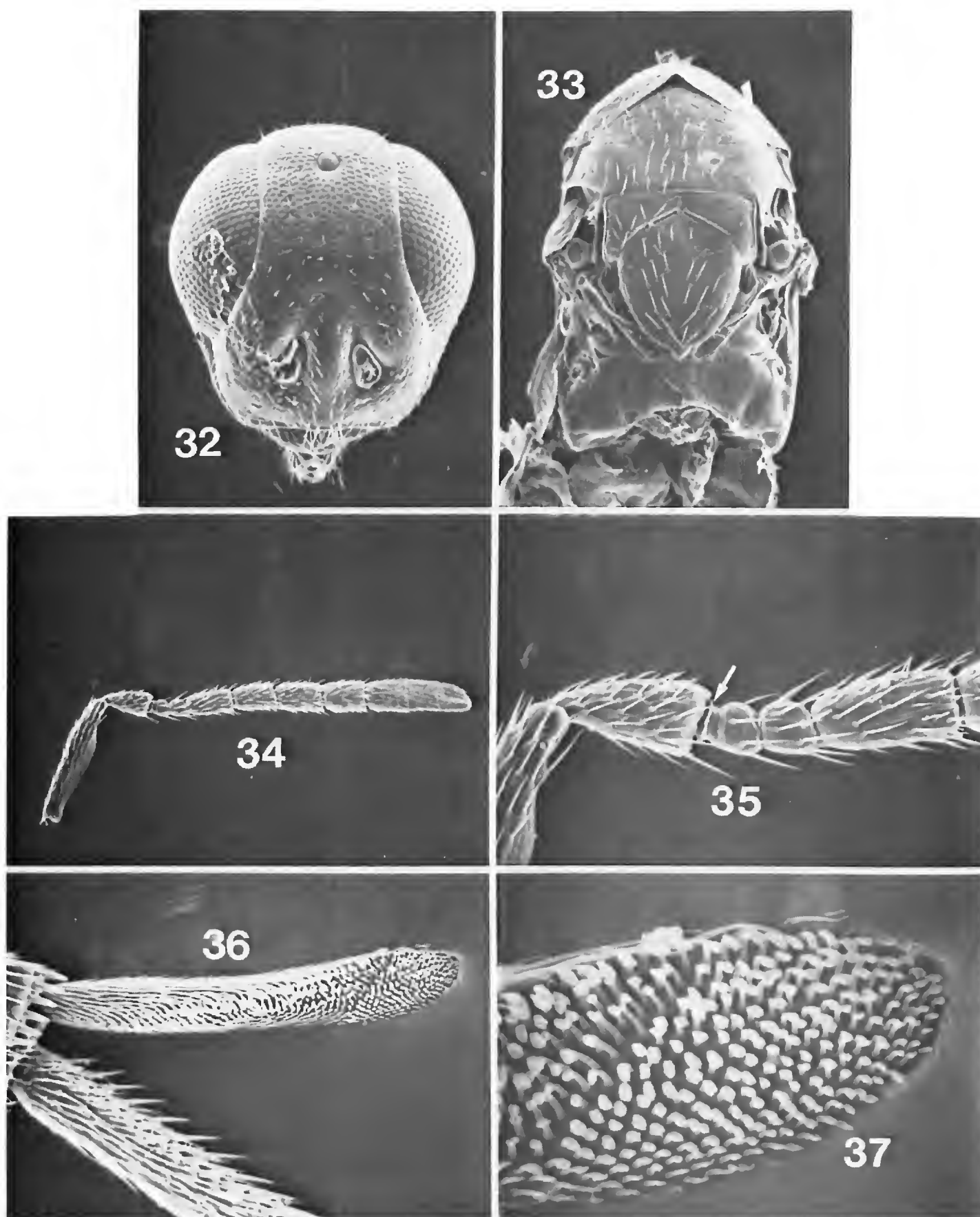


Figures 25–31. 25. *M. pedicelata* NEW SPECIES. Female head, frontal aspect. 26. *M. pedicelata*, female mesosoma. 27. *M. pedicelata*, female mesosoma and metasoma. 28. *M. pedicelata*, female antenna, medial aspect. 29. *M. pedicelata*, female pedicel, Funicular I–III. 30. *M. pedicelata*, female middle tibial spur and basitarsus, medial aspect. 31. *M. pedicelata*, female middle tibial spur setae on medial surface.

basitarsus; distally lobate (Figs. 30, 31); setae on medial surface moderately long, curved, with apical tines absent or very weakly developed.

Metasoma (Fig. 27) about as long as mesosoma; ovipositor and gonostyli very weakly exerted.

Metasoma 1.33 times as long as mesosoma. Terga weakly and uniformly reticulate; pygostyli just posteriad of imaginary line bisecting metasoma. Seventh

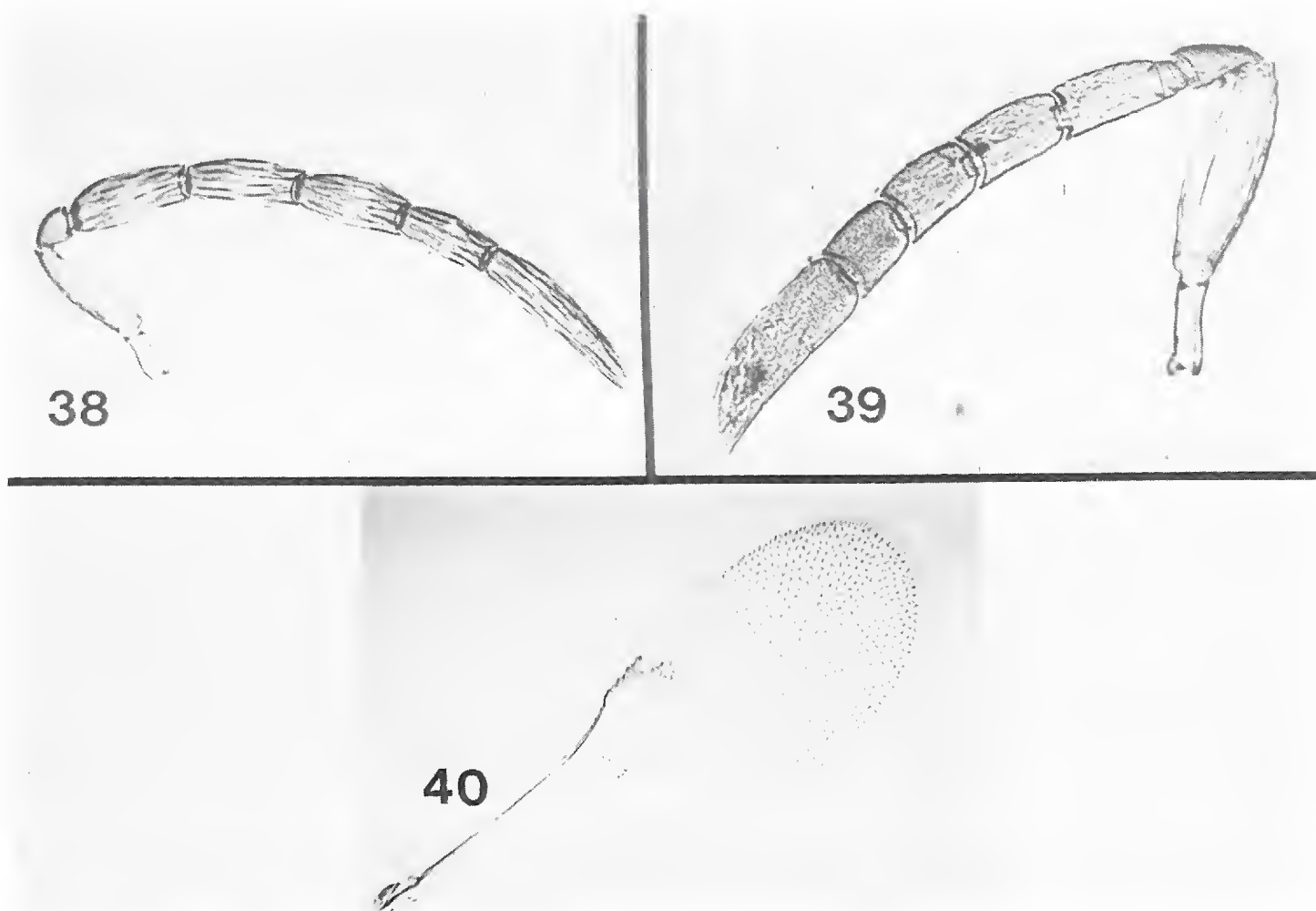


Figures 32–37. 32. *M. texana* NEW SPECIES. Female head, frontal aspect. 33. *M. texana*, female mesosoma (arrow to parapsidal suture). 34. *M. texana*, female antenna, lateral aspect. 35. *M. texana*, female antenna, annelus (arrow), Funicular I–III. 36. *M. texana*, female middle tibial spur, medial aspect. 37. *M. texana*, female middle tibial spur setae on medial surface.

sternum near imaginary line bisecting metasoma; posterior margin transverse. Ovipositor and gonostyli visible when specimen viewed in lateral aspect, but not exerted beyond apex of metasoma.

Male:—Unknown.

Described from six females reared from Orthoptera eggs attached to *Tripsacum laxum* Nash taken at Kicco, Florida, on 3 February 1932 by R. D. Kennedy. This



Figures 38–40. 38. *M. deserticola* NEW SPECIES. Male antenna, medial aspect. 39. *M. deserticola*, female antenna, medial aspect. 40. *M. deserticola*, male forewing.

plant is native to Central America and not common in the United States. Holotype and paratypes card-point mounted and deposited in the USNM collection. One paratype dissected and mounted on a microscope slide.

This species appears related to the type-species, *M. maculipennis*, and *M. bifasciata*, based on the large, robust body, forewing coloration and venation, mandible with one tooth and a broad truncation, and large, distally enlarged, middle tibial spur. It may be distinguished from those species based on the elongate pedicel, distinctive medial propodeal carina, and the host association. According to Dr. D. Nickle (pers. comm.), the host was probably a tettigoniid. The host association appears solid. Preserved with the type-series are the eggs from which the parasites emerged that contain the pupal exuviae of the parasites. Other species of *Meromyzobia* for which the biology is known develop within fly puparia.

Meromyzobia texana, NEW SPECIES

Female. —2.05 mm long. Body predominantly lemon yellow with following areas darker: anterior face and postero-lateral margin of pronotum, posterior half of tegula; metanotum, propodeum reddish brown; fourth metasomal tergum forming a broad, transverse dark brown dusky stripe; fifth tergum dusky, metasoma with a dusky spot on either side of apex. Antenna dusky. Forewing predominantly hyaline with infuscation distad of speculum and beneath marginal vein and expanding toward remigium, interrupted by a hyaline, transverse stripe at region of imaginary cubital vein; distal margin with an occasional darkened area. Coxae, fore and middle

femora, all tibiae yellow; basal half of hind femur and tibia pale, distal half dusky to dark brown; middle tibial spur white, tarsomeres off-white; apices of pretarsi dusky.

Head in dorsal aspect with frontovertex 0.41 times as wide as head; surface minutely reticulate with several shallow setigerous punctures; lateral ocellus separated from medial margin of compound eye by about one ocellar diameter; posterior margin of compound eye nearly confluent with posterior margin of head, separated by less than ocellar diameter. Head in frontal aspect (Fig. 32) as wide as tall; toruli just beneath imaginary transverse line extending between ventral margins of compound eyes. Toruli short and shallow. Clypeal margin transverse. Antenna as illustrated (Figs. 34, 35). Mandible tridentate.

Mesosoma (Fig. 33) with pronotum 0.30 times as long as mesoscutum; posterior margin broadly indented; surface weakly reticulate with moderate vestiture of dark setae. Mesoscutum with similar sculpture and vestiture of setae; parapsidal sutures transverse but not meeting mesad. Scutellum as long as wide, moderately robust. Middle tibial spur (Figs. 36, 37) as long as middle basitarsus; lobate distad. Setae on medial surface long and apically clubbed. Propodeum with subcuticular longitudinal carinae divergent posteriad, medially bearing a very weak, incomplete superficial carina.

Metasoma 1.25 times as long as mesosoma. Gonostyli very slightly exerted. Seventh sternum apically transverse, along with pygostyli just anterior of an imaginary line bisecting metasoma.

Male.—1.76 mm long. Apical half of metasoma dusky, otherwise identical to female in habitus, chaetotaxy and coloration.

Described from seven females and one male taken at Weslaco, Texas, on 15/II/1949 by P. T. Riherd from rhodesgrass infested with *A. graminis*, and two females taken by the same collector on *Chloris gayana* Kunth infested with *A. graminis* at the same locality on 14/I/1947. Material deposited in the USNM collection. All specimens card-point mounted except one female which is slide mounted.

DISCUSSION

Placement of this species is difficult. I have run it out among the smaller species in the genus because I believe that is where its affinities lie. This being despite the fact that *M. texana* is macropterous while *M. deserticola* and *M. flavicincta* are micropterous as females. Perhaps more meaningful in distinguishing *texana* from these two species is the curious directly convergent nature of the parapsidal sutures, a feature not seen in other *Meromyzobia*. An incipient medial propodeal carina suggests it may be related to *M. pedicelata*, but that species has mandibles with one tooth and a broad truncation. I no longer doubt that rhodesgrass scale could be a host of this parasite, but I have not seen it from other collections of this parasite taken from rhodesgrass scale in Texas. If *texana* is a parasite of *graminis*, the parasite shifted from a native host or was originally from the Orient, the natural range of *graminis*. The suggested host range of *Meromyzobia* is too broad to rule out any possibility for the origin of *texana* at this time. Curiously, *A. graminis* has been well studied in Texas and has other imported encyrtid parasites (Clausen, 1978), including other Miraini and mealybug parasites. *Meromyzobia* has not been reported from the Orient (Noyes and Hayat, 1984). Given very limited data, I suspect *texana* is probably attacking Diptera puparia in grasses, and that the species is native to North America.

Meromyzobia unifasciata (Ashmead), 1900. Proc. U.S. Natl. Mus. 22:350. Female.

This species was based on one female taken at Utica, Mississippi, and has not been recovered subsequently. The holotype is point mounted and stands in the USNM collection (#4724). The original description is generally accurate, but relies exclusively on coloration. More important diagnostic characters useful in identifying this species include the distally lobate middle tibial spur, conspicuously exerted ovipositor and gonostyli, parallel, subexocuticular, longitudinal propodeal carinae, frontovertex 0.72 times as wide as head is long and 0.39 times as wide as head. Mandible tridentate. Macropterous, forewing weakly infumated beneath marginal vein. Metasoma, excluding exerted gonostyli, as long as mesosoma. Coloration faded, but taken as generally accurate in the original description.

Scutellum with median length 1.18 times maximal width. Mesopleuron weakly reticulate with pattern fading posteriad and absent along posterodorsal margin.

Metasoma, excluding exerted portion of gonostyli, 0.89 times as long as mesosoma. Fuscous cloud beneath marginal and stigmal veins of forewing not projecting to posterior margin of wing.

The male remains unknown.

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Nest-site Preferences of the Giant Honey Bee, *Apis dorsata* (Hymenoptera: Apidae), in Borneo

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Abstract. — The characteristics of *Apis dorsata* (Hymenoptera: Apidae) nest-sites in Sabah, Borneo, are described on the basis of 15 nest-bearing trees. Nests were consistently high in very tall trees, exposed, and commonly aggregated. These features are consistent with what has been reported from mainland populations of *A. dorsata*, but not with giant honey bees from the Philippines. This supports the hypothesis that these latter are a distinct species.

The giant honey bees form a distinct species-group within *Apis* and are sometimes treated as a subgenus, *Megapis* Ashmead. At the most conservative modern estimate, the group contains two species, the Himalayan *A. laboriosa* Smith and Indomalaysian *A. dorsata* Fabricius. On the other hand, Maa (1953) divided the latter species into three: *A. dorsata*, *A. binghami* Cockerell (= *A. zonata* Smith) and *A. breviligula* Maa. This assessment is tentatively accepted by Sakagami et al. (1980), and Roubik et al. (1985), though not generally by other authors.

The name *A. binghami* applies to the little-known populations of *Megapis* on Celebes and associated smaller islands; *A. breviligula* applies to all populations in the Philippine islands aside from the Palawan group; and *A. dorsata* applies to all other non-*laboriosa* populations, including those of Borneo and neighboring Palawan. The distinctness of *A. binghami* and *A. breviligula* is currently under biometrical investigation (S.F. Sakagami, pers. comm.). For convenience, we refer to all *Megapis* from the Philippines proper as *A. breviligula*, without implying that the taxonomic question is settled, and to all non-*laboriosa* *Megapis* as the *A. dorsata* group.

Wallace (1869) was among the early naturalists who commented on these conspicuous bees and his remarks will serve as a summary for what many later travelers noted. *A. dorsata* in Borneo, he said, "build huge honeycombs, suspended in the open air from the underside of the lofty branches of the highest trees." He remarked especially on an aggregation of three nests that he watched being robbed by a team of men. The man who climbed the tree and cut down the combs protected himself with a heavy cloth wrapping and a smoke-torch, but was nonetheless repeatedly stung.

Morse and Laigo (1969) provided most of what is known of the biology of *A. breviligula* and reviewed the literature on both *A. breviligula* and *A. dorsata*. Since then, Deodikar et al. (1977), and Seeley et al. (1982; summarized by Seeley

1983) have contributed important new information on the biology of *A. dorsata* on the Asian mainland.

In this paper we describe nest-sites and colony aggregations of *A. dorsata* from Sabah and compare these taxonomically with data for *A. breviligula*.

MATERIALS AND METHODS

All observations from Sabah were made during May, 1985. Trees with active colonies of *A. dorsata* or which had had colonies in them were identified along the highways between Tamparuli-Marak Parak via Kota Maruda and between Ranau and Sandakan (lat. 6°N, long. 117°E). In most cases initial discoveries were made from the road. The nests were then often observed through binoculars and by approach on foot to the tree. *A. dorsata* trees were initially recognized by the presence of active colonies or parts of a honey hunting ladder, and in one case by vestiges of a nest (comb-scar).

RESULTS

Table 1 lists characteristics of the 15 nesting trees we found. Although we did not specifically search low vegetation, we saw no indication of *A. dorsata* nesting anywhere except on tree branches, an observation supported by the local people we contacted. All the trees were very tall, and we estimate that none had branches lower than 15m. Moreover, unlike many other trees of similar size and shape, the trees with bees were all clean and free of epiphytes or lianas on the trunk and main branches (Figs. 1, 3, 4). Almost all the nests were in open, unencumbered zones, without vegetation close to them. As seen in Table 1, a majority of the trees were smooth-barked. These had light-medium gray bark and appeared to be a single species. The usual tree for *A. dorsata* in that area is reported to be *Koompassia* [Fabaceae], (Orolfo 1965; Anthea Phillips pers. comm.). The description of *K. excelsa* (Becc.), one of the world's tallest known angiosperm tree species, agrees well with the trees, we observed. In addition, Corner (1952) remarked of *K. excelsa* that, "the branches often bear large combs of wild bees" in Malaya and cites a local name for it, *tualang*, meaning "tree of swarming bees." Roepke (1948) also noted a tendency for *A. dorsata* to nest in *Koompassia*. The bark of the three putative *Koompassia* trees that we closely inspected was smooth, hard, and compact, with no sign of flaking (Figs. 1, 2).

Many areas in which the bee trees were found had great numbers of tall, standing dead trees, as a result of habitat destruction through logging. Nonetheless, all eight trees with active bee colonies were living, as were six of the seven trees with signs of previous colonies (Table 1).

At least 10 of the 15 trees contained a ladder or vestiges of one going up the trunk to the bottom branches (Table 1, Fig. 2). Some of the other trees also might have had ladders, on a side hidden from us. The main part of the ladder consists of a series of sharp stakes with fire-hardened tips, from an exceptionally dense, hard dipterocarp tree, driven directly into the bee tree (Charles Jackson, pers. comm.). These are then lashed with rattan (*Calamus* sp. [Palmae]) to a bamboo upright (Fig. 3). Inasmuch as at least three of the trees with active colonies in them had vestiges of ladders—an indication that they had probably been hunted successfully at least once before—it seems likely that some trees are hunted repeatedly.

On eight trees we observed 22 active nests of bees in groups of 1–7 nests per tree

Table 1. Characteristics of nesting trees of *Apis dorsata* in Sabah.

| Tree Bark | Ladder | Number of Active Colonies | Remarks |
|------------------|-------------|------------------------------|---|
| rough | + | 0 | |
| rough | + | 0 | |
| rough | — | ≥ 2 | possibly one or two other hidden nests |
| semi-rough | — | 1 | |
| smooth | + | 0 | dead tree |
| smooth | + | 0 | |
| smooth | + | 0 | |
| smooth | + | 0 | |
| smooth | + | 1 | |
| smooth | + | 3 | |
| smooth | + | 7 | on two adjoining trees |
| smooth | — | 0 | definite comb-scar |
| smooth | — | 4 | |
| smooth | — | 4 | |
| smooth | — | 7 | |
| % of total trees | 60% ladders | 53% active | |

(Table 1). In those trees with multiple nests the nests appeared to be widely dispersed amongst the lower branches (Fig. 4), and certainly, no strong clumping within a tree was evident.

In the Philippines, one of us (CKS) has seen five swarms of *A. breviligula* on the island of Leyte and two of *A. dorsata* on the island of Palawan. These were all on the undersides of gently sloping branches. They resembled colonies with nests, but were more compact, i.e. forming a shallow, distinctly broader mass (Fig. 5). In a residential area of Kota Kinabalu, Sabah, we collected a small swarm of *A. dorsata* on a tree branch about 4m from the ground (Fig. 5). It appeared to have approximately one-tenth the volume of the five more uniform swarms mentioned above. Our collection, which appeared to encompass virtually all the bees in the swarm, comprised 1114 workers and 171 males. No queen was among them.

DISCUSSION

Deodikar et al. (1977) reported observations on 1860 *A. dorsata* nests in India. Of these, 55% were in trees, the rest on human-made structures. The majority of nests were between 6 and 12 m above ground, with only 6% lower down. Seeley et al. (1982) described 15 trees in Thailand with *A. dorsata* nests. Fourteen of these were straight, smooth-barked, and limbless for at least 13m. Although the lowest nest was only 3.5m above the ground, most nests were located at heights between 13 and 27m, and all were in open vegetation. These observations agree with ours from Sabah, as well as with various other reports on the nesting of *A. dorsata* (Morse and Laigo, 1969).

Seeley et al. (1982) also reported a significant tendency for colonies to aggregate, with up to 24 nesting in a single tree. Morse and Laigo (1969) reported that most colonies seen by Morse in India were also aggregated, the largest aggregation being



Figures 1–3. 1. Typical bee tree, showing height, smooth bark, and lack of epiphytes. *A. dorsata* colony is visible (arrow). 2. Vestiges of honey-hunting ladder on bee tree trunk. This ladder allowed access to the position of the lowest colony (arrow), and also went higher into the tree. 3. Detail of one step of honey-hunting ladder, just beginning to disintegrate.

34 colonies, and Deodikar et al. (1977) likewise reported nests generally aggregated. Even larger aggregations, the greatest number being 156 in a single tree (see Morse and Laigo, 1969, for citations), have been noted. These observations led Morse and Laigo to conclude that trees with 20–30 colonies of *A. dorsata* are not rare throughout most of its range.

The nesting characteristics of *A. breviligula* as reported by Morse and Laigo (1969) from 30 colonies in Luzon, Philippines, and corroborated by one of us (CKS) from five colonies in Leyte, are in strong contrast to the above. A number of consistent differences are apparent:

- a. *A. breviligula* nests are lower; they are rarely found in high trees, and often the bottom of the nest is within 1m of the ground.
- b. It shows no preference for smooth-barked trees.
- c. It tends to nest less in the open, often in the midst of fairly dense vegetation, so that the nests are much less conspicuous from a distance. Some nests even had small branches projecting through them.
- d. Colonies of *A. breviligula* are single, not aggregated.

Morse and Laigo (1969) explicitly noted the first and last of these contrasts between *A. breviligula* and *A. dorsata* and remarked on these “subtle differences.” In our view, they are important and lend support to the hypothesis that *A. breviligula* is a distinct species. The significance of our observations is strengthened by the fact that they were made in Sabah, very near the Philippines proper. If the two forms were the same species, we would expect bees from Sabah to be intermediate between those of Thailand and Luzon. With regard to nesting characteristics, this prediction is not corroborated. The distinct-species hypothesis further predicts that bees in Palawan will not differ significantly from those of Sabah, in the direction of resembling those of Luzon. This has yet to be tested.

Seeley et al. (1982) account for the nesting habits of *A. dorsata* as part of their defensive strategy against vertebrate enemies. The keys to this strategy are



Figure 4. Crown of bee tree with four active colonies and parts of one old nest in view (arrows).

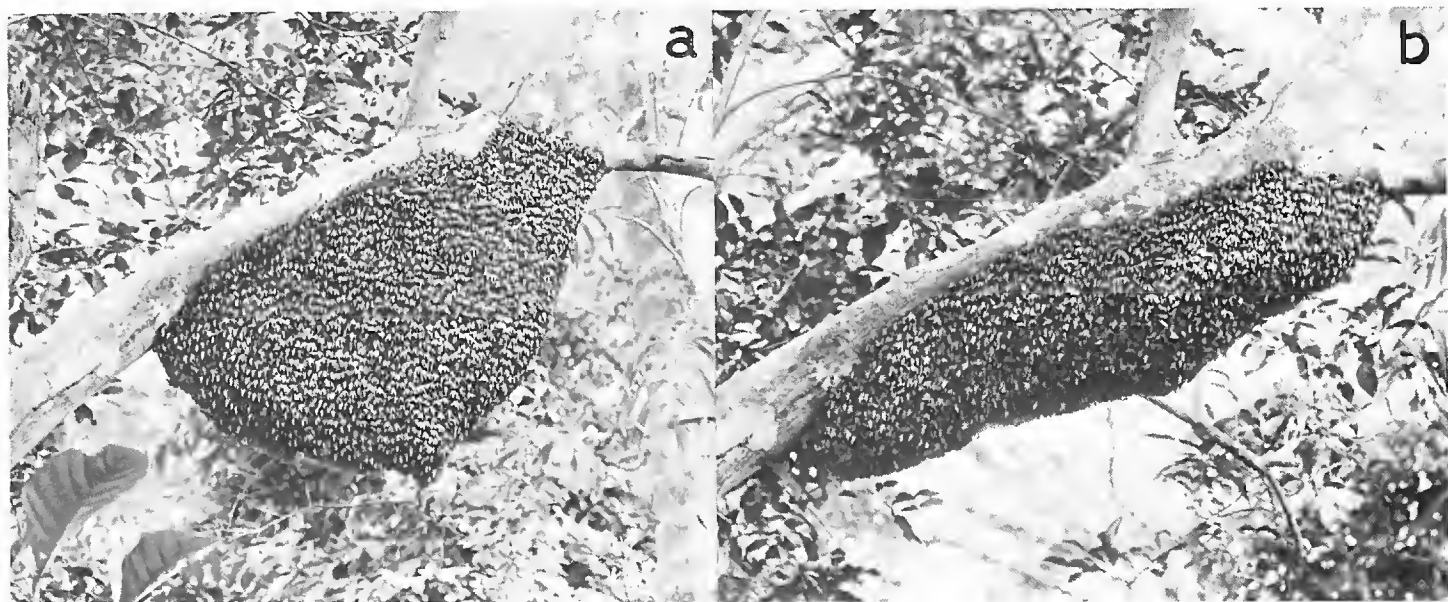


Figure 5. *A. dorsata* colony at Aborlan, Palawan, Philippines. a. As a normal colony, with bees covering a nest. b. As a swarm, resettled on the same branch after they had been driven away with smoke and the nest removed.

inaccessibility and a readiness to launch a massive attack. They reason that the depredations of humans, in particular, over the millenia must have constituted strong natural selection. The use of honey-hunting ladders today in Sabah indicates that this selection continues.

A. breviligula can launch comparable attacks against intruders (Morse and Laigo, 1969) but its nests are commonly quite accessible. It is not easy to explain this difference, unless *A. breviligula* had few natural vertebrate predators before the

arrival of humans. At present, *A. breviligula* colonies located in inhabited areas are rarely left undisturbed; instead they are usually destroyed or driven out with smoke and fire within a few days of discovery (Morse and Laigo, 1969; pers. obs.). It may be that they gain some cryptic protection by nesting lower and in denser vegetation, but the more likely hypothesis is that selection pressure from humans has until recently not been very strong in the Philippines proper.

The reason for colony aggregation in *A. dorsata* is obscure. In light of the scant available evidence, Seeley et al. (1982) tentatively concluded that the scarcity of suitable nest substrates best accounts for aggregation. Our own observations do not support this hypothesis; suitable unoccupied trees appeared plentiful in the vicinity of those with two or more active colonies.

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The Genus *Pachymerola* Bates (Coleoptera: Cerambycidae)

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Abstract.—The monobasic genus *Pachymerola* Bates is examined and redescribed; *P. vitticollis* is discussed and briefly redescribed. A new species and subspecies are proposed: *P. ruficollis ruficollis* from western Mexico to Honduras, and *P. ruficollis humeralis* from Costa Rica. The latter is figured. A change in tribal placement is proposed, assigning *Pachymerola* to the tribe Hyboderini.

Bates (1892) described *Pachymerola vitticollis* from a single male specimen taken at Chilpancingo (alt. 4600 ft.), Guerrero, Mexico, and assigned this new genus to the tribe Compsocerini, based on an observed similarity of the male to that of *Coremia* Serville. The modified abdomen of the female, herein described, necessitates reassignment of *Pachymerola* to the Hyboderini.

S. A. Fragoso (1978) has attempted to clarify the tribal classification of the North American Cerambycinae, primarily based on studies of the terminalia of both sexes. This work may result in a future change of status for the tribe Hyboderini.

Specimens of *Pachymerola* are fairly commonly taken on blossoms of *Croton*, and other flowering woody plants, although no larval host associations are recorded. The genus is thus far known from Sinaloa in western Mexico to the Cordillera de Tilaran of Costa Rica.

Examination of the large quantity of material at hand has failed to reveal any specimen agreeing with the unique type of *P. vitticollis*.

Genus *Pachymerola* Bates

Pachymerola Bates 1892:161; Blackwelder 1946:580 (list).

Form moderately small, elongate. Pubescence fine, short, sericeous, denser on ventral surfaces. Head coarsely punctate, with front canaliculate, clypeal suture deeply impressed; eyes finely faceted, deeply emarginate; antennae slender, not longer than body, with scape clavate, second segment short, fourth segment longest, outer segments subserrate. Pronotum pyriform, about as long as broad, sides obtusely angulate, widest behind middle; disk uneven, asperate-punctate; prosternum with intercoxal process narrow, procoxal cavities closed behind; mesosternal process wider; metasternum longitudinally impressed; metacoxae enlarged, tumid. Abdomen with first sternite elongate in both sexes; female with first abdominal sternite as long as remaining sternites together, second sternite deeply emarginate, with transverse brush composed of scooplike setae arising from distal border, lateral setae longer, incurved, pointed, remaining sternites shorter, concave, hairy. Elytra somewhat flattened, nearly parallel sided, asperate-punctate, alutaceous, apices obtusely acuminate. Legs with femora moderately clavate;

metafemora enlarged, thickened, exceeding elytral apices, alutaceous, asperate; metatibiae asperate.

Type Species. — *Pachymerola vitticollis* Bates (monobasic).

KEY TO SEPARATE THE SPECIES AND SUBSPECIES OF *PACHYMEROLA* BATES

1. Pronotum black with a yellowish-gray pubescent vitta on each side of disk.
 Antennae of male about as long as body, with 8th segment equal to 3rd.
 Guerrero, Mexico *P. vitticollis*
 – Pronotum orange or reddish, rarely infuscated, lacking pubescent vittae.
 Antennae of male reaching at most to apical $\frac{1}{5}$ of elytra, with 8th
 segment distinctly shorter than 3rd 2.
2. Elytra black, sometimes indistinctly suffused with orange or reddish at
 base, without distinct triangular orange humeral maculae. Femora, at
 least anterior pair, usually orange at base. Mexico to Honduras
 *P. ruficollis ruficollis*
 – Elytra black, with distinct orange triangular humeral maculae. Legs black.
 Costa Rica *P. ruficollis humeralis*

Pachymerola vitticollis Bates

Pachymerola vitticollis Bates 1892:161; Blackwelder 1946:580 (list).

Male. — Form moderately small, nearly parallel sided. Integument black. Antennae about as long as body, 8th segment subequal to 3rd. Pronotum asperate-punctate, with a yellowish gray pubescent vitta on each side of disk. Elytra somewhat flattened, asperate-punctate, alutaceous, with very fine, short, sericeous pubescence. Body beneath with somewhat more dense silvery-white pubescence; abdomen simple. Legs with metafemora enlarged, thickened, asperate, alutaceous, denticulate-asperate distally on underside, metatibiae sulcate, asperate. Length 8.5mm.

Female. — Unknown.

Type Locality. — Chilpancingo, Guerrero, Mexico.

Remarks. — Known from a unique male specimen, this species appears to differ from all but the most melanic individuals of the following new species by the black color, and from all individuals of that species by the vittate pronotum, and longer antennae.

Pachymerola ruficollis ruficollis Giesbert, NEW SPECIES

Male. — Form small to moderately small, nearly parallel sided, with sides feebly incurved behind middle. Integument piceous to black, with pronotum usually orange or reddish, rarely infuscated, and often with occipital area of head, bases of elytra indistinctly, femoral bases, coxae, and parts of sternum suffused with orange. Antennae reaching apical $\frac{1}{5}$ of elytra, with outer segments shortened, 8th segment shorter than 3rd. Pronotum opaque, usually densely asperate-punctate, without pubescent vittae. Elytra somewhat flattened distally, distinctly asperate-punctate, alutaceous, with fine, short, sericeous pubescence. Body beneath with somewhat denser sericeous pubescence; abdomen simple, with first sternite comprising $\frac{1}{3}$ to $\frac{1}{2}$

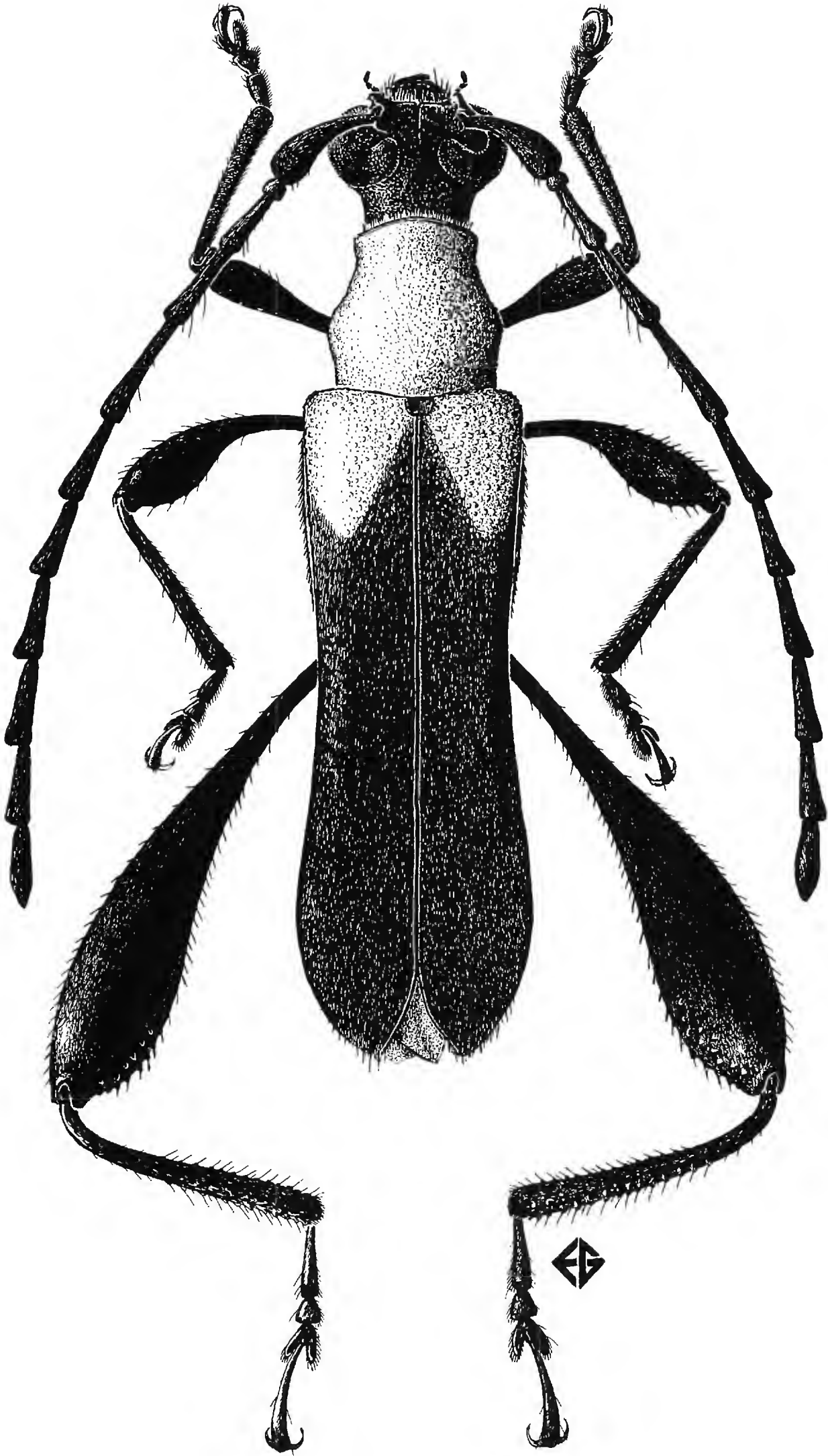
of abdominal length. Legs with metafemora enlarged, thickened, asperate, alutaceous, often somewhat nitid and denticulate distally beneath. Length 6–11mm.

Female.—Similar to male, but with antennae shorter, reaching just past middle of elytra. Abdomen modified with scopate second sternite. Length 7–13mm.

Types.—*Holotype* male, *allotype* (California Academy of Sciences), and 19 *paratypes* (7 male, 12 female) from 5 mi. N Mazatlan, Sinaloa, Mexico, July 28–August 3, 1973 (E. Giesbert). 167 additional *paratypes* as follows: MEXICO: Sinaloa; 26 males, 30 females, 5 mi. N Mazatlan, July 21–August 1, 1972, on flowers of *Buddleia wrightii* and *Jatropha curcas* (J. & M. A. Chemsak, A. & M. Michelbacher); 1 male, 5 mi. N Mazatlan, August 15, 1966 (J. A. Chemsak & J. Doyen); 1 male, 2.5 mi. N Mazatlan, August 12, 1970 (M. Wasbauer); 3 males, 1 female, 2.5 mi. N Mazatlan, August 10–11, 1970 (J. A. Chemsak); 2 males, 1 female, 5 mi. N Mazatlan, August 9–15, 1970 (J. A. Chemsak); 11 males, 14 females, 5 mi. N Mazatlan, July 25–August 1, 1973 (J. Chemsak, E. G. Linsleys & Michelbachers); 24 males, 4 females, 5 mi. N Mazatlan, July 30–August 8, 1983 (F. T. Hovore); 1 male, 5 mi. N Mazatlan, August 9, 1983 (E. Giesbert); Nayarit: 6 males, 2 females, Ahuacatlan, July 18–22, 1951, on flowers of *Donnellsmithia hintoni* M. & C. (P. D. Hurd, H. E. Evans); 3 males, Arroyo Santiago nr. Jesus Maria, July 5, 1955 (B. Malkin). Jalisco: 9 males, 3 females, Est. Biol. Chamela, July 10–20, 1985, on flowers of *Croton*. (E. Giesbert); 2 males, Est. Biol. Chamela, July 8–16, 1985 (J. Chemsak, H. Katsura, A. & M. Michelbacher); 1 male, Chamela, June 19, 1983 (S. H. Bullock); 1 male, Chamela, July 21, 1984, on flowers of *Croton* (J. A. Chemsak). Oaxaca: 2 males, 4 females, 30 mi. NE Tehuantepec, July 8, 1955 (D. Giuliani); 1 male, 6 mi. N Juchitan, July 3 1955 (Univ. Kans. Mex. Expedition); 1 male, 8 mi. N La Ventosa, July 20, 1963 (W. A. Foster); 1 female, Isth. of Tehuantepec, (F. Sumichrast); 2 males, 56 mi. NW Tehuantepec, July 27, 1963 (J. Doyen). Chiapas: 1 female, 8 mi. E Rizo de Oro, June 22, 1985 (D. Heffern). Quintana Roo: 3 males, 2 females, 18 km N Felipe Carillo Puerto, May 27–June 1, 1984 (J. E. Wappes); 1 male, 10 km N Puerto Morelos, June 15–16, 1983 (E. Giesbert). EL SALVADOR: 1 male, 1 female, Dept. Ahuachapan, Bosque El Imposible (745m), June 18, 1979 (R. D. Cave). HONDURAS: 1 female, Tegucigalpa, June 12, 1918 (Dyer).

Remarks.—Integumental color is somewhat unstable within populations in this species. The Sinaloa population exhibits the greatest tendency toward reduced melanism throughout, with pronota and femoral bases consistently orange. The Jalisco population, also with somewhat reduced melanism, exhibits pronota of a rich red color, sometimes partially infuscated. Specimens from further south in Mexico exhibit an orange pronotum, which is sometimes infuscated to varying degrees, legs with only the procoxae and bases of profemora usually suffused with orange, and consistently black elytra. The small amount of material available from Central America is also quite melanic: specimens from El Salvador are entirely black with orange pronota, the Honduran example similar, but with orange profemoral bases. A single entirely black specimen was seen from Tehuantepec, but generally, it would appear that melanism tends to increase clinally north to south.

In addition, the Sinaloan population exhibits a more nitid, less alutaceous surface on the underside of the enlarged metafemora, and northern populations exhibit a tendency toward a more densely asperate pronotal surface.



Figures 1. *Pachymerola ruficollis humeralis* Giesbert; male.

Pachymerola ruficollis humeralis Giesbert, NEW SUBSPECIES

(Fig. 1)

Male.—Form moderately small, with sides slightly incurved behind middle. Integument black, with pronotum and large triangular maculae on humeri orange. Antennae reaching apical $\frac{1}{5}$ of elytra, with 8th segment shorter than 3rd. Pronotum opaque, somewhat indistinctly asperate-punctate, without pubescent vittae. Abdomen simple, with first sternite comprising $\frac{1}{2}$ of abdominal length. Legs with metafemora elongate, thickened, asperate-punctate, alutaceous, with underside denticulate distally; metatibiae asperate. Length 9–12mm.

Female.—Similar to male, but with antennae shorter, just surpassing middle of elytra. Abdomen modified with scopate second sternite. Length 9.5–13.5mm.

Types.—*Holotype* male, *allotype* (California Academy of Sciences), and 23 *paratypes* (15 males, 8 females), from 6 km S Santa Elena, 1100m, Puntarenas prov., Costa Rica, June 5–7, 1980, on flowers of *Croton* (E. Giesbert). 36 additional *paratypes*, all from the same locality, as follows: 9 males, June 2, 1979 (H. & A. Howden); 8 males, 7 females, June 4–7, 1980 (J. E. Wappes); 7 males, 1 female, June 6–7, 1983 (E. Giesbert); 2 males, June 6–7, 1983 (J. E. Wappes); 2 males, May 18, 1984 (F. T. Hovore).

Remarks.—This apparently isolated and genetically stable population is characterized by the large orange triangular humeral patches of the elytra, and by a slightly larger average size than *Pachymerola r. ruficollis*.

ACKNOWLEDGMENTS

I wish to thank John A. Chemsak of The University of California, Berkeley, for the loan of material and review of the manuscript, Frank T. Hovore and James E. Wappes for specimen data, and R. D. Pope of the British Museum (Nat. Hist.) for allowing me to examine and photograph the type. I would also like to thank Dr. Henry Howden for generous collecting information on the Costa Rican locality.

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New Host Records of Bruchidae (Coleoptera) From *Desmanthus* (Leguminosae) From Texas and Mexico

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Abstract.—Nine species and two varieties of *Desmanthus* are reported as hosts from new localities in Texas and Mexico for four species of Bruchidae. New records reported include *Acanthoscelides compressicornis* feeding in the seeds of *Desmanthus painteri*, *D. pringlei*, and *D. virgatus* var. *glandulosus*; *A. pectoralis* in the seeds of *D. reticulatus*; and *A. desmanthi* in the seeds of *D. subulatus*. Other species of *Desmanthus* reported as hosts for bruchids are *D. covillei*, *D. obtusus*, *D. velutinus*, *D. virgatus* var. *depressus*, *D. virgatus* var. *virgatus*, and *D. fruticosus*.

The bruchids *Stator pruininus* and several species in the genus *Acanthoscelides* have been reported to feed in the seeds of species of *Desmanthus* from the United States to Central America (Bottimer, 1969; Center and Johnson, 1974, 1976; Johnson, 1970, 1977, 1983, 1984; Johnson and Kingsolver, 1976). It also has been observed by CDJ that bruchids feed in the seeds of *Desmanthus* in northern South America.

Recently a number of new host records from new localities in Texas and Mexico were obtained by ML in the course of her work on the systematics of *Desmanthus*. Because of ongoing research on bruchids and their hosts, these records are published here to make them available for studies on bruchid-host interactions. New records found and reported upon here include *Acanthoscelides compressicornis* feeding in the seeds of *Desmanthus painteri*, *D. pringlei*, and *D. virgatus* var. *glandulosus*; *A. pectoralis* in the seeds of *D. reticulatus*; and *A. desmanthi* in the seeds of *D. subulatus*.

Desmanthus virgatus var. *glandulosus* Turner is believed to be a distinct and separate species more closely related to *D. velutinus* and *D. cooleyi* than *D. virgatus* by ML so we are listing it here under its currently accepted name pending further study.

ACKNOWLEDGMENTS

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NEW HOST RECORDS

Acanthoscelides compressicornis (Schaeffer)

1. *Desmanthus covillei* (Britton & Rose) Wiggins ex Turner: Mexico. Sonora: Mpio Cd. Obregon: 3 mi NW Santini on Hwy 15, 26 August 1985 (ML 2806).

2. *Desmanthus obtusus* S. Wats.: Texas. Upton Co.: 2 mi W Rankin on Hwy 67, 5 August 1985 (ML 2737). Reagan Co.: 9 mi W Big Lake on Hwy 67, 5 August 1985 (ML 2738).

3. *Desmanthus painteri* (Britton & Rose) Standley: Mexico. Coahuila: Mpio Arteaga: 8.1 mi SE turnoff to San Antonio de Las Alazana on Rte 57, 2 July 1985 (ML 2641).

4. *Desmanthus pringlei* (Britton & Rose) Hermann: Mexico. Nuevo Leon: Mpio Allende: 1.7 mi N of Allende on Hwy 85, 2 July 1985 (ML 2640).

5. *Desmanthus velutinus* Scheele: Texas. Reeves Co.: 10.6 mi W jctn Hwy 290 on Hwy 10, 21 August 1985 (ML 2750). Travis Co.: Big Sandy Creek Park outside of Austin, 31 July 1985 (ML 2709). Val Verde Co.: Pecos River near intersection with Hwy 10, 2 August 1985 (ML 2721).

6. *Desmanthus virgatus* var. *depressus* (H. & B.) Turner: Texas. Uvalde Co.: Sabinal Cemetery, 1 mi E Sabinal on Hwy 90, 2 August 1985 (ML 2713).

7. *Desmanthus virgatus* var. *glandulosus* Turner: Texas. Brewster Co.: Iron Mt. Ranch, plateau just below Gilliland Peak near the main ranch house, 3 August 1985 (ML 2729).

Acanthoscelides pectoralis (Horn)

1. *Desmanthus reticulatus* Benth.: Texas. Uvalde Co.: Sabinal Cemetery, 1 mi E Sabinal on Hwy 90, 2 August 1985 (ML 2712).

Acanthoscelides desmanthi Johnson

1. *Desmanthus subulatus* (Britton & Rose) Wiggins ex Turner: Mexico. Sinaloa: Mpio Mazatlan: Hwy 15, 3.8 mi NW of Rio San Lorenzo, 8 January 1986 (ML 2980).

2. *Desmanthus virgatus* (L.) Willd. var. *virgatus*: Mexico. Guerrero: Mpio Tecpan: 12 mi W of bridge at San Luis on Hwy 200, 13 March 1985 (ML 2615).

Stator pruininus (Horn)

1. *Desmanthus fruticosus* Rose: Mexico. Baja Sur: Mpio Todos Santos: 2.4 mi S of Todos Santos on Hwy 19, 30 August 1985 (ML 2823).

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**Sex-influenced Protibial Spines
And Synonymy in Dasytidae (Coleoptera),
Study Number Three**

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Abstract.—Protibial spines are sex-influenced in many populations of *Emmenotarsus* and *Trichochrous*. In the extreme case, they are found to be sex-limited to females in *Listropsis*, an emmenotarsus-like genus. This led to the discovery that *Listropsis* and *Trichochroides* are synonymous, and *Trichochroides* must be suppressed on basis of priority.

Considerable confusion exists in the systematics of Dasytidae. Synonymy of some species was noted by Fall (1901) and more can be expected since many species were based by Casey (1895) on only one specimen. What effect the synonymy may have on the total number of species is uncertain, for new collections continue to reveal populations so different from those described as to require the addition of new specific names (e.g. Howell, 1979).

Adding to the confusion, some populations contain a tremendous variety of morphs, species, and even genera. Howell (1985) reports finding seven genera of Dasytidae in the flowers of one bush of *Ceanothus*; and nine morphs of one genus, *Eschatocrepis*, in a small local area. The present study describes a situation in which males and females of the same species can be keyed to different genera.

This came about by using the characteristic “protibiae beset with spines” in current keys (Casey, 1895; Blaisdell, 1938) to separate two fairly large divisions of Dasytidae. Among the genera with spines is *Trichochrous*, the largest dasytid genus according to Casey. Among those lacking them is *Amecocerus* (*Listrus*, in Blaisdell, 1921), which is the second largest.

Blaisdell (1938) subdivided *Trichochrous* into several genera, among which *Emmenotarsus* was set apart for its bristling fringes and shaggy appearance. At the same time he selected *Trichochrous sexualis* Casey, also emmenotarsus-like, as the type of the genus *Trichochroides* which is defined by a male-limited feature, a striking impression on the fifth abdominal sternite. Earlier, Blaisdell (1924a, 1924b) described species of *Listropsis*, based on males lacking protibial spines. This latter feature led him to underestimate the obvious emmenotarsus-like appearance of *Listropsis* based on males lacking protibial spines. This latter feature led him to underestimate the obvious emmenotarsus-like appearance of *Listropsis* and to place it among listrus-like genera.

A study of the number of spines on protibiae led me to discover that in many species of *Trichochrous* and *Emmenotarsus* the number of spines on the protibiae is sex-influenced, females having significantly more than males. The number may vary

from zero to over a dozen, so that specimens at the extremes, at least, would end up in widely different genera if keyed individually.

This challenged me to devise a key avoiding a major reliance on protibial spines. Such a key is in use in our laboratory and appears to be as reliable as Blaisdell's (1938) key. It brings *Trichochrous* and *Amecocerus* close to each other, which is concordant with their gross similarity. It also brings *Listropsis* close to *Emmenotarsus*, which resemble each other.

The significance of this latter relation was long undetected, for my early collections of these two genera consisted of small collections composed wholly or largely of one sex. Later, obtaining a larger bisexual collection, I sexed it and discovered that all the males keyed into *Listropsis* and all the females into *Emmenotarsus*. This collection was made above the 5000 foot elevation on Mt. Pisgah, near Yucaipa, San Bernardino County, CA. On reviewing all my collections from this same area, I found a total of 109 *Emmenotarsus*-like specimens in seventeen separate collections made between 1969 and 1981.

A disproportionate sex ratio was found in these 109 specimens with 80 males and only 29 females. The feature, "protibiae beset with spines" was sex-limited to females, which had an average of 6.1 spines per protibia, as compared with 0.3 in males. All the males had the fifth sternite impressed. Therefore, I concluded that the specimens represented a population of *Trichochroides* according to Blaisdell, and that *Listropsis* and *Trichochroides* are synonyms.

This conclusion was further substantiated on examination of specimens available to me, which Blaisdell had labelled *Trichochroides*. In all examples in which males were present, they keyed to *Listropsis*, and the females to *Emmenotarsus*. On reviewing Blaisdell's descriptions of *Trichochroides* (1941) I found that he never once made a reference to protibial spines, and thus missed the relationship of these two genera.

These observations all support the conclusion that *Listropsis* and *Trichochroides* are synonyms. By rules of priority *Trichochroides* must be suppressed and be replaced by *Listropsis*.

The Mt. Pisgah collection is believed to be *Listropsis virilis* (Blaisdell, 1941), formerly *Trichochroides*.

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A New species of *Actaletes* from México (Collembola: Actaletidae)

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Abstract.—*Actaletes nemyops* new species is described from Sonora, México. Males possess differentiated setae on the third and fourth antennal segments but lack the metatibiotarsal spur present in other New World species.

Thanks to the kindness of Drs. Kenneth Christiansen and Peter F. Bellinger I was able to study several specimens of *Actaletes* from México which represent the new species described below. Only four species of *Actaletes* have been described so far, one from Europe (France) and three from America (Jamaica, Venezuela and México). All species are strictly littoral and rarely seen or collected.

The species name, *nemyops*, refers to the absence of a metatibiotarsal spur in the male.

Actaletes nemyops NEW SPECIES

Habitus typical of genus. Length to 1.24mm (\bar{x} for females 1.03mm; only male 0.83). Head, body and appendages pale brown. Proportions of antennal segments 1–4 as 10:27:22:20. Apex of fourth antennal segment (Ant. 4) with a pin seta on a papilla (Fig. 3), 3 apically curved setae, 5–6 stout setae and several blunt sensillae—one being much larger than the others (Figs. 13–14). Ant. 4 of male with a large seta expanded as a lamella (Fig. 12). Ant. 3 sense organ of 2 mushroomlike setae on a shallow depression (Fig. 1); a sensillar triangle is opposed to this organ (Fig. 2). Medial region of Ant. 3 with a prominent spinelike seta (Fig. 5). Apex of Ant. 2 with a short blunt spine similar to that on *A. venezuelensis*. Eyes 8 + 8; 6–8 hairs within eye patch (Fig. 4). Postantennal organ 1.1× wider than the lower innermost eye (Fig. 9). Right mandible with 6 teeth (Fig. 18), left mandible with 4 teeth (Fig. 17). Terminal seta of outer maxillary lobe somewhat smaller than basal seta. Labial triangle with 4 setae; 10–11 setae in an irregular row almost perpendicular to the cephalic groove (Fig. 16). Male without profemoral or protibiotarsal spinelike setae; metatibiotarsal spur absent (Fig. 10). Tenent hair lamellar. Ungues with a small tunica (Fig. 6). One small tooth on unguis II, without teeth on unguis I and III. Inner margin of unguiculi I and II concave (Figs. 6–7), inner margin of unguiculus III convex (Fig. 8). Fourth abdominal segment dorsally 2× longer than segments 1–3 combined; with 4 pairs of bothriotricha (Fig. 15). Tergal sutures almost reaching bothriotrix II. Colophore with 3 + 3 setae. Tenaculum with 5 setae, upper pair smaller than the others. Ratio length dens: mucro 70:10 in female and 54:10 in male. Distribution of dental spines as in Figure 19. Inner margin of dens with 4–5 long setae. Mucro tridentate (Fig. 20), basal and subapical teeth close together but not facing each other. Mucronal seta present. Male genital plate with 2 differentiated setae (Fig. 11). Female genital plate without such setae.



Figs. 1–11. *Actaletes nemyops* new species. 1. Ant. 3 sense organ. 2. Ant. 3 apical triangle of blunt setae. 3. Apex of Ant. 4. 4. Left eye patch. 5. Ant. 3, ventral view. 6. Mesothoracic claw. 7. Prothoracic unguiculus. 8. Metathoracic unguiculus. 9. Lower innermost eye and postantennal organ. 10. Dorsal view of metatibiotarsus. 11. Differentiated seta of male genital plate.



Figs. 12–20. *Actaletes nemyops* new species. 12. Modified setae on mid-ventral region of Ant. 4. 13. Normal blunt seta of Ant. 4. 14. Large blunt seta of Ant. 4. 15. Tergum of fourth antennal segment showing bothriotrichal pattern and tergal suture. 16. Cephalic groove and seta behind labial triangle. 17. Apex of left mandible. 18. Apex of right mandible. 19. Arrangement of dental spines, thickest circles represent spines seen directly from above, other circles represent smooth setae. 20. Mucro and insertion of mucronal seta.

Diagnosis.—*Actaletes nemyops* new species can be distinguished from *A. venezuelensis* Najt y Rapoport 1972 (Venezuela) by the color of the body, antennal chaetotaxy, absence of teeth on unguis I, form of third unguiculus and by the distance between the basal and subapical mucronal teeth. *Actaletes nemyops* is easily separated from *A. calcarius* Bellinger 1962 (Jamaica) and *A. boneti* Parisi 1972 (México) because males of the latter species possess a conspicuous metatibiotarsal spur. *Actaletes neptuni* Giard 1889 (France) can be distinguished from *A. nemyops* by the labial chaetotaxy, form of the third unguiculus, relative position of basal and subapical mucronal teeth and by the presence of sexual dimorphism in *A. nemyops*.

Material examined.—México, Sonora, on surface of tide pool, 20.II.1974. V. Roth and W. Brown. Holotype male and 4 paratypes on slides, one paratype in alcohol. The specimen in alcohol remains in my collection, the holotype and paratypes are deposited in the Museum of Comparative Zoology, Cambridge, Massachusetts.

ACKNOWLEDGMENTS

I wish to thank Dr. José A. Mari Mutt for his guidance and critical review of the manuscript.

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**New Species of *Cleptes* Latreille from Asia and North America
(Chrysididae, Hymenoptera)**

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Abstract.—Three new species of *Cleptes* are described, *asiana* and *townesi* from Taiwan, and *canadensis* from western Canada.

While examining miscellaneous unidentified Chrysididae from the American Entomological Institute (GAINESVILLE) and Canadian National Collection (OTTAWA), 3 new species of *Cleptes* Latreille became apparent. Two of these are from Taiwan and the third is from western Canada.

The following abbreviations are used: F–I etc. = flagellomere I and so on, MOD = midocellus diameter, PD = puncture diameter.

***Cleptes asianus* Kimsey, NEW SPECIES**

Holotype female.—Body length 5 mm. Face (Fig. 4) punctures small and 1–3 PD apart; least interocular distance as long as head length from midocellus to antennal socket; malar space 1.5 MOD long, clypeal truncation 2 MOD wide at apex; ocellocular distance about three-fourths ocelloccipital distance; F–I length 2.1 times breadth; F–II 1.1 times as long as broad; pronotum (Fig. 3) somewhat flattened in profile with row of deep pits across posterior margin, with medial pair largest, punctures small and 2–3 PD apart; scutal punctures sparser than on pronotum; mesopleuron (Fig. 7) with deeply impressed somewhat foveate scrobal sulcus forming a loop with oblique mesopleural carina, mesopleural punctures tiny and 3–5 or more PD apart; propodeum coarsely punctate, lateral angles obtuse; forewing radial cell about 2.5 times as long as wide. Head, thorax, abdomen, scape, pedicel, femora and tibiae purple; flagellum and tarsi dark brown to blackish; wings evenly brown-tinted.

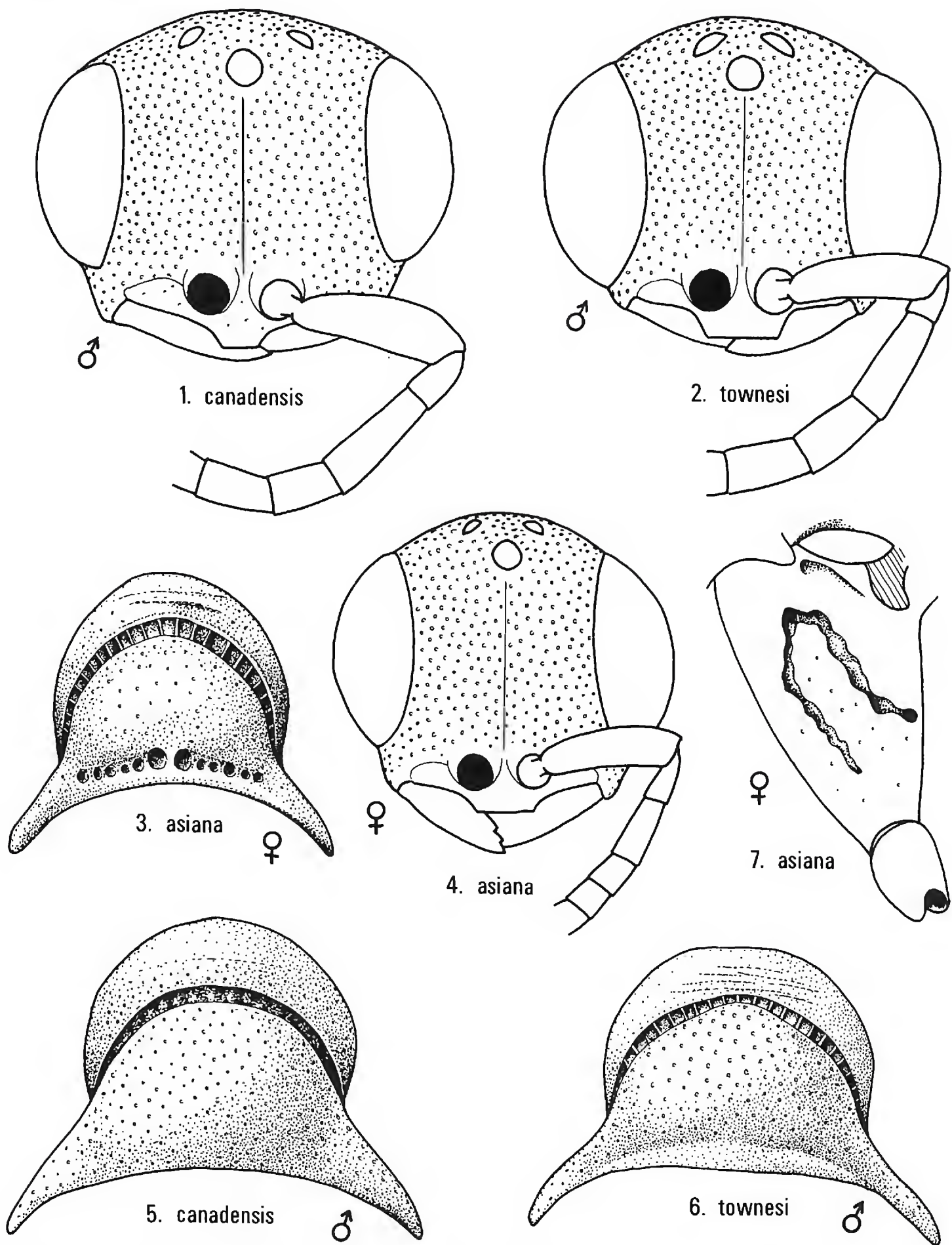
Male.—Unknown.

Holotype female.—TAIWAN: Wushe, 1150 m, 15 May 1983 (H. Townes, GAINESVILLE).

Discussion.—Based on Tsuneki (1959) *asiana* most closely resembles *seoulensis* Tsuneki and *fudzi* Tsuneki, based on the mesopleuron having a long foveate scrobal sulcus connected to a foveate oblique mesopleural carina and the entirely purple body. However, *asiana* differs from these species in the following characteristics: genae only slightly converging, mandibles reddish, clypeal truncation not trilobate, anterior two-thirds of pronotum parallel-sided and the entire body including femora and tibiae purple without other tints or highlights.

***Cleptes canadensis* Kimsey, NEW SPECIES**

Holotype male.—Body length 6 mm. Face (Fig. 1) with deep medial sulcus extending from midocellus to clypeal margin; punctures 1 PD apart; least interocular



Figures 1,2,4. Front view of face. 3,5,6. Dorsal view of pronotum. 7. Mesopleuron and midcoxa showing scrobal sulcus (ss).

distance 1.3 times head length from midocellus to antennal socket; malar space and clypeal truncation at apex 1.3 MOD long and wide; ocellocular distance equal to ocelloccipital distance; F-I 2.8 times as long as broad, F-II length 1.7 times breadth; pronotum (Fig. 5) evenly rounded with medial groove or posterior groove or pits, punctures 1-3 PD apart; scutal punctures 4-6 PD apart; mesopleuron smooth with

deep scrobe, punctures slightly striatiform, about 1 PD apart; propodeum coarsely and irregularly reticulate, lateral tooth acute but apically blunt. Head, thorax, scape and femora coppery with strong green highlights becoming darker and bluish on propodeum, with erect blonde setae; wings evenly and lightly brown stained; rest of antennae dark brown; tibiae, tarsi and abdominal segments I–II red; abdominal segment III red basally and black apically; segments IV and V black.

Female.—Same as male, except legs entirely red, with forefemur coppery; F–I 1.8 times as long as broad; F–II 0.8 times as long as broad, and scape, pedicel and F–I–III red, F–IV to apex dark brown.

Holotype male.—CANADA: Saskatchewan, 28 June 1950, reared from the tenthredinid *Pikonema alaskensis* (Rohwer) (Dalton, OTTAWA). Paratypes: CANADA: British Columbia, Ft. Nelson, 14 June 1948, W. R. M. Mason (1 male); Northwest Territory, Norman Wells, 12 July 1949, W. R. M. Mason (1 male and 1 female).

Discussion.—This species is closest to the palearctic species *nitidula*, based on the lack of a posterior or medial groove on the pronotum, the reddish basal abdominal segments and the smooth mesopleuron. Aside from these characteristics *canadensis* can be distinguished by the coppery green color of the head and thorax in both sexes, the male F–I nearly 3 times as long as broad, female F–I twice as long as wide; and propodeal dorsal surface finely reticulate.

Cleptes townesi Kimsey, NEW SPECIES

Holotype male.—Body length 5.5 mm. Face (Fig. 2) punctures shallow 0.3–0.5 PD apart; least interocular distance 1.1 times head length from midocellus to antennal socket; malar space 0.8 MOD, clypeal truncation 2 MOD wide at apex; ocellocular distance subequal to ocelloccipital distance; F–I length 2.4 times breadth; F–II 1.8 times as long as broad; pronotum (Fig. 6) flattened in profile, with posterior subapical transverse groove, punctures 1–2 PD apart; scutal punctures 3–5 PD apart; mesopleuron smooth with small scrobal pit and punctures 0.5–1.0 PD apart; propodeum sparsely reticulate with large blunt lateral angles; propodeum laterally and metapleuron smooth and impunctate; T–V medially emarginate. Face with blue tints; rest of head, thorax, abdomen, antenna and femora dark brown; body covered with erect blonde setae; wings lightly and evenly brown-tinted.

Female.—Unknown.

Holotype male.—TAIWAN: Wushe, 1150 m, 15 May 1985, H. Townes (GAINESVILLE). Paratypes: 1 male, same data as type, 10 May 1983; 3 males TAIWAN: Wu-feng, 10 April 1983, C. Townes.

Discussion.—The most distinctive feature of *townesi* is the non-metallic black body. This species most closely resembles *crassiceps* Tsuneki and *thaiensis* Tsuneki, based on the posterior pronotal groove and dark coloration. *C. townesi* can be distinguished from these and other species of *Cleptes* by the simple mesopleuron, metallic coloration restricted to the face, the pronotum without a medial groove and the ocellocular distance subequal to the ocelloccipital distance.

ACKNOWLEDGMENTS

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**Observations on Insects Associated with a
Nectar-bearing Chilean Tree,
Quillaja saponaria Molina (Rosaceae)**

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Abstract.—Several species of entomophagous insects were observed feeding on floral nectar of a specimen of soapbark tree, *Quillaja saponaria* Molina (Rosaceae), a landscape plant introduced into northern California from Chile. Entomophaga observed in relatively large numbers included a green lacewing (*Chrysoperla carnea* (Stephens)), convergent ladybeetle (*Hippodamia convergens* Guerin-Meneville), and a brown lacewing (*Hemerobius* sp. (prob. *ovalis* Carpenter)), as well as various unidentified parasitic Hymenoptera. Contingency table analyses of weekly vacuum samples indicated that members of each taxon were significantly more abundant during, as opposed to after, flowering. Samples taken at different times of day indicated that the brown lacewing was mainly a nocturnal visitor, whereas the green lacewing was present at similar densities at all hours tested. These findings suggest that the soapbark tree should be included in experimental schemes for enhancing biological control of agricultural pests.

The use of nectar-bearing trees and shrubs in windbreaks and hedgerows has been suggested as a means of enhancing biological control (Solomon, 1980; Altieri and Letourneau, 1983). The present study concerns attendance by various entomophagous insects at the flowers of soapbark tree, *Quillaja saponaria* Molina (Rosaceae), a landscape tree introduced into northern California from Chile. These initial observations serve as a first step in assessing the possible value of this tree in enhancing biological control of agricultural pests.

In its native Chile, the soapbark tree is said to be responsible for the production of abundant and exquisite honey (Muñoz Pizarro, 1973). In Davis, CA, the plant flowered from early June through early July, and it appeared to be andromonoecious, featuring hermaphroditic flowers early in the blossoming period, and exclusively male flowers thereafter. The flowers exuded a shiny, sticky nectar that was fed upon by a diverse assemblage of insects. The vast majority of flower visitors observed were feeding upon nectar rather than pollen. A sampling program was set up to investigate insect attendance at the tree, with special emphasis on potential biological control agents.

MATERIALS AND METHODS

All data were recorded from one specimen of *Q. saponaria*, approximately 12 m in height and 4 m in basal diameter, growing at the Environmental Horticulture Department grounds, University of California, Davis. Specimens were also present

Table 1. Counts for weekly vacuum samples from *Quillaja saponaria*.

| Taxon | Quadrant | No. Collected/Subsample/Date | | | | |
|---|----------|------------------------------|------|------|---------------|-----|
| | | In Flower | | | Out of Flower | |
| | | 6/4 | 6/11 | 6/18 | 6/25 | 7/2 |
| <i>Hippodamia convergens</i> | West | 3 | 14 | 18 | 2 | 2 |
| | South | 9 | 30 | 33 | 0 | 0 |
| | East | 13 | 35 | 27 | 0 | 0 |
| <i>Chrysoperla carnea</i> | West | 7 | 11 | 7 | 0 | 0 |
| | South | 6 | 15 | 5 | 1 | 1 |
| | East | 14 | 13 | 4 | 0 | 1 |
| <i>Hemerobius</i> sp. (prob. <i>ovalis</i>) | West | 0 | 0 | 0 | 0 | 0 |
| | South | 1 | 0 | 0 | 0 | 1 |
| | East | 2 | 2 | 0 | 1 | 0 |
| Parasitic Hymenoptera | West | 8 | 5 | 5 | 2 | 2 |
| | South | 7 | 4 | 22 | 11 | 3 |
| | East | 5 | 19 | 19 | 3 | 9 |

at the Berkeley and Santa Cruz campuses of University of California, but none of these trees, to my knowledge, flowered appreciably during the year of this study.

In the immediate vicinity of the experimental site were various trees and shrubs suitable for landscaping in Mediterranean climates; within ca. 2 km were fields of hay alfalfa and winter wheat. The agricultural fields were likely sources of ladybeetles and lacewings observed in the present study.

Using the U.C. Vac suction device (Summers et al., 1984), insects were sampled on 4, 11, 18, and 25 June, and 2 July, 1982. The first three dates occurred during flowering, whereas the latter two occurred after blossom fall. Samples were taken during the early afternoon hours, 1300–1530 PDT. The insects were vacuumed from the flowers and foliage during three one-minute intervals, each corresponding to one of the three accessible quadrants of the tree (east, south, and west—the north quadrant was obstructed by an adjoining shrub). During each one-minute episode, the tree was sampled from ground level to a height of about 2 m. Vacuum samples were retained in organdy net bags, placed on ice, taken to the laboratory, and frozen. Samples were later sorted, and the arthropods in the different taxa counted.

In addition to the regular weekly samples mentioned above, supplementary samples were taken on 5 June at 1200, 7 June at 1800, 5 June at 2215, 12 June at 1800, and 12 June at 2300 (PDT). Together with samples from one of the regular weekly visits (11 June), these latter data were used to compare the diel patterns of attendance by a green lacewing, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), and a brown lacewing, *Hemerobius* sp. (prob. *ovalis* Carpenter) (Neuroptera: Hemerobiidae).

Visitation by nectarivorous insects was assessed both qualitatively and quantitatively. A species list was compiled based on the vacuum samples and observation or collection of flower visitors by insect net. The regular weekly vacuum data were analyzed using separate chi-square analyses for 1×2 contingency tables constructed for each of the three taxa, *C. carnea*, convergent ladybeetle (*Hippodamia convergens* Guerin-Meneville; Coleoptera: Coccinellidae), and

parasitic Hymenoptera (all species pooled). As *Hemerobius* were seldom encountered in the regular weekly samples, which were all taken during early afternoon hours, that predator was excluded from these analyses. Comparisons were made for numbers obtained during flowering vs. those obtained after blossom fall. Expected values were generated based on the 3 to 2 ratio of sample dates during vs. after flowering, and the assumption that under the null hypothesis the observed numbers of insects should follow the same ratio. A significant deviation in favor of higher attendance during flowering would be taken to indicate that these entomophaga were attracted to flowers, and not to some unrelated feature of the tree.

In order to determine whether the green and brown lacewings exhibited significantly different diel patterns of attendance, the relevant data were subjected to contingency table analyses via the BMPD-4F program (Dixon, 1983). These data were arrayed in a three-dimensional contingency table employing species, date, and time of day (early afternoon, late afternoon, and late evening) as the variables, and all possible loglinear models were reviewed (see Fienberg, 1977). In the event that a time X species interaction term were required to explain the data, the green and brown lacewings could be said to differ significantly in their diel patterns of attendance.

RESULTS

Several species of insects were found foraging for nectar on the soapbark tree. These included convergent ladybeetle and the green and brown lacewings mentioned. Among the parasitic Hymenoptera, unidentified Diapriidae and Chalcidoidea were most frequently observed. The former were subject to vacuum sampling, whereas the latter tended to pass through the mesh of the net bags. Honeybees, *Apis mellifera* L. (Hymenoptera: Apidae), were commonly collected from soapbark tree flowers. I also observed various aphidophagous hover flies (Diptera: Syrphidae) taking nectar; these included *Scaeva pyrastris* (L.), *Eupeodes volucris* Osten Sacken, and *Metasyrphus* sp. Also, two chloropid flies, probably the aphidophagous *Thaumatomyia glabra* (Meig.) and *T. rubida* (Coquillett), were observed at the flowers, as was Argentine ant, *Iridomyrmex humilis* Mayr (Hymenoptera: Formicidae), and European earwig, *Forficula auricularia* L. (Dermaptera: Forficulidae) (earwigs and ants were encountered principally at night). Minute pirate bug, *Orius tristicolor* (White) (Hemiptera: Anthocoridae) was also commonly found. Neither syrphids nor anthocorids were subject to reliable collection by the vacuum method: the former were too quick to fly, while the latter were so small that many escaped through the organdy mesh of the net bags.

The results for weekly afternoon suction samples are presented in Table 1. The mean counts (\pm S.E.) obtained during flowering were 20.22 ± 3.8 , 9.11 ± 1.39 , and 10.44 ± 2.44 for *H. convergens*, *C. carnea*, and parasitic Hymenoptera, respectively ($n = 9$ for each estimate). The corresponding figures obtained after flowering were 0.67 ± 0.42 , 0.50 ± 0.22 , and 5.00 ± 1.61 ($n = 6$ for each estimate). *Hemerobius* were scant in these diurnal samples that they were not included in these assessments. The contingency table analyses (d.f. = 1 for each test) revealed highly significant differences ($p < 0.01$) for all three taxa assessed (*H. convergens*, chi-square = 111.03; *C. carnea*, chi-square = 47.1; and pooled parasitic

Table 2. Diel attendance patterns for *Chrysoperla carnea* and *Hemerobius* sp. (prob. *ovalis*) on flowering soapbark tree.

| Species | Total no. per vacuum sample/time/date ^a | | | | | |
|---|--|----|----|---------------------|----|----|
| | First week in June | | | Second week in June | | |
| | EA | LA | LE | EA | LA | LE |
| <i>Chrysoperla carnea</i> | 36 | 45 | 20 | 28 | 26 | 44 |
| <i>Hemerobius</i> sp. (prob. <i>ovalis</i>) | 6 | 3 | 26 | 2 | 1 | 30 |

^aEA = early afternoon, LA = late afternoon, LE = late evening.

Hymenoptera, chi-square = 12.908). These results indicate significantly higher numbers during flowering for all three taxa.

The data for lacewing attendance, presented in Table 2, indicate a strong nocturnal tendency for the brown lacewing, whereas the green lacewing was abundant on the plant at all hours assessed. Totals of 64, 71, and 64 were observed for green lacewings for early afternoon, late afternoon, and late evening, respectively. The corresponding totals for brown lacewing were 8, 4, and 56. The chi-square statistics of all possible loglinear models were reviewed, and the most parsimonious model acceptable under the conventional criterion of $p > 0.05$ involved all three main effects plus time \times date and time \times species interaction terms (Likelihood-Ratio Chi-Square = 3.84; d.f. = 3; $p = 0.2790$). The need for the time \times species interaction term indicates that the green and brown lacewings exhibited significantly different temporal patterns of attendance on the flowering tree.

The results do not necessarily indicate that the green lacewing adults were nectar-feeding throughout the day. In fact, the green lacewings were most commonly observed feeding at flowers during the evening hours, so most individuals were probably resting in the tree's foliage during the afternoon and early evening hours. Perhaps the brown lacewing merely rested diurnally in a different stratum than did the green, and so was seldom collected except late at night, when feeding. These questions warrant further investigation.

In summary, the flowering soapbark tree investigated here attracted large numbers of nectar-feeding predators, several of which are known to be important in reducing agricultural pests, and which are known to feed on nectar or honeydew (see Hagen, 1962; New, 1975; Sundby, 1967; Neuenschwander and Hagen, 1980). These results are suggestive, but because of the limited scope of this study, they should be viewed with caution. Given its reputation as a "honey plant," the soapbark tree might be of some value in urban apiculture, quite apart from any role it might play in pest management. The nutritional value of the nectar should also be explored. Finally, the tree should be included in experimental trials of windbreak, hedgerow, and urban landscape vegetation to determine whether it can enhance biological control by the predators that feed so avidly at its blossoms.

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***Cosumnoperla hypocrena*, a new genus and species of western
Nearctic Isoperlinae (Plecoptera: Perlodidae)***

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Abstract. — *Cosumnoperla hypocrena*, a new genus and species of Isoperlinae is described from specimens of male, female, nymph and ova. The major diagnostic characters of this new genus include: 1. male 10th tergum with a broad, elevated, notched triangular process; 2. small bulbous male supra-anal process; 3. male vesicle absent; 4. male paraprocts reduced, flat and lightly sclerotized; 5. female subgenital plate large with a deep posteromedian notch; 6. ova oblong, collar and eclosion line absent; 7. nymphal mandibles with 6 teeth and lacinia bidentate; 8. adult and nymphal mesosternal Y-ridge attached to posterior ends of furcal pits, transverse ridge connecting anterior ends of furcal pits, and 9. gills absent. Based on these characters this genus is thought to be most closely related to *Calliperla* Banks. Isoperlinae now includes the endemic Nearctic genera *Calliperla*, *Cascadoperla* Szczytko and Stewart, *Clioperla* Needham and Claassen, and *Cosumnoperla*, the Holarctic genus *Isoperla* Banks, and the Palearctic genera *Kaszabia* Rauser and *Mesoperlina* Klapalek.

Isoperlinae is a small group of 6, mostly monotypic genera including Palearctic-Oriental endemics (*Mesoperlina* Klapalek and *Kaszabia* Rauser), Nearctic endemics (*Calliperla* Banks, *Cascadoperla* Szczytko and Stewart, and *Clioperla* Needham and Claassen), and the large Holarctic genus *Isoperla* Banks. *Rickera* Jewett and *Bulgaroperla* Rauser have recently been placed in Perlodinae (Szczytko and Stewart, 1984; Stark and Szczytko, 1984).

In the Nearctic and Palearctic Regions *Isoperla* contains the greatest diversity of Isoperlinae species with ca. 95% of the Nearctic and 91% of the Palearctic species. The number of *Isoperla* species in North America is divided into western and eastern faunal segments generally delineated by the eastern edge of the Rocky Mountains and the Great Plains. The eastern faunal segment is the most diverse with ca. 67% of the North American Isoperlinae species. The western genera *Calliperla* and *Cascadoperla* have fairly restricted distributions along the coastal range while the eastern *Clioperla* is widely distributed (Szczytko and Stewart, 1984).

Recently while R. L. Bottorff was studying the ecology of stoneflies in the Cosumnes River, El Dorado County California, a series of Isoperlinae were discovered which did not key to any known genus. Detailed study of the adults indicated that these specimens represented a new genus and species. This discovery parallels other recent finds of rare and unique stoneflies in similar habitats (eg. *Viehopera* Stark and Stewart, 1982a; *Oconoperla* Stark and Stewart, 1982b).

MATERIALS AND METHODS

Illustrations of adult and nymphal structures were drawn using a Wild M8 stereo dissecting microscope equipped with lightfield-darkfield base and camera lucida. Nymphal mouthparts were drawn from scanning electron micrographs made using an ISI Super III SEM.

Male and female terminalia were treated for study according to the methods described by Szczytko and Stewart (1981). Aedeagal armature was studied using the method of Szczytko and Stewart (1984).

Ova dissected from preserved gravid females were prepared for SEM study as described by Szczytko and Stewart (1979). Scanning electron micrographs of ova were made with an ISI Super III SEM.

Terminology used to describe antennal and cercal sensory structures follows Kapoor (1985); egg terminology follows Stark and Szczytko (unpub.)

RESULTS AND DISCUSSION

Cosumnoperla, NEW GENUS

Type species.—*Cosumnoperla hypocrena* Szczytko and Bottorff Generic Characters: Adult and nymphal mesosternal Y-ridge arms meet posterior corners of furcal pits; transverse band connects anterior corners of furcal pits (Fig. 7). Gills absent.

Male.—Tenth tergum entire with broad, elevated notched triangular process (Fig. 3). Supra-anal process small, bulbous and lightly sclerotized (Fig. 3). Paraprocts reduced and lightly sclerotized (Figs. 3, 5). Vesicle absent. Aedeagus membranous (Fig. 2).

Female.—Subgenital plate large with deep posteromedian notch (Fig. 4).

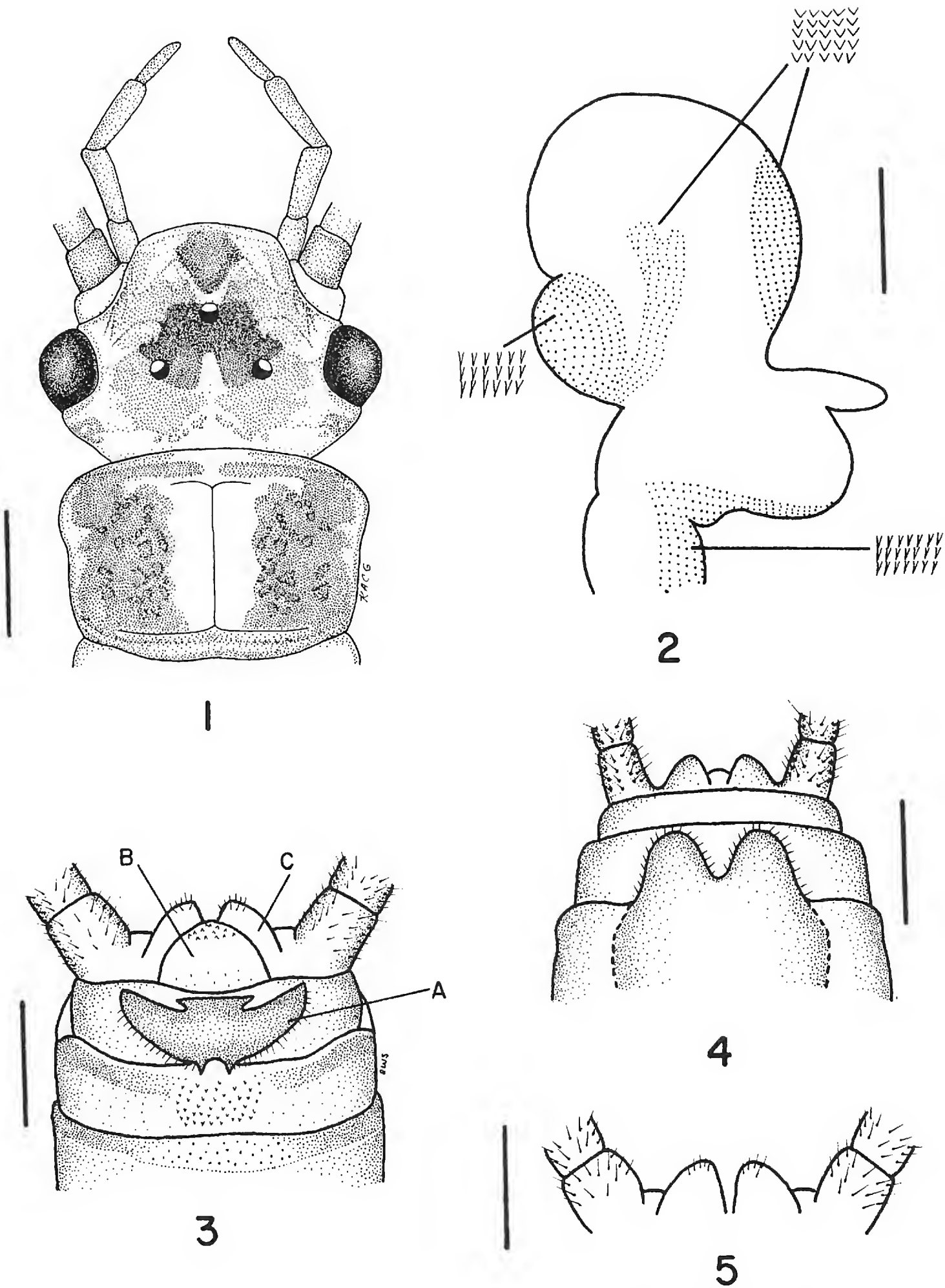
Ova.—Outline oblong, cross-section circular. Collar absent (Fig. 20).

Nymph.—Lacinia bidentate (Figs. 13, 14). Mandibles with 6 teeth, not deeply incised (Figs. 8, 9, 16, 18). Abdominal terga with 3 longitudinal dark stripes and 2 median and 6 lateral longitudinal rows of dots (Fig. 10).

Distribution.—This monotypic genus is known only from the Cosumnes River in the Sierra Nevada Mountains of northern California.

Cosumnoperla hypocrena, NEW SPECIES

Male.—Macropterous. Body length 11–13mm; forewing length 10–11mm. General body color light creamy yellow with dark brown markings on the head and thorax. Dorsum of head with wide dark brown patch connecting lateral and anterior ocelli, light, small inverted U-shaped spot extending midlength of interocellar area; lighter brown patches separated medially, extending from lateral ocelli to occiput, few scattered small spots in light area between light brown patches; light brown patches extending from dark brown ocellar patch to bases of antennae, thin U-shaped, light patch above anterior ocellus with dark brown median patch extending to frons (Fig. 1). Pronotum with median light stripe, disks medium brown, rugosities dark brown (Fig. 1). Meso- and metanota medium brown. Antennal flagella medium brown, pedicle light; surface of flagellar segments covered with long and short sensilla trichodea (Fig. 30) and sensilla companiformia (Fig. 24). Cerci light basally, progressively darker apically, cercal segments covered with long sensilla trichodea and with posterior whorl of short and 4 long posteroventral sensilla trichodea (Fig. 22). Maxillary and labial palpi dark brown. Wings medium smoky

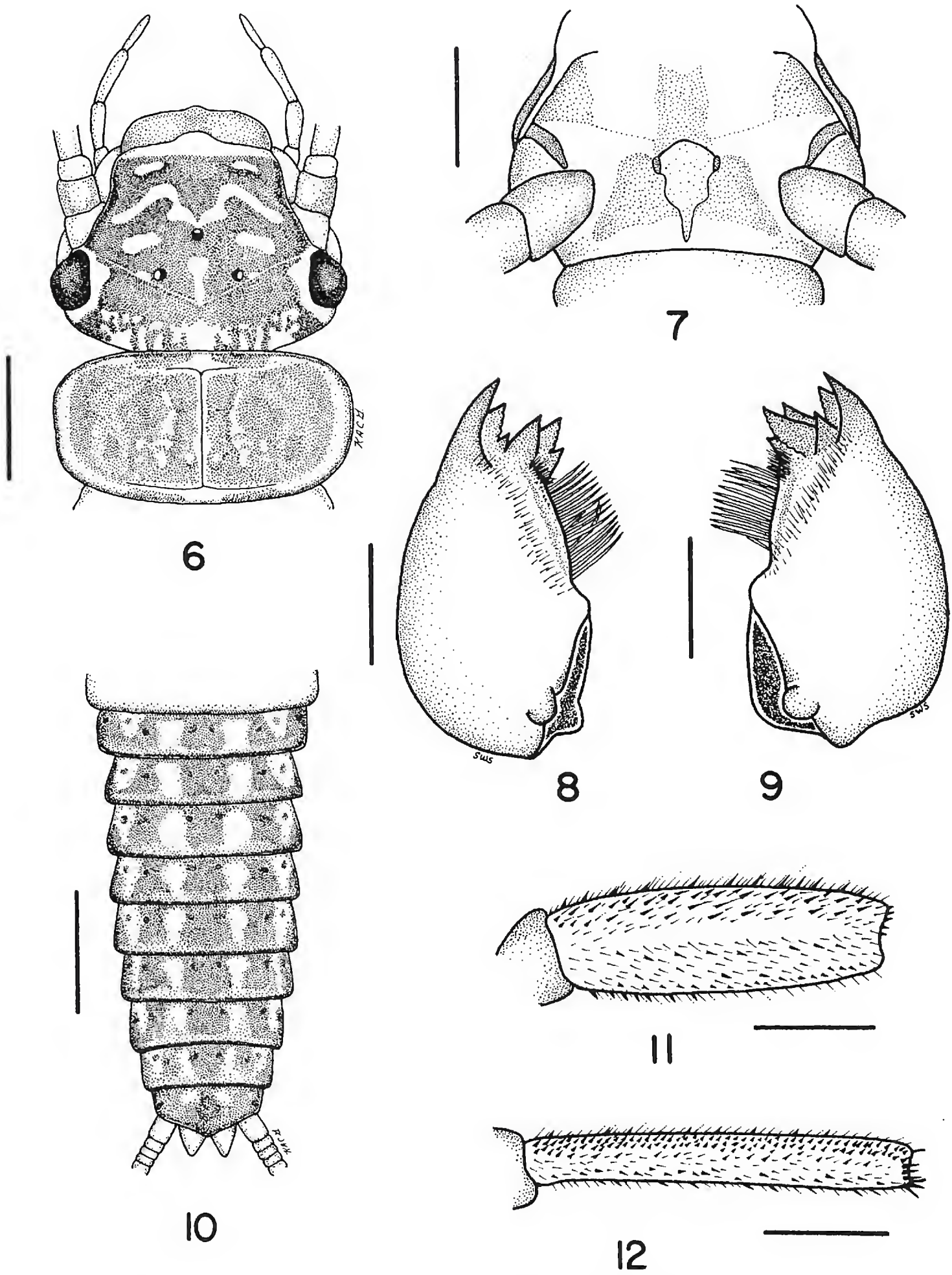


Figures 1–5. *Cosumnoperla hypocrena*. 1. Adult head and pronotum; line = 0.9mm. 2. Male aedeagus, lateral aspect; line = 0.5mm. 3. Male terminalia, dorsal aspect (A.-tenth tergal process, B.-supra-anal process, C.-paraprocts); line = 0.5mm. 4. Female terminalia, ventral aspect; line = 0.8mm. 5. Male paraprocts, dorsal aspect; line = 0.5mm.

brown with dark brown veins. Dorsal surface of femora dark brown, most of tibia and tarsi dark brown. Abdomen creamy yellow. Eighth tergum with posteromedian patch of short stout setae (Fig. 3). Ninth tergum with median patch of stout reddish brown spinulae (Fig. 3). Elevated triangular process of 10th tergum heavily sclerotized, darker than rest of tergum, highest at anterior margin with 2 sharply pointed anterior lobes, margins fringed with long fine setae, base depressed (Fig. 3). Supra-anal process with dark stout apical spinulae, basal area with scattered small, fine, light spinulae (Fig. 3). Paraprocts nearly flat, broadly triangular, positioned below supra-anal process (Figs. 3, 5). Aedeagus with large anteromedian and posteroventral lobes, small finger-like lobe above posteroventral lobe, apical section expanded into large balloon-like tip; posterior patch of small stout, golden brown spinulae above small finger-like lobe, patch of longer stout spinulae below large posteroventral lobe, patch of medium spinulae on large anteromedian lobe which grade into short stout spinulae laterally, patch of lateromedian small stout spinulae posterior to large anteromedian lobe (Fig. 2).

Female.—Macropterous. Body length 11–15mm; forewing length 11–14mm. Body coloration and external morphology similar to male. Subgenital plate broadly truncate extending to near posterior margin of 9th sternum, base extending to midlength of sternum 8 (Fig. 4).

Nymph.—Body length of mature nymph 10–13mm. General body coloration medium brown. Dorsum of head with distinct broad, light M-shaped band anterior to median ocellus; broad median brown patch connecting ocelli extending across head anteriorly to frons with light spots anterior to lateral ocelli and also anterior to light M-shaped band; interocellar area with irregular shaped light spot; irregular reticulate light patches posterior to occiput; frontoclypeus light (Fig. 6); occiput with irregular sinuous row of short spinulae. Dorsum of head and thorax with scattered fine black clothing hairs. Lacinia triangular with 4–5 long axillary setae between apical teeth; shoulder with 7–8 long stout spine-like setae below subapical tooth; row of 5–6 long finer marginal setae below shelf; 5–6 small fine marginal setae scattered to lacinal base; subapical tooth ca. $\frac{3}{4}$ length of apical tooth (Figs. 13, 14); teeth with fine striations (Fig. 17). Mandibles with median ventral row of long setae from base of outer tooth extending to near mandibular base; inner mandibular surface concave with row of long stout marginal setae; dorsal surface with median row of medium length setae from base of inner tooth to base of marginal setal row; brush of short stout, thick setae from base of inner teeth to marginal setal row (left mandible with thicker, longer setal brush) (Figs. 8, 9, 16, 18); inner tooth and subapical tooth with 2 rows of small, shallow crenulations (Fig. 14). Antennae light, distal margin of flagellar segments with thin and thick wall sensilla trichodea and coniform sensilla complexes consisting of 4–6 cuticular spines (Figs. 23, 25); conical poreless coeloconic pegs scattered on flagellar surface (Figs. 27, 29); pedicle surface covered with scattered thick-walled and thin-walled sensilla basiconica and distal margin with complete row of long, stout sensilla basiconica (Fig. 23); first flagellar segment with sparse median row of long sensilla basiconica (Fig. 23). Pronotum with light median stripe and lateral margins; disks light brown; rugosities light; margin completely fringed with short stout setae; occasional longer setae at posterior margins. Meso-metanota medium brown with irregular reticulate light areas. Thoracic and abdominal sterna with numerous chloride cells on integumental membranes (Fig. 28). Femora light brown with continuous row of long, fine dorsal setae and scattered



Figures 6-12. *Cosumnoperla hypocrena*. 6. Nymph head and pronotum; line = 1.0mm. 7. Nymph mesosternum; line = 0.7mm. 8. Nymph right mandible, ventral aspect; line = 0.3mm. 9. Nymph left mandible, ventral aspect; line = 0.3mm. 10. Nymph abdomen, dorsal aspect; line = 1.4mm. 11. Nymph right, hind femora, dorsal aspect; line = 0.7mm. 12. Nymph right, hind tibia, dorsal aspect; line = 0.7mm.

stout setae; dorsal $\frac{1}{3}$ of outer surface with numerous medium length, stout setae and numerous fine black setae (clothing hairs); thin light stripe void of setae below dorsal $\frac{1}{3}$; ventral $\frac{2}{3}$ with sparser medium length, stout setae and numerous fine black clothing hairs; no long ventral fringe; inner surface with few scattered medium length, stout setae (Figs. 11). Tibia with sparse dorsal fringe of long setae; ventral margin with fringe of medium length stout setae; outer surface covered with long black clothing hairs (Fig. 12). Abdominal terga with 2 noncontinuous light median, and 2 lateral longitudinal bands between dark median bands, usually enclosed by thin dark irregular anterior and posterior bands (may vary to some degree between individuals) (Fig. 10). Terga with posterior fringe of medium length stout setae and numerous scattered intercalary spinules (Fig. 19). Cerci light, segments with posterior whorl of short and several scattered long sensilla basiconica; longitudinal grooves at posterior margins (Fig. 26).

Ovum.—Length 0.8–0.9mm; width 0.4–0.5mm (fresh ova with living embryos are 0.6–0.7mm wide). Color light green. Chorion covered with irregular hexagonal follicle cell impressions (FCI's); FCI walls thick, raised; floor flat, irregularly shaped (quadrangular to hexagonal). Micropylar row subequatorial; orifices small without lips, set in floor of FCI's, some associated with FCI rosettes. Eclosion line absent (Figs. 20, 21).

Distribution.—This species is known only from the type locality.

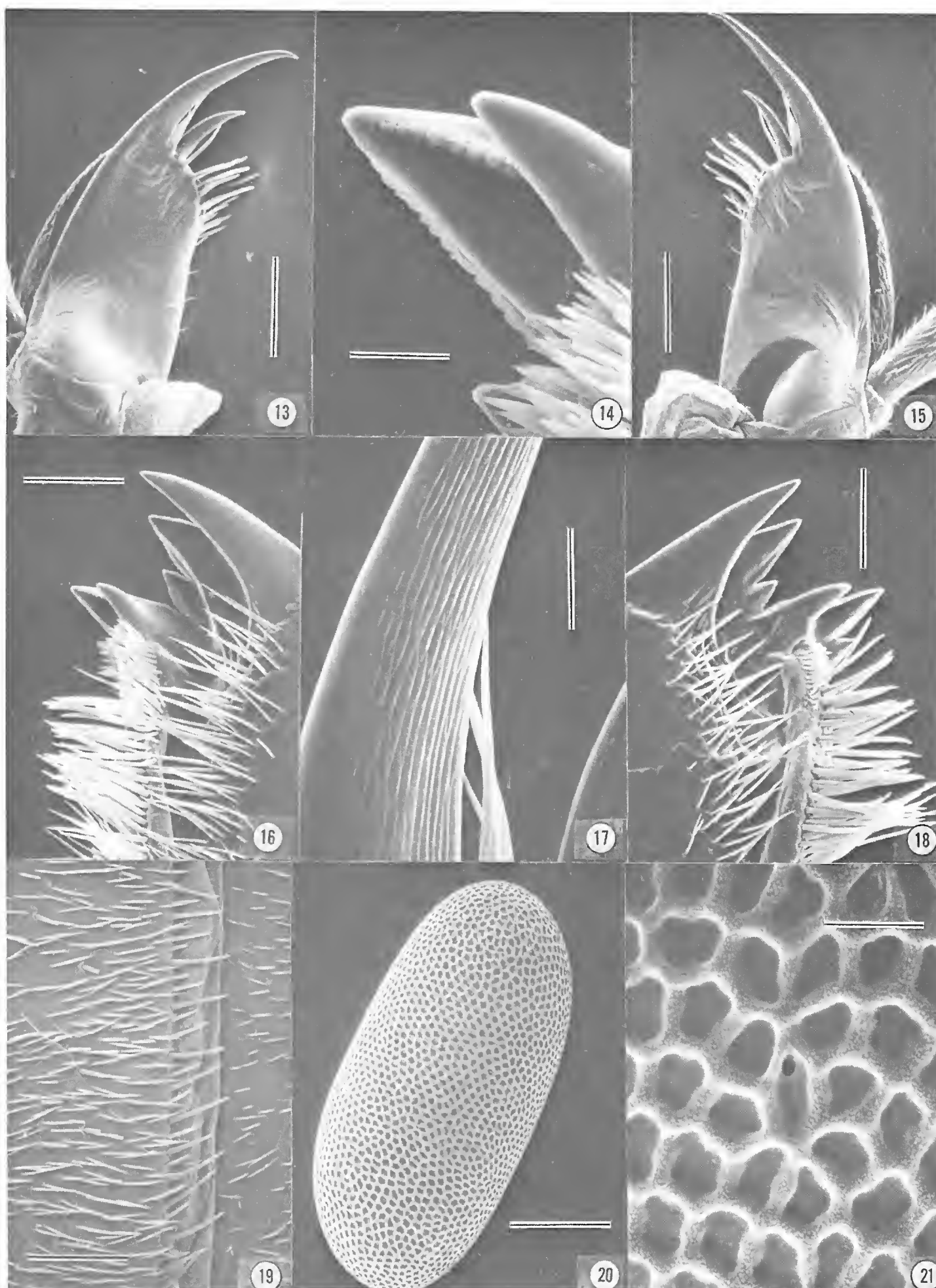
Material Examined.—USA. California. El Dorado Co., 5.8 km E. of Somerset, Unnamed trib., 500m upstream from Sweeneys Crossing Bridge on North Fork Cosumnes River, 28–V–1983, R. L. Bottorff (3 females), 4–VI–1983 (2 females), 24–VI–1983 (1 female), 11–V–1984 (6 nymphs, 3 males, 1 female), 27–V–18–VI–1984 (3 males, 2 females), 22–VI–1984 (1 female), 24–VI–1984 (1 female), 29–V–1985 (1 male, lab-reared), 22–VI–1985 (2 females, lab-reared), 24–VI–1985 (1 male, 7 females lab-reared).

Types.—Holotype male, allotype female and 1 paratype nymph from the above locality deposited in the U.S. National Museum, one male, one female and one nymph paratypes deposited in the Brigham Young University collection. Six male, 18 female and 4 nymph paratypes deposited in the collections of S. W. Szczytko and R. L. Bottorff.

Etymology.—The genus was named in honor of the Cosumnes River and a tribe of Miwok Indians in central California. The species name is derived from the “hypocrenon” (head water tributary stream) of Illies and Botosaneanu's (1963) river classification scheme, as a habitat descriptor of this species.

Biological Notes.—The type locality is shallow spring water flowing over moss covered rocks and is heavily shaded. The stream only flows about 7 months (November–June) each year, then is dry in summer and autumn. Intensive collecting along the main Cosumnes River, its North Fork, and a few smaller tributaries, involving slit traps (Kuusela and Pulkkinen, 1978) and searching methods, as part of a larger ecological study of all Cosumnes River stoneflies, failed to produce any additional specimens of this species. The restricted habitat preference of *C. hypocrena* has, most likely, precluded previous collection by other workers.

Emergence begins the first week in May and extends through late June, or until the stream dries up. Males emerge before females and continue into early June. Females begin emerging in late May.



Figures 13–21. *Cosumnoperla hypocrena*. 13. Nymph right, lacina, ventral aspect; line = 263 microns. 14. Detail of inner left mandibular tooth, ventral aspect; line = 26 microns. 15. Nymph left lacina, ventral aspect; line = 263 microns. 16. Detail of nymph left mandibular teeth, ventral aspect; line = 132 microns. 17. Detail of right, apical lacinial tooth, ventral aspect; line = 4 microns. 18. Detail of nymph right mandibular teeth, ventral aspect; line = 132 microns. 19. Nymph second and third abdominal terga, dorsal aspect; line = 208 microns. 20. Ova; line = 208 microns. 21. Detail of ova chorion and micropyle; line = 25 microns.

This species has the largest egg of any described Isoperlinae species. Most *Isoperla* species have eggs which range from 0.21–0.45 mm-length and 0.13–0.36 mm-width (Jop and Szczytko, 1984; Nelson and Kondratieff, 1983; Szczytko and Stewart, 1976, 1978, 1979 and 1984). The egg of *Clioperla clio* (Newman) is 0.42 mm-length and 0.31 mm-width (Szczytko and Stewart, 1981) and the egg of *Calliperla luctuosa* (Banks) is 0.36 mm-length and 0.28 mm-width (Szczytko and Stewart 1984). The egg is also fairly atypical of most Isoperlinae species in that the collar and eclosion line are absent, although *C. luctuosa* also has an egg with no collar or eclosion line (Szczytko and Stewart, 1984).

Females of this species have the lowest fecundity of any reported Isoperlinae species. Eggs from 9 gravid females with abdomens extended with well developed eggs, were counted and mean fecundity was 39 with a range of 19–58 eggs. Harper (1973) reported mean fecundities of 441 (range–113–788) for *C. clio*, 95 (range–23–190) for *Isoperla transmarina* (Newman), 177 (range–17–392) for *I. cotta* Ricker and 146 (range–18–277) for *I. frisoni* Frison. These data were generated from lab-reared and field-collected specimens and the determined means are most likely low, due to field oviposition. The low fecundity of *C. hypocrena* is probably related to the large size of the egg and the physical restriction of space within the female abdomen.

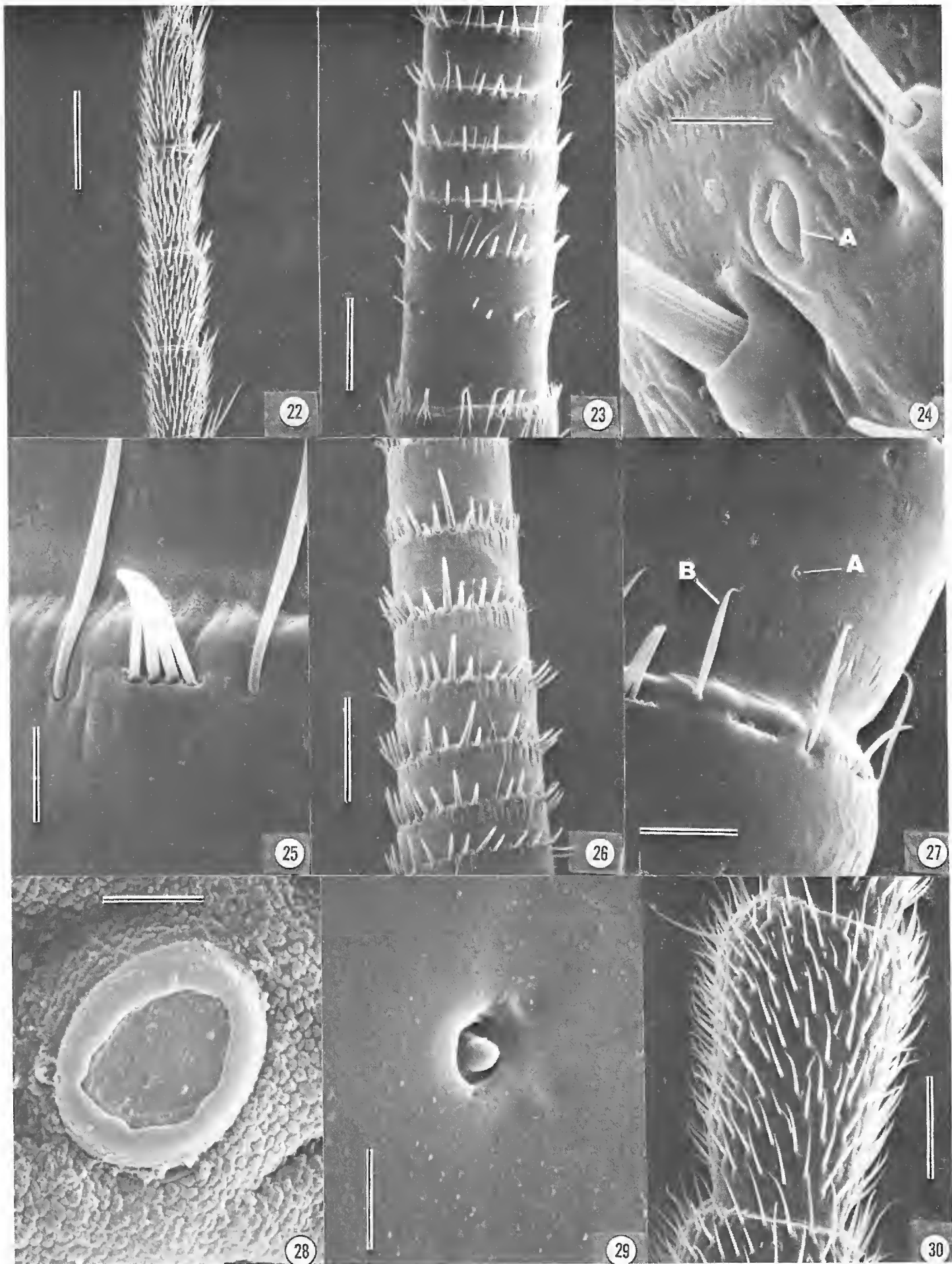
Several nymphs were dissected and the gut contents examined for food items. Two nymphs had several culicid larvae, as well as diatoms in the hind gut, indicating that this species is probably omnivorous in late instars.

Diagnosis.—*Cosumnoperla* and *Calliperla* share the following synapomorphies; mostly membranous male supra-anal process, reduced male paraprocts not recurved to level of 10th tergum and large oblong ova without collar and eclosion line. *Cosumnoperla* males can be distinguished from *Calliperla* by aedeagus lacking tubular, striated apical portion, vesicle absent from 8th sternum, supra-anal process without finger-like apical section, 10th tergal process elevated and triangular and head pattern with interocellar light spot. Females can be separated by the large, truncated, deeply notched subgenital plate and light interocellar spot of the head pattern. Nymphs can be differentiated by the longer subapical lacinal tooth, 4–5 axillary setae and $\frac{7}{8}$ long stout spine-like setae on shelf, cercal segments without long dorsal setae, transverse ridge connecting anterior corners of mesosternal furcal pits, dark lateral abdominal bands without light spots and head pattern with light interocellar spot. Ova can be separated by larger size, FCI floors not punctate, micropyles positioned in FCI floors and some associated with FCI rosettes.

CONCLUSIONS

Cosumnoperla is apparently most closely related to *Calliperla*. This relationship is supported by synapomorphies exhibited in males, females and ova discussed above. *Cosumnoperla* also shares characters with *Mesoperlina* such as modified male 10th tergum, vesicle absent, distinct spinule patches on male 9th tergum, presence of supra-anal process and transverse ridge connecting anterior corners of mesosternal furcal pits. The phylogenetic relationships of *Cosumnoperla* and other Nearctic Isoperlinae genera with *Mesoperlina* and *Kaszabia* are suspect at this time due to the paucity of material available for critical study of all life stages.

Cosumnoperla shares characters with other Isoperlinae genera such as absence of gills and mesosternal Y-ridge attached to posterior corners of furcal pits, but also



Figures 22–30. *Cosumnoperla hypocrena*. 22. Adult cerci; line = 250 microns. 23. Nymph antennae, basal segments; line = 132 microns. 24. Detailed adult antennal segment (A.-sensilla companiformia); line = 8 microns. 25. Detailed adult antennal segment with coniform sensilla complex and cuticular spines; line = 18 microns. 26. Nymph cerci, ventral aspect; line = 125 microns. 27. Nymph antennal segment (A.-conical poreless coeloconic peg, B.-thick-walled sensilla basiconica); line = 26 microns. 28. Nymph chloride cell; line = 4 microns. 29. Detailed nymph antennal segment with conical, poreless coeloconic peg; line = 4 microns. 30. Adult antennal segment; line = 63 microns.

shares characters such as male supra-anal and 10th tergal processes, with some Perlodinae.

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Diversity, Seasonality, and Annual Variability of Caddisfly (Trichoptera) Adults from Two Streams in the California Coast Range

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Abstract.—Faunal composition and fluctuations in abundance of Trichoptera adults were analyzed from three years of pan trap collections (1979–1981) made during the dry season (April–October) at two streams (Big Sulphur Creek, Sonoma County; Big Canyon Creek, Lake County) located 11 km apart in the California Coast Range. At least 57 species in 15 families were identified among the 2003 individuals collected; 24 species were common to both sites. The length of the flight period of these adults, on average, was significantly longer than that observed at four temperate sites in eastern North America. Most probably, this is related to the warmer temperature regime associated with the Mediterranean climate of the California Coast Range. When years with varying amounts of precipitation were compared, the annual variability of Coast Range Trichoptera (as measured by year-to-year changes in population abundances) was found to be similar to annual variability observed for other temperate caddisfly faunas. When precipitation amounts were similar, year-to-year differences in caddisfly abundance were reduced.

INTRODUCTION

Environments that have stable climatic characteristics have been assumed to exhibit greater faunal and floral diversity (Klopfer, 1959). As a result, tropical areas have been assumed to contain faunas that are less variable temporally than their temperate counterparts (MacArthur, 1972). Wolda (1977, 1978, 1980a, b) and Wolda and Fisk (1981) examined the temporal variability of insect faunas from (mostly terrestrial) habitats worldwide and concluded that tropical insects are often less seasonal than temperate insects, but they also observed that tropical insect populations are not generally more stable on a year-to-year basis (i.e., climatic stability is not reflected in the annual variability of the insect populations). Temperate/tropical comparisons of seasonality and annual variability for aquatic insects are more difficult because most research has been done in areas with continental temperate climates (hot summers, cold winters) and over relatively short terms (≤ 2 years). McElravy et al. (1981, 1982) compared the diversity and temporal variability of an adult caddisfly fauna from a climatically stable “non-seasonal” tropical environment in Panama with several faunas from continental temperate climates in North America and Europe. They found that tropical caddisflies exhibited higher diversity and have longer flight periods than adults of most temperate species, but that these caddisflies did not show an increase in the stability of their populations on a year-to-year basis.

Within the temperate-zone areas of the world there are regions with climatic differences that are analogous to those that occur between the temperate and tropical zones. For example, the streams of the California Coast Range are not tropical, but they are located in a region with a Mediterranean-type climate (i.e., hot, dry summers and mild, wet winters). Subfreezing temperatures are uncommon as a result of maritime influences, and insect faunas in these areas are subject to less seasonal temperature variation than is found in most other temperate-zone sites. Temperature, along with photoperiod, is known to be an important factor in determining several life history features of aquatic insects (e.g., Hynes, 1970; Butler, 1984; Sweeney, 1984).

Does the diversity and temporal variability of caddisflies from temperate-zone streams in regions with Mediterranean climates differ from those in more typical temperate systems (i.e., hot summers, cold winters)? This paper presents the results of a three-year study of Trichoptera adults from two nearby streams in the California Coast Range, and compares the diversity and temporal variability of this fauna with that of other temperate-zone caddisfly communities.

STUDY AREA

Big Sulphur Creek, Sonoma County, California, is a third-order stream that flows northwesterly through The Geysers Known Geothermal Resources Area (KGRA). The stream traverses a steep-sided valley characterized by an unstable terrain (Brown and Jackson, 1974; Neilson, 1975). In this region, more than 95% of the annual precipitation occurs during the rainy season (late September–early May). Following cessation of rains in the spring, streamflows gradually recede, reaching a minimum level by early September. Extensive blooms of the green alga *Cladophora glomerata* (L.) Kutzing can occur within the stream over the summer. Collections of caddisfly adults were made near the confluence of Big Sulphur Creek and a major tributary, Little Geysers Creek (38° 46' N, 122° 45' W, elevation 680m, gradient 47m/km).

Big Canyon Creek is located in a separate drainage basin approximately 11 km northeast of Big Sulphur Creek in Lake County, California. As at Big Sulphur Creek, most precipitation and maximum discharge occurs from late September to early May. Samples were collected near the headwaters of Big Canyon Creek (38° 51' N, 122° 41' W, elevation 570m, gradient 61m/km). At this location, the watershed is covered with a mixed hardwood-conifer forest, which provides dense shading for a large portion of the stream.

Although Big Sulphur Creek and Big Canyon Creek are both within The Geysers KGRA and are subject to similar climatic influences, some differences exist between the two stream systems. First, the liquid-dominated, subsurface, geothermal reservoir in the Big Canyon Creek watershed produces alkaline conditions in the overlying streams; in contrast acidic conditions predominate at Big Sulphur Creek where the geothermal reservoir consists of dry steam (McColl et al., 1978). Second, the presence of numerous springs in the upper reaches of the Big Canyon Creek watershed (and near the study site) reduce seasonal variation in discharge by maintaining higher summer streamflows than in Big Sulphur Creek. Third, much of the substrate at Big Canyon Creek consists of large particles that are “cemented” in place. Compared to the loose gravel-boulder substrate at Big Sulphur Creek, the compacted substrate of Big Canyon Creek is less likely to be displaced during the

spates that occur in both watersheds during the wet season; however, this substrate provides less interstitial habitat. Finally, the riparian vegetation at the Big Canyon Creek study site is largely deciduous and quite dense, forming a canopy that provides shading during most of the day. In contrast, the canopy at Big Sulphur Creek is intermittent and the stream is only partially shaded, particularly during the middle of the day. The increased shading, lack of surface geothermal inputs, and presence of numerous springs produce a temperature regime at Big Canyon Creek that is more constant on a seasonal basis than the temperature regime of Big Sulphur Creek. Further descriptions of these streams are provided by Lamberti (1983), Lamberti and Resh (1983), McColl et al. (1978), and McMillan (1985).

METHODS

Rainfall.—During most of the period covered by this study daily precipitation data for The Geysers, California, were available from National Oceanic and Atmospheric Administration records (NOAA, Hourly Precipitation Data, California, 1979–1981). Estimates of rainfall for periods with missing data were calculated by the normal-ratio method (Gilman, 1964) using records from surrounding stations.

Collection Methods.—Caddisfly adults were collected using pan traps, which are 28×40 cm aluminum pans supported 20–30 cm above the stream surface by a metal frame. The pans are filled with a 50–50 mixture of ethylene glycol and water, and capture and preserve adult insects for periods up to one month (see Resh et al. [1984a, b] for pictures of pan traps and a further description of their use). Although fewer adult insects are collected with pan traps than with traditional attractive traps (such as light traps), we have found that these traps are generally nonselective and that samples obtained provide an accurate, relative estimate of adult insect abundance. Jones and Resh (unpublished data) compared pan trap and Malaise trap captures in a Montana stream; with one exception, pan traps collected all species that had > 1 individual in the Malaise trap collections.

At Big Sulphur Creek, four pan traps were placed streamside and continuous collections were made from the end of the rainy season (mid April–early May) until the end of the summer dry season (September) in 1979 and 1981, and until the end of October during 1980. At Big Canyon Creek, four pan traps were used from July until the end of August in 1979, and two to four pan traps were operated from early May until late October in 1980 and until late September in 1981. Pan traps were usually emptied bi-weekly by draining through a $250 \mu\text{m}$ sieve. Caddisflies were separated from other insects, collected, transferred to alcohol, and identified.

Data Analysis.—Seasonal Range (SR) (Wolda, 1979) is a statistic that measures in weeks the length of the adult flight season of a population, correcting for sample size (SR can be calculated for samples $N \geq 6$ in a given year, Wolda, 1979). Higher values of SR indicate less seasonality for a species (i.e., the adults have longer flight periods during the year). Seasonal Range was calculated for those species in which six or more individuals were collected in a given year (SR was not calculated for Big Canyon Creek species during 1979 because of the short collecting season). In order to compare the seasonality of the fauna at each site with other temperate sites, the SR values for the populations at a given site are arranged in a frequency distribution and differences between sites are analyzed with χ^2 tests.

Year-to-year differences in Seasonal Range values were examined for species in

which SR values were available for two or more years. The Annual Variability statistic (AV) of Wolda (1978) provides a measure of the stability of the community in terms of the variability of its constituent populations. This parameter was calculated for the caddisflies at Big Sulphur Creek for the years 1979–1980, 1980–1981, and 1979–1981, and at Big Canyon Creek for 1980–1981; the AV statistic was not calculated for other years due to low numbers of captures. Species for which ≥ 10 individuals were collected in the two years that were being compared were included in the analysis. To make years comparable, data from October 1980 and April 1981 were omitted from Big Sulphur Creek samples, whereas the number of captures at Big Canyon Creek in 1981 was doubled because only two pans were operated (cf. four pans in 1980). The values obtained for both sites were compared with previously reported values of this statistic for temperate and tropical caddisfly communities.

RESULTS AND DISCUSSION

Rainfall.—Precipitation data for the rainy season (September–May) at The Geysers indicates a 25-yr. mean (\pm SD) of 145 ± 38.3 cm yr⁻¹. Total precipitation during the 1979–1980 rainy season (155.1 cm) was near this average. However, the 1978–1979 and 1980–1981 totals were below average (98.4 cm and 90.5 cm, respectively); hence the 1979 and 1981 collections were made during “dry” years.

The Fauna.—During the three-year sampling period 1979–1981 at Big Sulphur Creek, 1039 Trichoptera adults were collected. Although females could not be associated with males for 183 (18%) of these adults, the remaining 856 specimens represent 39 species in 14 families (Table 1). At least 10 of the species (26%) appear to be undescribed (D. Denning, pers. comm.). Since some of the unassociated females are probably not represented by males in the 39-species count, the actual number of species collected is most likely higher.

At Big Canyon Creek, a total of 964 adult Trichoptera was collected during 1979–1981, including 317 unassociated females (33%). The remaining 647 individuals represented 42 species in 15 families (Table 2). At least seven of these species (17%) appear to be undescribed (D. Denning, pers. comm.). A total of 24 species was common to both streams, and at least 57 species were collected from these two sites.

The Trichoptera diversity of Big Sulphur Creek and Big Canyon Creek may be compared with other sites by examining the relationship between the number of species and the number of individuals collected (i.e., the species-abundance curve). These two California sites are near the center of the diversity-abundance distributions for temperate-zone sites in North America and Europe examined by McElravy et al. (1981) and, in terms of diversity, they represent typical temperate caddisfly communities. The proportion of undescribed species (17–26%), however, is much higher than usual (cf. Resh et al. [1975] for a Kentucky stream, Morse et al. [1980] for a South Carolina stream).

Seasonal Occurrence.—The seasonal occurrence of the caddisfly adults at Big Sulphur Creek that composed $\geq 1\%$ of the total number collected from 1979 to 1981 is presented in Fig. 1. Although year-to-year variation is apparent for most of these species, some general patterns can be observed. Most species have adults emerging and active over a fairly long time period in at least one of the years. Only two species, *Rhyacophila angelita* Banks and *Amiocentrus aspilus* (Ross) have short flight periods

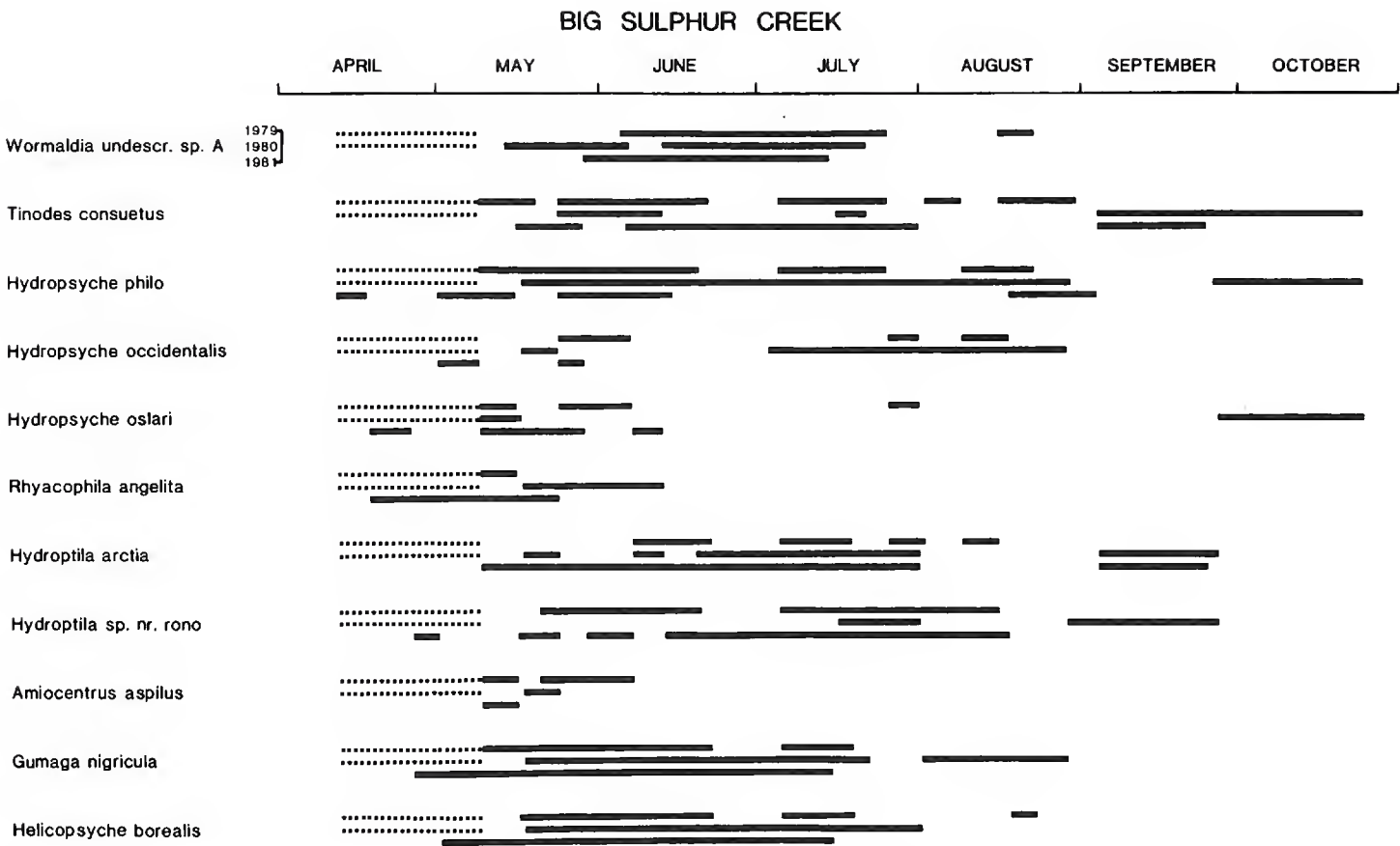


Figure 1. Seasonal occurrence of 11 numerically dominant ($\geq 1\%$ of total 1979–1981) species of Trichoptera collected at Big Sulphur Creek 1979–1981. Values of Seasonal Range (SR) calculated according to Wolda (1979). Dotted lines indicate periods when pan traps were not operated, and for which flight information is not available.

in the spring. The patterns of seasonal occurrence of the 13 species of Trichoptera adults that composed $\geq 1\%$ of the total collected from 1979–1981 at Big Canyon Creek (Fig. 2) were similar to those observed for the Big Sulphur Creek fauna. Only the Rhyacophilidae (except for *Rhyacophila vao* Milne) and *Amiocentrus aspilus* have short flight periods in the spring.

The seasonal occurrence of the Trichoptera faunas at the two northern California sites was compared with other temperate-zone sites by examining the frequency distributions of the SR statistic between two sites using χ^2 tests. When the distribution of SR for the Big Sulphur Creek fauna (Fig. 3a) is compared with the four temperate sites in eastern North America described in McElravy et al. (1982), the fauna at Big Sulphur Creek is significantly less seasonal in all cases ($p < 0.05$, Table 3); that is, caddisfly adults at Big Sulphur Creek have longer flight periods than the other sites. When a similar comparison is made for the Big Canyon Creek fauna (Fig. 3b), all sites except Mahoning River, Ohio, St. #3, were also significantly less seasonal ($p < 0.05$, Table 3).

These California sites are in an area that is climatically different from the other sites. Most obviously, Big Sulphur Creek and Big Canyon Creek have higher mean air temperatures than the other sites during late fall to early spring (Table 3). As a result, these California streams are not subjected to long periods of near-freezing or subfreezing conditions over the winter, which occur at the other sites that are, at least in respect to temperature, located in a much more severe climate. We assume that these higher temperatures permit longer flight periods for the adult caddisflies by

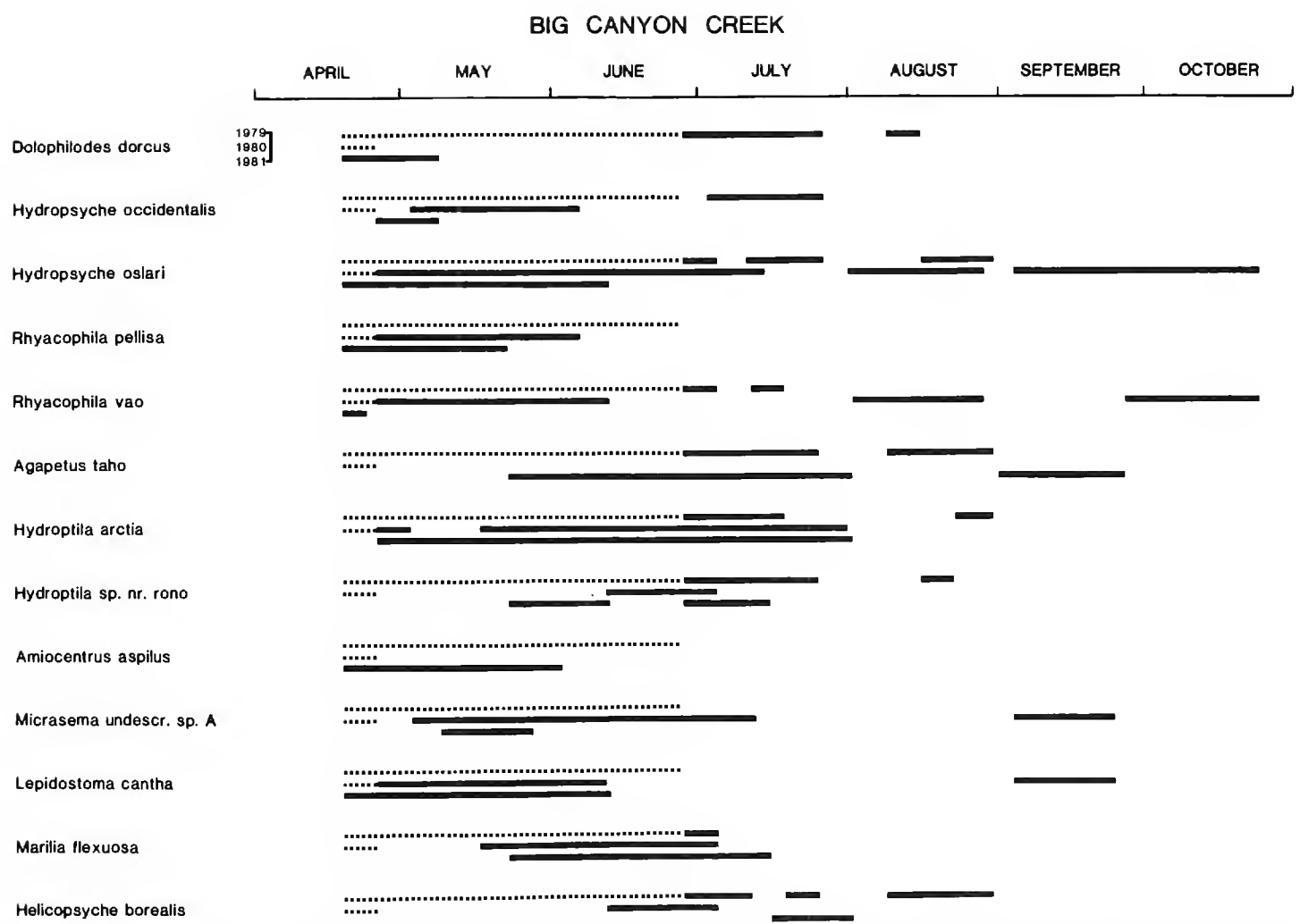


Figure 2. Seasonal occurrence of 13 numerically dominant ($\geq 1\%$ of total 1979–1981) species of Trichoptera collected at Big Canyon Creek 1979–1981. Values of Seasonal Range (SR) calculated according to Wolda (1979). Dotted lines indicate periods when pan traps were not operated, and for which flight information is not available.

providing longer periods of favorable weather conditions during early spring and late autumn.

Annual Variability.—At Big Sulphur Creek, the number of taxa varied little over the three years of this study (Table 1). However, the total numbers of individuals varied greatly. For example, the relative abundance of *Helicopsyche borealis* (Hagen), which as larvae are important grazers in this stream (Lamberti and Resh, 1983), and *Hydropsyche* spp. was fairly constant over 1979–1980, but was reduced in 1981 (Table 1). *Gumaga nigricula* (McLachlan), another numerically dominant macroinvertebrate in Big Sulphur Creek (Resh et al., 1981), was less abundant during 1980 than in 1979 or 1981. The 1980 decrease in *G. nigricula* may be related to the higher rainfall totals and increased substrate disturbance the previous winter, which has been shown to adversely affect *G. nigricula* densities (Resh et al., 1981).

Further evidence that substrate disturbance resulting from high winter discharge events can reduce caddisfly densities was obtained when Big Sulphur Creek pan trap collections were made in 1986. The 1985–1986 rainy season included two 50-year floods, both occurring in February, that resulted in considerable rearrangement of stream bed materials, including displacement of large boulders and logs. Only 10 *G. nigricula* adults were collected during 1986, one-half of the 1980 total and less than one-sixth of the numbers of *G. nigricula* collected in 1979 or 1981. A similar trend was observed for total numbers of individuals (89 in 1986; cf. 501 in 1979, 252 in 1980,

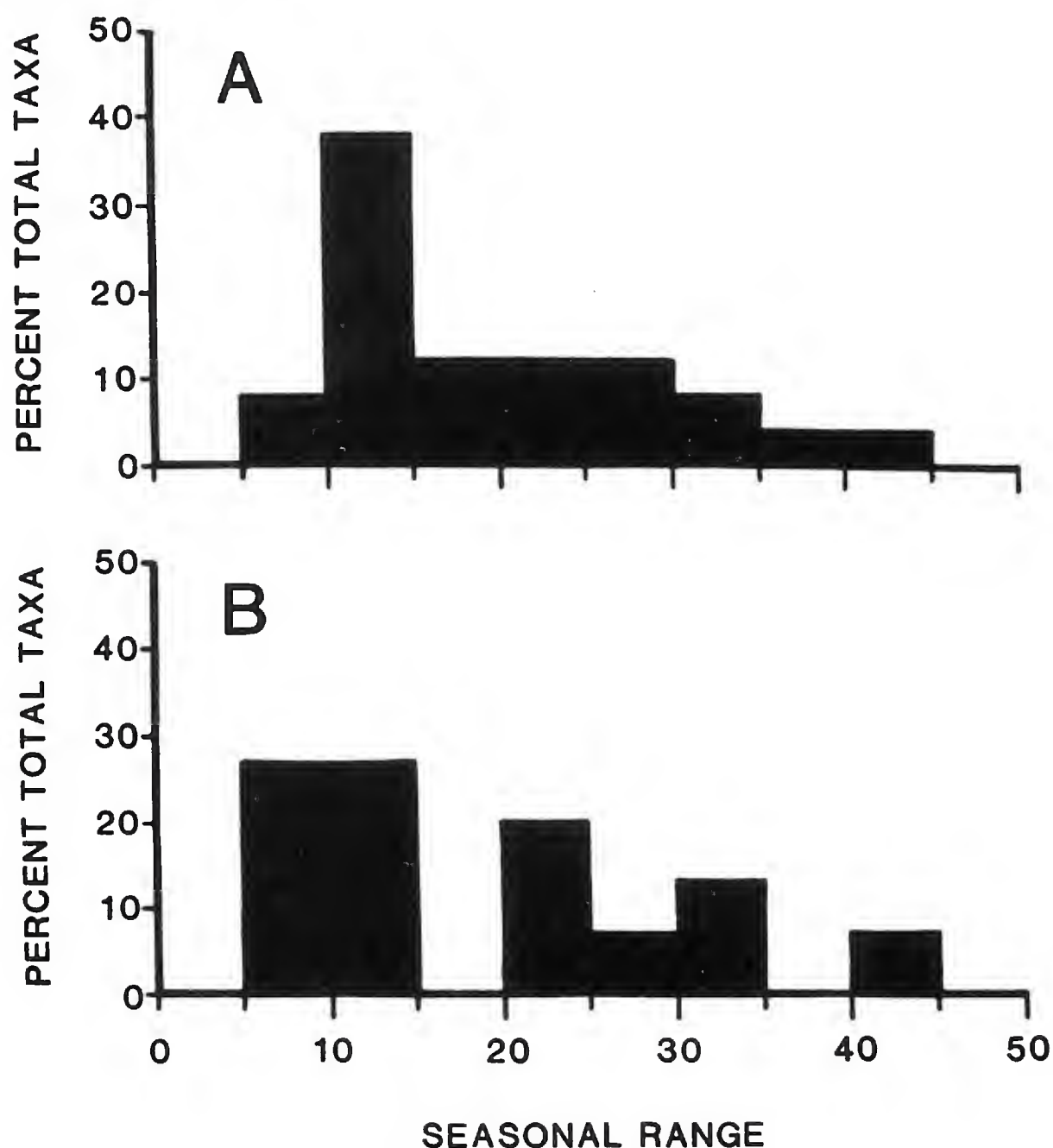


Figure 3. Histograms showing distribution of Seasonal Range (SR) as percentages. Values along abscissa from left to right indicate decreasing seasonality. Trichoptera from A. Big Sulphur Creek (N = 24); B. Big Canyon Creek (N = 15).

and 286 in 1981) as well as number of taxa (14 in 1986; cf. 23 in 1979, 25 in 1980, and 26 in 1981).

At Big Canyon Creek, the number of taxa collected was similar during the two years for which sampling was complete (1980 and 1981) (Table 2). However, the total number of individuals collected decreased from 1980 to 1981. Over this period, the relative abundance of the Lepidostomatidae increased, while that of the Brachycentridae declined. Little change in abundance of Rhyacophilidae was observed (Table 2).

Year-to-year changes in the seasonality of the Trichoptera fauna at Big Sulphur Creek and Big Canyon Creek can be examined with between-year plots of SR for those species with $N \geq 6$ in two or more years. Since SR is corrected for sample size, this procedure allows data, such as presented in Figs. 1 and 2, to be compared. In both 1979–1980 and 1980–1981, the numerically dominant caddisfly species at Big Sulphur Creek did not exhibit similar seasonality patterns over the two years (Fig. 4a,b). This may be related to variation in abiotic and/or biotic factors caused by differences in hydrologic regimes between the two relatively dry years (1979, 1981)

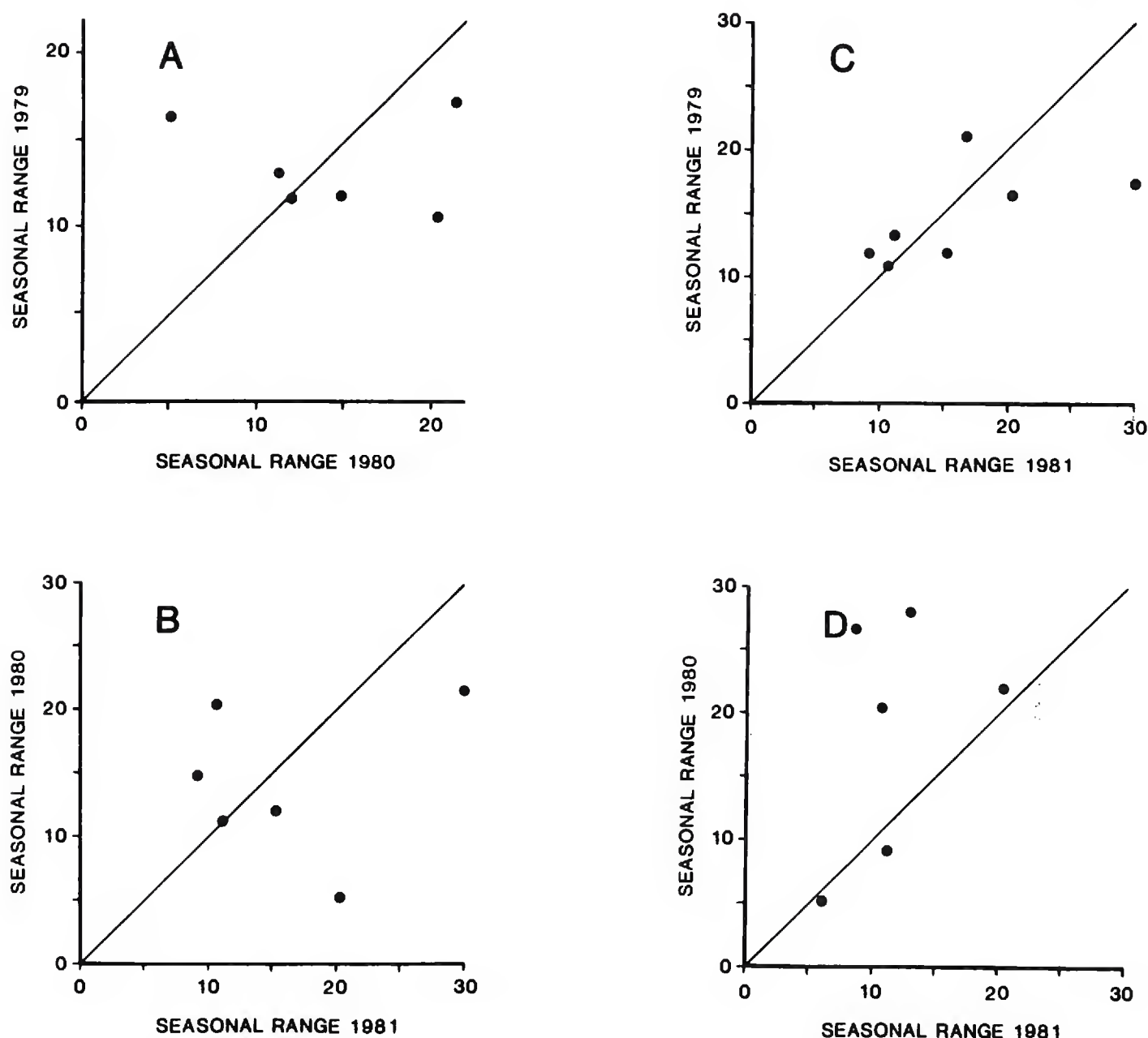


Figure 4. Between-year comparison of seasonal occurrence of Trichoptera adults (measured by SR) at two sites in the central California Coast Range. A. Big Sulphur Creek 1979–1980; B. Big Sulphur Creek 1980–1981; C. Big Sulphur Creek 1979–1981; D. Big Canyon Creek 1980–1981.

and a wetter year (1980). When the two dry years are compared (Fig. 4c), less year-to-year variability in the length of the species' active seasons is evident. Mean wet season stream temperature was probably less important than precipitation in producing this pattern; temperature did not vary between 1979–1980 (October–April mean temperature = 11.4°C) and 1980–1981 (October–April mean temperature = 11.3°) and was lower during 1978–1979 (October–April mean temperature = 9.6°). At Big Canyon Creek (Fig. 4d), a comparison of SR values for 1980–1981 also showed considerable variation for three of the six species examined; these three species had considerably longer active seasons in 1980 than in the relatively dry year of 1981.

Year-to-year variability of the entire fauna at a particular site can be assessed using the Annual Variability statistic (AV) (Wolda, 1978), which takes into account changes in total numbers of each species over the years of comparison. When this statistic is calculated for Big Sulphur Creek (Table 4), the pattern of faunal variation is similar to that seen above when the SR values were plotted, i.e., less variation occurs when the two drier years (1979 and 1981) are compared than when a dry and a

Table 1. Species present, number of individuals collected, and abundance as percent of individuals collected in each year, from Big Sulphur Creek, 1979–1981.

| | No. | 1979 Percent of total | No. | 1980 Percent of total | No. | 1981 Percent of total |
|--------------------------------------|-----|-----------------------------|-----|-----------------------------|-----|-----------------------------|
| Philopotamidae | | | | | | |
| <i>Chimarra</i> undescr. sp. A | 2 | 0.3 | 0 | 0.0 | 2 | 0.7 |
| <i>Wormaldia</i> undescr. sp. A | 44 | 8.8 | 12 | 4.7 | 21 | 7.3 |
| Psychomyiidae | | | | | | |
| <i>Tinodes consuetus</i> McL. | 24 | 4.8 | 10 | 3.9 | 10 | 3.5 |
| <i>Tinodes siskiyou</i> Denning | 0 | 0.0 | 2 | 0.8 | 0 | 0.0 |
| Polycentropodidae | | | | | | |
| <i>Polycentropus halidus</i> Milne | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 |
| Unassociated <i>Polycentropus</i> | | | | | | |
| Females: | | | | | | |
| <i>Polycentropus</i> sp. #1 | 3 | 0.6 | 0 | 0.0 | 0 | 0.0 |
| <i>Polycentropus</i> sp. #2 | 1 | 0.2 | 0 | 0.0 | 0 | 0.0 |
| Hydropsychidae | | | | | | |
| <i>Cheumatopsyche mickeli</i> | | | | | | |
| Denning | 3 | 0.6 | 5 | 2.0 | 0 | 0.0 |
| <i>Homoplectra oaklandensis</i> | | | | | | |
| (Ling) | 1 | 0.2 | 0 | 0.0 | 0 | 0.0 |
| <i>Hydropsyche californica</i> Banks | 0 | 0.0 | 2 | 0.8 | 0 | 0.0 |
| <i>Hydropsyche philo</i> Ross | 51 | 10.2 | 25 | 9.8 | 14 | 4.9 |
| <i>Hydropsyche occidentalis</i> | | | | | | |
| Banks | 5 | 1.0 | 7 | 2.7 | 2 | 0.7 |
| <i>Hydropsyche oslari</i> Banks | 4 | 0.8 | 2 | 0.8 | 7 | 2.4 |
| <i>Hydropsyche</i> sp. A | 1 | 0.2 | 0 | 0.0 | 1 | 0.3 |
| <i>Parapsyche almota</i> Ross | 1 | 0.2 | 0 | 0.0 | 3 | 1.0 |
| Rhyacophilidae | | | | | | |
| <i>Rhyacophila angelita</i> Banks | 1 | 0.2 | 3 | 1.2 | 12 | 4.2 |
| <i>Rhyacophila vedra</i> Milne | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Rhyacophila vocala</i> Milne | 1 | 0.2 | 2 | 0.8 | 4 | 1.4 |
| <i>Rhyacophila</i> undescr. sp. A | 1 | 0.2 | 0 | 0.0 | 2 | 0.7 |
| <i>Rhyacophila</i> undescr. sp. B | 0 | 0.0 | 1 | 0.4 | 1 | 0.3 |
| <i>Rhyacophila</i> undescr. sp. C | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 |
| Unassociated <i>Rhyacophila</i> | | | | | | |
| Females: | | | | | | |
| <i>Rhyacophila</i> sp. #1 | 1 | 0.2 | 2 | 0.8 | 4 | 1.4 |
| <i>Rhyacophila</i> sp. #2 | 0 | 0.0 | 3 | 1.2 | 16 | 5.6 |
| <i>Rhyacophila</i> sp. #3 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Rhyacophila</i> sp. #4 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| Glossosomatidae | | | | | | |
| Unassociated <i>Agapetus</i> | | | | | | |
| Female: | | | | | | |
| <i>Agapetus</i> sp. #1 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |

Table 1. *continued*

| | No. | 1979 Percent of total | No. | 1980 Percent of total | No. | 1981 Percent of total |
|------------------------------------|-----|-----------------------------|-----|-----------------------------|-----|-----------------------------|
| <i>Glossosoma califica</i> Denning | 1 | 0.2 | 0 | 0.0 | 0 | 0.0 |
| <i>Glossosoma oregonense</i> Ling | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| Unassociated <i>Glossosoma</i> | | | | | | |
| Females: | | | | | | |
| <i>Glossosoma</i> sp. #1 | 0 | 0.0 | 2 | 0.8 | 0 | 0.0 |
| <i>Glossosoma</i> sp. #2 | 0 | 0.0 | 0 | 0.0 | 3 | 1.0 |
| Hydroptilidae | | | | | | |
| <i>Hydroptila arctia</i> Ross | 31 | 6.2 | 47 | 18.7 | 22 | 7.7 |
| <i>Hydroptila</i> sp. A nr. | | | | | | |
| <i>rono</i> Ross | 18 | 3.6 | 9 | 3.5 | 10 | 3.5 |
| Unassociated <i>Hydroptila</i> | | | | | | |
| Females: | | | | | | |
| <i>Hydroptila</i> sp. #1 | 39 | 7.8 | 12 | 4.7 | 8 | 2.8 |
| <i>Hydroptila</i> sp. #2 | 0 | 0.0 | 1 | 0.4 | 4 | 1.4 |
| <i>Ithytrichia</i> sp. A | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 |
| <i>Neotrichia</i> sp. A | 1 | 0.2 | 0 | 0.0 | 0 | 0.0 |
| <i>Neotrichia</i> undescr. sp. A | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 |
| Unassociated <i>Neotrichia</i> | | | | | | |
| Female: | | | | | | |
| <i>Neotrichia</i> sp. #1 | 11 | 2.2 | 2 | 0.8 | 0 | 0.0 |
| <i>Ochrotrichia</i> undescr. sp. B | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Ochrotrichia</i> undescr. sp. C | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Ochrotrichia</i> undescr. sp. D | 0 | 0.0 | 0 | 0.0 | 2 | 0.7 |
| <i>Ochrotrichia</i> undescr. sp. E | 1 | 0.2 | 0 | 0.0 | 1 | 0.3 |
| Unassociated <i>Ochrotrichia</i> | | | | | | |
| Female: | | | | | | |
| <i>Ochrotrichia</i> sp. #1 | 4 | 0.8 | 2 | 0.8 | 1 | 0.3 |
| <i>Oxyethira</i> sp. A | 0 | 0.0 | 5 | 2.0 | 0 | 0.0 |
| Unassociated Hydroptilidae | | | | | | |
| Females: | | | | | | |
| Hydroptilidae sp. #1 | 0 | 0.0 | 3 | 1.2 | 0 | 0.0 |
| Brachycentridae | | | | | | |
| <i>Amiocentrus aspilus</i> (Ross) | 4 | 0.8 | 3 | 1.2 | 2 | 0.7 |
| Unassociated <i>Amiocentrus</i> | | | | | | |
| Females: | | | | | | |
| <i>Amiocentrus</i> sp. #1 | 2 | 0.3 | 0 | 0.0 | 0 | 0.0 |
| <i>Amiocentrus</i> sp. #2 | 5 | 1.0 | 3 | 1.2 | 14 | 4.9 |

Table 1. continued

| | No. | 1979 Percent of total | No. | 1980 Percent of total | No. | 1981 Percent of total |
|--|-----|-----------------------------|-----|-----------------------------|-----|-----------------------------|
| Lepidostomatidae | | | | | | |
| <i>Lepidostoma strophis</i> Ross | 7 | 1.4 | 0 | 0.0 | 1 | 0.3 |
| Unassociated <i>Lepidostoma</i> | | | | | | |
| Females: | | | | | | |
| <i>Lepidostoma</i> sp. #1 | 15 | 3.0 | 3 | 1.2 | 2 | 0.7 |
| <i>Lepidostoma</i> sp. #2 | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 |
| Sericostomatidae | | | | | | |
| <i>Gumaga nigricula</i> (McL.) | 78 | 15.6 | 20 | 7.9 | 62 | 21.7 |
| Odontoceridae | | | | | | |
| <i>Marilia flexuosa</i> Ulmer | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 |
| Unassociated <i>Marilia</i> | | | | | | |
| Females: | | | | | | |
| <i>Marilia</i> sp. #1 | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 |
| <i>Marilia</i> sp. #2 | 4 | 0.8 | 0 | 0.0 | 0 | 0.0 |
| Unassociated Odontoceridae | | | | | | |
| Female: | | | | | | |
| Odontoceridae sp. #1 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| Helicopsychidae | | | | | | |
| <i>Helicopsyche borealis</i> | | | | | | |
| (Hagen) | 126 | 25.1 | 51 | 20.2 | 42 | 14.7 |
| Calamoceratidae | | | | | | |
| <i>Heteroplectron californicum</i> | | | | | | |
| McL. | 0 | 0.0 | 1 | 0.4 | 2 | 0.7 |
| Leptoceridae | | | | | | |
| <i>Mystacides alafimbriata</i> | | | | | | |
| Hill-Griffin | 0 | 0.0 | 2 | 0.8 | 1 | 0.3 |
| <i>Ylodes frontalis</i> | | | | | | |
| (Banks) | 6 | 1.2 | 2 | 0.8 | 0 | 0.0 |
| Unassociated <i>Ylodes</i> | | | | | | |
| Females: | | | | | | |
| <i>Ylodes</i> sp. #1 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Ylodes</i> sp. #2 | 4 | 0.8 | 1 | 0.4 | 1 | 0.3 |
| Total N | 501 | | 252 | | 286 | |
| Total No. Taxa (Excluding Unassociated Females) | 23 | | 25 | | 26 | |
| No. Unassociated Females | 89 | | 36 | | 58 | |

Table 2. Species present, number of individuals collected, and abundance as percent of individuals collected in each year, from Big Canyon Creek, 1979–1981.

| | No. | 1979 Percent of total | No. | 1980 Percent of total | No. | 1981 Percent of total |
|------------------------------------|-----|-----------------------------|-----|-----------------------------|-----|-----------------------------|
| Philopotamidae | | | | | | |
| <i>Dolophilodes dorcus</i> (Ross) | 24 | 16.7 | 0 | 0.0 | 2 | 0.6 |
| <i>Wormaldia cruzensis</i> (Ling) | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| <i>Wormaldia</i> undescr. sp. A | 0 | 0.0 | 2 | 0.4 | 0 | 0.0 |
| Psychomyiidae | | | | | | |
| <i>Nyctiophylax</i> sp. A | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Tinodes siskiyou</i> Denning | 1 | 0.7 | 1 | 0.2 | 0 | 0.0 |
| Unassociated <i>Tinodes</i> | | | | | | |
| Female: | | | | | | |
| <i>Tinodes</i> sp. #1 | 0 | 0.0 | 2 | 0.4 | 0 | 0.0 |
| Polycentropodidae | | | | | | |
| <i>Polycentropus halidus</i> Milne | 0 | 0.0 | 2 | 0.4 | 1 | 0.3 |
| Unassociated <i>Polycentropus</i> | | | | | | |
| Female: | | | | | | |
| <i>Polycentropus</i> sp. #3 | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| Hydropsychidae | | | | | | |
| <i>Hydropsyche philo</i> Ross | 0 | 0.0 | 0 | 0.0 | 2 | 0.6 |
| <i>Hydropsyche occidentalis</i> | | | | | | |
| Banks | 11 | 7.6 | 3 | 0.6 | 1 | 0.3 |
| <i>Hydropsyche osleri</i> Banks | 12 | 8.3 | 21 | 4.4 | 10 | 2.9 |
| <i>Parapsyche almota</i> Ross | 0 | 0.0 | 2 | 0.4 | 3 | 0.9 |
| Rhyacophilidae | | | | | | |
| <i>Rhyacophila narvae</i> Navas | 0 | 0.0 | 3 | 0.6 | 2 | 0.6 |
| <i>Rhyacophila pellisa</i> Ross | 0 | 0.0 | 35 | 7.3 | 22 | 6.4 |
| <i>Rhyacophila sierra</i> Denning | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Rhyacophila vao</i> Milne | 2 | 1.4 | 13 | 2.7 | 2 | 0.6 |
| <i>Rhyacophila vedra</i> Milne | 0 | 0.0 | 5 | 1.0 | 0 | 0.0 |
| <i>Rhyacophila vocala</i> Milne | 0 | 0.0 | 1 | 0.2 | 1 | 0.3 |
| <i>Rhyacophila</i> undescr. sp. A | 0 | 0.0 | 1 | 0.2 | 1 | 0.3 |
| <i>Rhyacophila</i> undescr. sp. C | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| Unassociated <i>Rhyacophila</i> | | | | | | |
| Females: | | | | | | |
| <i>Rhyacophila</i> sp. #2 | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| <i>Rhyacophila</i> sp. #5 | 0 | 0.0 | 3 | 0.6 | 10 | 2.9 |
| <i>Rhyacophila</i> sp. #6 | 0 | 0.0 | 35 | 7.3 | 27 | 7.9 |
| <i>Rhyacophila</i> sp. #7 | 0 | 0.0 | 4 | 0.8 | 6 | 1.7 |
| <i>Rhyacophila</i> sp. #8 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Rhyacophila</i> sp. #9 | 0 | 0.0 | 6 | 1.3 | 0 | 0.0 |
| <i>Rhyacophila</i> sp. #10 | 3 | 2.1 | 2 | 0.4 | 0 | 0.0 |

Table 2. continued

| | No. | 1979 Percent of total | No. | 1980 Percent of total | No. | 1981 Percent of total |
|------------------------------------|-----|-----------------------------|-----|-----------------------------|-----|-----------------------------|
| Glossosomatidae | | | | | | |
| <i>Agapetus taho</i> Ross | 23 | 16.0 | 0 | 0.0 | 7 | 2.0 |
| Unassociated <i>Agapetus</i> | | | | | | |
| Female: | | | | | | |
| <i>Agapetus</i> sp. #1 | 0 | 0.0 | 3 | 0.6 | 1 | 0.3 |
| <i>Anagapetus</i> sp. A | 1 | 0.7 | 2 | 0.4 | 0 | 0.0 |
| <i>Glossosoma oregonense</i> Ling | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| Unassociated <i>Glossosoma</i> | | | | | | |
| Female | | | | | | |
| <i>Glossosoma</i> sp. #1 | 0 | 0.0 | 8 | 1.7 | 4 | 1.2 |
| Hydroptilidae | | | | | | |
| <i>Hydroptila arctia</i> Ross | 9 | 6.3 | 14 | 2.9 | 15 | 4.4 |
| <i>Hydroptila</i> sp. A nr. | | | | | | |
| <i>rono</i> Ross | 12 | 8.3 | 1 | 0.2 | 3 | 0.9 |
| Unassociated <i>Hydroptila</i> | | | | | | |
| Females: | | | | | | |
| <i>Hydroptila</i> sp. #1 | 8 | 5.6 | 9 | 1.9 | 5 | 1.5 |
| <i>Hydroptila</i> sp. #2 | 0 | 0.0 | 1 | 0.2 | 1 | 0.3 |
| <i>Neotrichia</i> sp. A | 5 | 3.5 | 1 | 0.2 | 0 | 0.0 |
| Unassociated <i>Neotrichia</i> | | | | | | |
| Female: | | | | | | |
| <i>Neotrichia</i> sp. #1 | 5 | 3.5 | 0 | 0.0 | 0 | 0.0 |
| <i>Ochrotrichia</i> undescr. sp. A | 1 | 0.7 | 0 | 0.0 | 0 | 0.0 |
| <i>Ochrotrichia</i> undescr. sp. E | 1 | 0.7 | 0 | 0.0 | 0 | 0.0 |
| <i>Ochrotrichia</i> undescr. sp. F | 0 | 0.0 | 0 | 0.0 | 2 | 0.6 |
| Unassociated <i>Ochrotrichia</i> | | | | | | |
| Female: | | | | | | |
| <i>Ochrotrichia</i> sp. #1 | 1 | 0.7 | 3 | 0.6 | 1 | 0.3 |
| <i>Oxyethira</i> sp. A | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| Unassociated Hydroptilidae | | | | | | |
| Females: | | | | | | |
| Hydroptilidae sp. #1 | 1 | 0.7 | 0 | 0.0 | 1 | 0.3 |
| Brachycentridae | | | | | | |
| <i>Amiocentrus aspilus</i> (Ross) | 0 | 0.0 | 9 | 3.0 | 13 | 3.8 |
| Unassociated <i>Amiocentrus</i> | | | | | | |
| Females: | | | | | | |
| <i>Amiocentrus</i> sp. #1 | 0 | 0.0 | 95 | 20.1 | 54 | 15.7 |
| <i>Amiocentrus</i> sp. #2 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| <i>Amiocentrus</i> sp. #3 | 0 | 0.0 | 0 | 0.0 | 8 | 2.3 |
| <i>Micrasema</i> undescr. sp. A | 0 | 0.0 | 123 | 25.8 | 38 | 11.1 |

Table 2. continued

| | No. | 1979 Percent of total | No. | 1980 Percent of total | No. | 1981 Percent of total |
|--|-----|-----------------------------|-----|-----------------------------|-----|-----------------------------|
| Lepidostomatidae | | | | | | |
| <i>Lepidostoma cantha</i> Ross | 0 | 0.0 | 36 | 7.5 | 67 | 19.5 |
| <i>Lepidostoma fischeri</i> Denning | 0 | 0.0 | 0 | 0.0 | 2 | 0.6 |
| <i>Lepidostoma strophis</i> Ross | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| Unassociated <i>Lepidostoma</i> | | | | | | |
| Females: | | | | | | |
| <i>Lepidostoma</i> sp. #1 | 0 | 0.0 | 0 | 0.0 | 5 | 1.5 |
| <i>Lepidostoma</i> sp. #2 | 0 | 0.0 | 0 | 0.0 | 1 | 0.3 |
| Limnephilidae | | | | | | |
| Limnephilidae sp. A | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| Sericostomatidae | | | | | | |
| <i>Gumaga nigricula</i> (McL.) | 1 | 0.7 | 2 | 0.4 | 2 | 0.6 |
| Odontoceridae | | | | | | |
| <i>Marilia flexuosa</i> Ulmer | 2 | 1.4 | 16 | 3.4 | 14 | 4.1 |
| <i>Nerophilus californicus</i> (Hagen) | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| <i>Parthina vierra</i> Denning | 1 | 0.7 | 0 | 0.0 | 0 | 0.0 |
| Helicopsychidae | | | | | | |
| <i>Helicopsyche borealis</i> (Hagen) | 17 | 11.8 | 2 | 0.4 | 1 | 0.3 |
| Calamoceratidae | | | | | | |
| <i>Heteroplectron</i> californicum McL. | 1 | 0.7 | 2 | 0.4 | 2 | 0.6 |
| Leptoceridae | | | | | | |
| <i>Mystacides alafimbriata</i> Hill-Griffin | 0 | 0.0 | 1 | 0.2 | 0 | 0.0 |
| <i>Oecetis</i> sp. A | 2 | 1.4 | 1 | 0.2 | 0 | 0.0 |
| Total N | 144 | | 477 | | 343 | |
| Total No. Taxa (Excluding Unassociated Females) | 18 | | 30 | | 27 | |
| No. Unassociated Females | 18 | | 173 | | 126 | |

wet year are compared. This statistic also allows the Trichoptera fauna at Big Sulphur Creek and Big Canyon Creek to be compared with other faunas. The 1979–1980 and 1980–1981 values of 0.104 and 0.098, respectively (each comparing a dry with an average year), are within the range of AV values for 14 temperate and tropical sites reported by McElravy et al. (1982) for Trichoptera; a comparison between the two dry years (1979 and 1981 AV = 0.063), however, is lower than any previously reported value.

Table 3. Comparison of Seasonal Range (SR) frequency distributions between Big Sulphur Creek (BSC) and Big Canyon Creek (BCC), and with four sites in North America having a continental temperate climate. Number of species for which SR was calculated is given below each site. Temperature data from the National Oceanic and Atmospheric Administration.

| Site | Location | Elevation (m) | Latitude N | Mean Temp. (Oct.–April) °C | SR with BSC | SR with BCC |
|-----------------------------------|-----------|------------------|---------------|----------------------------------|----------------|----------------|
| Big Sulphur Creek (N = 24) | N. Calif. | 680 | 38° 46' | 12.2 | — | p = 0.49 |
| Big Canyon Creek (N = 15) | N. Calif. | 570 | 38° 51' | 9.3 | p = 0.49 | — |
| Mahoning R. St. #2 (N = 33) | N.E. Ohio | 347 | 41° 12' | 2.9 | p = 0.01 | p = 0.02 |
| Mahoning R. St. #3 (N = 30) | N.E. Ohio | 326 | 41° 14' | 2.9 | p = 0.05 | p = 0.16 |
| Linesville Creek (N = 50) | N.W. Pa. | 317 | 41° 40' | 1.9 | p = 0.01 | p = 0.01 |
| Fourmile Creek (N = 59) | N.W. Pa. | 259 | 42° 7' | 2.2 | p < 0.01 | p = 0.01 |

Table 4. Annual Variability (AV) of caddisfly faunas of Big Sulphur Creek and Big Canyon Creek as indicated by the mean and variance of the net reproductive rate (*sensu* Wolda, 1978). Calculations based on species for which the total number in both years ≥ 10.

| Site | Years Compared | DF | Mean | Variance (= AV) |
|-------------------|-------------------|----|-------|---------------------|
| Big Sulphur Creek | 1979–1980 | 7 | −0.35 | 0.104 |
| Big Sulphur Creek | 1980–1981 | 7 | 0.09 | 0.098 |
| Big Sulphur Creek | 1979–1981 | 7 | −0.29 | 0.063 |
| Big Canyon Creek | 1980–1981 | 8 | 0.36 | 0.373 |

The 1980–1981 AV for Big Canyon Creek, 0.373, is higher than that of Big Sulphur Creek for the same year. This value is exceptionally high for Trichoptera. In fact it is exceeded only by an AV of 0.925 that was reported for a Kentucky stream (Haag et al., 1984), in a study that compared pre-impact 1973 and impact 1979 faunas at a single site affected by siltation. Since we have only one set of comparative of data (from a dry to average pair of years) we do not know if AVs are generally higher in Big Canyon Creek than in Big Sulphur Creek. The benthic (immature) stages of the Trichoptera at both Big Sulphur Creek and Big Canyon Creek respond to year-to-year differences in precipitation (Resh et al., 1981; McElravy et al.,

unpublished data). In all probability, changes in numerical abundance of adult Trichoptera also result from the same conditions that affect the benthic stages of these species.

Faunal studies, in addition to providing descriptive accounts of insect populations and communities, are often done to make spatial (e.g., temperate/tropic; upstream/downstream) or temporal (e.g., changes in populations and communities following perturbation) comparisons. Wolda (1979) has emphasized that quantifying fluctuations in abundances is important in understanding the ecology of insect populations and communities. Quantitative indices such as Seasonal Range and Annual Variability may be used to summarize faunal information and permit statistical tests of temporal parameters among different data sets. The separation of seasonal or annual variability from variability produced by perturbation is a major concern in aquatic biology. If sampling programs for faunal studies can be designed and data reported in such a way that seasonality and/or annual variability measures can be applied, the value of such studies to researchers interested in partitioning this variability can be greatly enhanced.

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**New Species of the Genus *Styringomyia*
from the South Pacific and Southeast Asia (Diptera, Tipulidae)**

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This paper reports on new species of *Styringomyia* from specimens collected in Fiji, New Caledonia, Ryuku Islands, Sarawak (British North Borneo), Solomon Islands, and Vietnam. I wish to thank Dr. Neal Evènhuis for the privilege of studying specimens from the Bernice P. Bishop Museum Collections, in Honolulu, Hawaii. All types are being returned to the Bishop Museum. Thanks are also due to Dr. Van L. Johnson, Professor Emeritus of Classics, Tufts University, for reviewing the Latin forms used in the names of the species.

The genus *Styringomyia* is considered an abberant group within the tribe Eriopterini, and its affinities to other groups in the tribe have not been well worked out. Although the larvae have not as yet been described, the cervical sclerite on the adult of all species appears as an L-shaped plate, which places the genus in, or very close to, the genera which comprise the Eriopteraria.

***Styringomyia bidentata* NEW SPECIES**

Male.—Length, 5.8 mm; wing, 3.4 mm. Rostrum yellow-brown. Antennae with scape light brown, pedicel and flagellar segments fulvous. Head yellow-gray. Thorax with nota brown, with two narrow, dark brown lines on either side of center. Legs missing. Wings with brown veins, lighter in cell areas; a dark brown stripe along Cu from base to midwing. A yellow tinge is found along costal and subcostal regions. Cell 2nd M₂ weakly petiolate; vein 2A curves gently to the margin of the wing. Abdomen with terga and sterna brown, unpatterned; last segment and hypopygium (Fig. 1) yellow. The apex of ninth tergite terminating with a setiferous lobe that is subtended by small lobes. Ninth sternite truncated at tip, each outer apical angle with a long, slender seta. Basistyle terminating with a small thick tubercle bearing two long, modified setae, the bases of which are contiguous. Outer dististyle flat, broad, bearing abundant retrorse setae with the upper and inner edge glabrous. Inner dististyle with the outer lobe a flattened, quadrate blade, and with the inner surface covered with setae. The inner lobe a U-shaped rod. The posterior arm obtuse with three to four strong setae emerging at tip; the anterior arm longer, ending in two strong teeth, the upper tooth thicker and with one or two setae emerging from posterior surface.

Holotype.—(Male) New Caledonia, Mt. Koghi, 27.i.1963 (C. Yoshimoto and N. Krauss) BPBM Slide 2042.

***Styringomyia bidens* NEW SPECIES**

Male. Length 5.3 mm; wing 4.3 mm. Antennae with scape and pedicel brown, remainder broken. Palps light brown, the tip yellow. Head, thorax, and abdomen brown with light yellow stripe down midline, continuing to hypopygium. Halteres

light brown at bases, yellow at tips. Hind coxae yellow, other coxae brown. Front femur yellow with light brown ring at the three-quarter mark, remainder of legs broken. Wings with yellow tinge, veins light brown, with branches of Rs, r-m, m-cu and 2A darker; a barely perceptible brownish cloud over cord and r-m. Venation standard, with 2nd Cell M_2 sessile; vein 2A strongly curved to margin. Hypopygium (Fig. 2) with basistyle having two modified setae at tip of the distal tubercle. Ninth sternite parallel-sided, the apex with a deep U-shaped notch, the lateral angles produced into slender lobes, not tipped with setae. The ninth tergite is broad at the base, forming a triangle at the setiferous tip, which extends posteriorly to the level of the tubercles of the basistyles. The outer dististyle an elongate blade, the distal end with one short and one elongate seta directed cephalad. Inner dististyle with the outer lobe a small, triangular plate, with about 14–15 sclerotized teeth on the inner surface. The middle lobe with a row of sclerotized teeth at the base, six teeth near the apex, the remainder of the teeth as in Fig. 2. The outer surface of the middle lobe platelike and glabrous; the inner lobe a long heavily sclerotized bar which forks into two thick points, the ventral point thicker than the dorsal.

Holotype.—(Male) Ryuku Islands, Iriomote I., Mt. Ushiku, 350 m, 2.xi.1963 (G. A. Samuelson) BPBM Slide 2106.

Styringomyia digitostylus NEW SPECIES

Male.—Length 5.6 mm; wing 5.0 mm. Antennae with scape and pedicel yellow on ventral half, brown on dorsal half. Head dark brown, pronotum slightly lighter. Mesonotum with three brown stripes separated by yellow to wing base, remainder of mesonotum and metanotum brown with a yellow stripe at midline. Coxae and trochanters yellow, remainder of legs missing. Wings tinged with yellow, veins light brown with brown clouds over fork of Rs, the basal portion of Cell 1st M_2 , m, and r-m. Venation standard with Cell 2nd M_2 sessile. First abdominal segment brown, remainder of segments yellow brown with a darker brown ring at posterior border of each segment. Hypopygium (Fig. 3) with basistyle having one strong modified seta at tip of tubercle; tubercle and seta subequal in length. Ninth sternite elongate, slender, with two setae at tip. Ninth tergite short and truncate. Outer dististyle an elongate blade, with long setae at tip. Inner dististyle with outer lobe an elongate blade having short, blunt, black teeth bordering distal end. Mesal lobe also an elongate blade with short, blunt, and black spines at distal margin; the inner margin directed dorsad and mesad forming a small membranous tooth, darkened at point. Beneath the distal spines is a bulbous area, from which extends a prominent, curved, and coiled fingerlike projection.

Holotype.—(Male) Ryuku Islands, Iriomote I., Mt. Ushiku, 350 m, 7-10.xi.1963 (G. A. Samuelson) BPBM Slide 2105.

Styringomyia rostristylus NEW SPECIES

Male.—Length 4.7 mm; wing 3.5 mm. Antennae with scape and pedicel dark brown ventrally, light yellow dorsally, flagomeres yellow. Palpi ochreous, darker at tips. Head yellow. Pronotum, mesonotum, metanotum, and first abdominal segment light brown. Remainder of thorax, coxae, and trochanters yellow. Dorsum of abdominal segments yellow, dark brown on latero-posterior margin; sterna yellow. Legs yellow. Front femur with an incomplete dark brown band at midlength, another smaller band at three-quarter length; hind femur with same coloration and markings;

front tibia with complete dark brown band at midlength, another at distal end; tarsi yellow, darker at tips, last segment dark brown; remainder of legs broken. Wings tinged with yellow, brighter along costal edge. Veins yellow with dark brown markings at anterior arculus, fork of Rs, r-m, m-cu, fork of M_{3+4} , base of 2nd Cell M_2 , and distal section of 2A. Venation standard, with 2nd Cell M_2 sessile; 2A curved sharply to margin. Hypopygium with one modified seta extending from the basistyles; the ninth sternite and tergite as indicated in Fig. 4. The outer dististyle an elongate blade, curved slightly mesad at midlength, with one short and one elongate seta at the tip, the latter directed cephalad. Inner dististyle as in the drawing. The basal extension of what appears to be the inner lobe elongate, expanded and rounded at the tip, and a thick spine extending from the ventral edge, appearing much as a beak or rostrum from the head of a bird.

Holotype.—(Male) British N. Borneo, Forest Camp, 19 km N. of Kalabaken, 25.x.1962 (K. J. Kuncheria) BPBM Slide 2104.

Styringomyia vietnamensis NEW SPECIES

Male.—Length 5.1 mm; wing 6.5 mm. Antennae with scape, pedicel, and first flagellomere yellow, remainder of flagellomeres missing. Palps yellow. Head yellow, vertex mottled. Prothorax reddish brown with lateral yellow markings on either side and along posterior margin. Mesothorax reddish brown with gray pruinosity over surface; inner area of scutellum marked with yellow; paratergites yellow. Metanotum brown. Abdomen yellow, only slightly patterned with brown dorsally and ventrally. Wings tinged with yellow, lighter in cells. Veins yellow. No markings on wings except a slight darkened at r-m. Venation standard with Cell 2nd M_2 scarcely sessile. Foreleg yellow with no rings; last tarsal segment abruptly dark brown. Remainder of the legs missing. Hypopygium (Fig. 5) slightly darker yellow than the remainder of the body. Basistyle with two modified setae from tubercles, one slightly behind the other. The ninth tergite and oval-shaped hirsute lobe abruptly expanding on the lateral edges. The ninth sternite truncate with a large seta at either corner of the posterior margin. Outer dististyle bladelike, clear, with an elongate seta at the tip directed cephalad. Inner dististyle with the three lobes having a continuous comb of peglike spines on outer edges; the inner surface of the lobes also with peglike spines. At the outer tip of what appears to be the middle lobe is an elongate, slightly sinuate spine.

Holotype.—(Male) Vietnam, Fyan, 900-1000 m, 11.vii-9.viii.1961 (N. R. Spencer) BPBM Slide 2109.

Paratype.—(Male) same information as given for holotype.

Styringomyia ysabellae NEW SPECIES

Male.—Length 5.7 mm; wing 4.5 mm. Antennae with scape and pedicel light yellow dorsally, brown ventrally; flagellomeres missing. Palps fulvous at base becoming pale yellow at tips. Head dark brown. Thorax ochreous; haltere yellow at base, lighter at tip. Coxae and remainder of legs yellow; femur with incomplete brown bands at midlength, three-quarter length, and very tip; tibia with brown band at one-third length and very tip. Tarsi light yellow, abruptly dark brown on last segment. Middle legs missing. Abdomen yellow with posterior margin of each vergum dark brown. One strong black seta above each inner edge of the antennal scape, directed laterad and cephalad; one on each side of the vertex at about the level

of the posterior margin of the eye, erect and directed cephalad; two on each antero-lateral edge of the antepronotum, subtended by two to three smaller setae, both sets directed cephalad; one at each postero-lateral corner of the postpronotum, directed cephalad. At the lateral end of the preascutal suture are smaller, but still strong, pencils of two setae each; on either side of the midline behind the transverse suture are two pairs of setae, the larger on the scutellum near the base of the wing, the other on the postscutellum. Venation standard, cell 2nd M_2 sessile and vein 2A strongly curved to the edge of the wing. Dark brown marks at anterior arculus, fork of Rs, r-m, fork of M_{3+4} , junction of m, and all tips of veins reaching lateral and posterior margins of wing. Membrane surrounding r-m also with dark brown cloud. Hypopygium (Fig. 7) yellow. Basistyle with two strong modified setae, the dorsal thicker and curved medially. The ninth tergite elongate, triangular, covered with numerous, very small setae. The ninth sternite truncate, with a small protrusion at midline. Outer dististyle bladelike with two setae at tip, one small, the other elongate and directed cephalad; at midlength a puffed cushion covered with setae; on the outer edge, at the base of the style, is a row of four to six small, dark, peglike setae. The inner dististyle is a flattened plate narrowing distally to a point. The distal third has a row of about 20 peglike spines; at midlength on the inner edge occurs an expanded cushion from which many setae project medially. The inner edge with a dorsal, stout, sharp, triangular tooth and a ventral dark, thick, rectangular, projection with the outer corners forming small teeth.

Holotype.—(Male) Solomon Islands, Santa Ysabel SE, Tatamba, 0–50 m, 7.ix.1964 (R. Straatman) BPBM Slide 2117.

Paratype.—(Male) Solomon Islands, Santa Ysabel SE, Tatamba, 0–50 m, 8.ix.1964 (R. Straatman).

Styringomyia dilinhi NEW SPECIES

Male.—Wing 4.1 mm. Head missing. Thorax and abdomen dark brown with yellow on the paratergite and on the katapisternum, giving the appearance of broken stripes on the pleural area. Coxae and trochanters brown. All legs missing except for femur of foreleg. The femur is light brown with two broad dark brown bands, one midlength, the other at distal end; halteres light brown. Venation standard, Cell 2nd M_2 sessile and vein 2A strongly curved to edge of wing. Wing with brownish tinge, veins brown, darker marking at r-m, extending on to surrounding membrane. Hypopygium (Fig. 8) brown with one thick, modified seta coming off a tubercle, both subequal in length and directed mesad. The ninth sternite is slender, elongate, with two setae at the tip. The ninth tergite is broad at its base, which then narrows into a short protrusion covered by many fine setae. The outer dististyle is a very slender, curved, blade with two setae at the tip, one very short, the other noticeably elongate, nearly three-fourths the length of the blade and directed cephalad. The inner dististyle arises at the base of the tubercle of the basistyle, extending mesad at a right angle. The inner lobe is a flattened plate with dark teeth at its apex. Two rows of nine to ten peglike setae are beneath the teeth. The outer lobe is also flattened and elongate. The tip is expanded into a triangular plate with four to six short, dark teeth at the most posterior point. At midlength, along the inner edge, arise several strong, elongate setae, directed basad.

Holotype.—(Male) Vietnam, Di Linh (Djfring), 1200 m, 22-28.iv.1960 (L. W. Quate) BPBM Slide 2066 (genitalia).

Styringomyia labuanae NEW SPECIES

Male.—Length 4.8 mm; wing 3.4 mm. Antennae with scape yellow, pedicel brown, flagellomeres missing. Palpi and head light brown, darker on either side of midvertex to posterior margin. Pronotum brown on sides, light brown medially. Praescutum dark reddish brown, yellow along lateral margins and including paratergites. Scutellum and metanotum dark reddish brown, yellow spots at base of wing and edges of metanotum. Halteres light brown. Pleura, coxae, and trochanters yellow. Hind legs yellow, darkened at tip of femur; remainder of legs broken. Abdomen yellow, darker at hypopygium. Wings yellow with dark brown markings, which include both veins and surrounding membranes in areas r-m, m-cu, base of cell 1st M_2 , and at bend of 2A, and tips of veins reaching outer margin of wing. Venation standard, with cell 2nd M_2 short petiolate, 2A bent sharply at a right angle to the margin of the wing, a spur at the angle. Hypopygium (Fig. 6) with one modified seta from tubercle of basistyle (spines on holotype broken). The ninth sternite elongate, coming to a blunt point from which two short, thickened setae extend. The ninth tergite a small plate, tip obtuse, and covered with fine setae. Outer dististyle flat, slender (probably with an elongate seta at the tip, although these are broken on the type). Inner dististyle with three lobes; the outer with short setae lining the margins, the middle lobe with 10–11 large teeth on margins, the inner lobe a short triangular plate, with a brush of setae directed laterally on its inner surface.

Holotype.—(Male) British N. Borneo, Labuan Island, 28–29.xi.1958 (L. W. Quate) BPBM Slide 2110 (genitalia).

Paratype.—(Male) same data as given for holotype.

Styringomyia idioformosa NEW SPECIES

Male.—Length 6.0 mm; wing 5.3 mm. Antennae with scape large and light brown, pedicel and flagellomeres darker; palpi dark brown. Head dark brown with yellowish tinge on vertex. Thorax dark brown; scutum with a light yellowish brown stripe on either side of the midline; scutellum slightly lighter, with a yellowish tinge. Abdomen dark brown. Legs dark brown with a yellowish ring about three-quarter length and at base of tibia; remainder of leg lighter. Hind leg with the first tarsal segment abruptly white, remainder of the tarsi brown. Venation standard, with m-cu gently sigmoid, cell 2nd M_2 sessile; 2A curved gently to margin. Wing dark brown with white transverse stripes at base, middle, and extreme tip. Hypopygium (Fig. 9) yellow brown, dististyles darker. Basistyle with three strong modified setae, two at the end of an elongate tubercle, one slightly posterior. The ninth tergite a dark brown, wide, elongate plate from which emerges a small obtuse plate covered with numerous, small, golden setae. The sternite brown, short, obtuse. Phallosome an elongate rod with two black dots just before the blackened tip. Outer dististyle a long, brown blade with one short seta and one long seta extending cephalad; the inner face with a group of short, spinous setae about midlength; the base with six to seven black, peglike setae along the inner edge. Inner dististyle with the outer lobe a flattened, oval plate, glabrous on the outer surface; setae over entire inner surface, more numerous at tip and along edges. Inner lobe a small triangular plate with several setae along the basal margin.

Holotype.—(Male) Solomon Islands, Bougainville near Crown Prince Rs., 900 m. 11.vi.1956 (J. L. Gressitt).

Paratype.—(Male) same data as given for the holotype. BPBM Slide 2122 (genitalia).

The species *Styringomyia idioformosa* (*idio* = strange, *formosus* = pretty) is very interesting in having banded wings and three modified spines extending from the basistyle, features found in no other species of this genus described to date.

EXPLANATION OF FIGURES

Figures 1–9. 1. *Styringomyia bidentata* n. sp. 2. *S. bidens* n. sp. 3. *S. digitostylus* n. sp. 4. *S. rostrastylus* n. sp. 5. *S. vietnamensis* n. sp. 6. *S. labuanae* n. sp. 7. *S. ysabellae* n. sp. 8. *S. dilinhi* n. sp. 9. *S. idioformosa* n. sp. (b = basistyle, t = ninth tergite, s = ninth sternite, od = outer dististyle, id = inner dististyle, il = inner lobe of inner dististyle, ol = outer lobe of inner dististyle, p = phallosome).

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*Dedicated
to
E. Gorton Linsley*



E. Gorton Linsley

E. Gorton Linsley
Professor Emeritus
University of California, Berkeley

I have a twofold purpose in this dedication to E. Gorton Linsley. The first is to acknowledge on behalf of the Pacific Coast Entomological Society his dedication, efforts, and contributions, not only to the Society, but to the field of entomology as well. The second, more personal, is to express my gratitude, gratification, and satisfaction for the years of friendship and collaboration. It has been an honor and a privilege to have been closely associated with Gort for the past 30 years.

It is not my intended purpose to build a chronological list of Professor Linsley's accomplishments in the field of entomology, since even a neophyte is aware of these to some degree. The more than 400 published scientific papers, books and articles attest to his academic productivity. Although a large portion of Gort's career was spent on the study of systematics and biologies of the Apoidea and wild bee pollination studies, the systematics of the Cerambycidae are probably his first love. It was due to his efforts that the "Monograph of the Cerambycidae of North America" was initiated. This project, now nearing completion, will surely remain a monument in the forthcoming years.

Gort has been an inspiration to those closely associated with him, both as students and as collaborators. His associations with the author, R. F. Smith, John MacSwain, P. D. Hurd, Jr., A. E. Michelbacher and R. L. Usinger are some examples of not only working, but close personal relationships.

No tribute to Gort would be complete without mention of Juanita Linsley who has been wife, companion and field assistant for over 50 years. Their relationship is an excellent example of the harmonious blending of professional and personal life.

On this, the occasion of Gort's 77th birthday, the entire community of the field of entomology wishes him well and many happy returns. Also our thanks for setting an example of personal integrity and professionalism of the highest caliber.

John A. Chemsak, Editor
Pan-Pacific Entomologist

The Relictual Bee Genus *Manuelia* and Its Relation to Other Xylocopinae (Hymenoptera: Apoidea)

HOWELL V. DALY, CHARLES D. MICHENER, J. S. MOURE, S. F. SAKAGAMI

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Abstract.—The bee genus *Manuelia* Vachal (subfamily Xylocopinae) is redescribed, and its three species, all found in Chile and Argentina, are also characterized. Although *Manuelia* looks superficially like *Ceratina*, it is intermediate in its character combination between the tribes Xylocopini and Ceratinini, and has a few synapomorphies of its own. Its nests are more similar to those of *Xylocopa* than to those of *Ceratina*. It appears to be a relict genus, nearer than any other to the ancestral group from which Xylocopini and Ceratinini diverged. The three species of *Manuelia* are redescribed and emphasis is placed on striking morphological characters that make them as different from one another as subgenera in other Xylocopinae.

Ceratina herbsti Friese is shown to be a new synonym of *Manuelia gayatina*. Because of nomenclatural confusion the type species of *Manuelia* and of the halictid generic name *Corynogaster* Sichel are designated.

A genus of small xylocopine bees, *Manuelia*, consisting of three species found in Chile and Argentina, is so similar superficially to the widespread genus *Ceratina* that it has attracted relatively little attention. Our study, however, shows that it is a relict type, almost as close to *Xylocopa* as to *Ceratina*.

This study was first made by two of us (HVD and JSM) over 20 years ago, then independently repeated with additional material by SFS and CDM; the two manuscripts were amalgamated by CDM since the coverage and conclusions were too similar to justify independent publication. Each manuscript was stronger than the other in some features, and each recorded some significant characters not noted in the other. The illustrations except for the maps were made by SFS.

Nomenclatural Problems

The taxonomic history of the three species is confused and involves the generic name *Manuelia* as well as the names *Corynura* and *Corynogaster* in the Halictidae. Spinola (1851) described the three species of *Manuelia* as species of *Halictus* that possessed certain distinctive characters not shared by other Halictinae. The bees were *Halictus gayi* (p. 208, no. 10, female, male), *H. posticus* (p. 208, no. 11, female, male) and *H. gayatinus* (p. 209, no. 12, female). In the same volume he described the

male of a genuine halictid bee, *Corynura gayi* (p. 301, no. 1), but placed it in the Thynnidae. His associated female was a wasp, but the male was described first and the name *Corynura* has been used for the bee; the problem was discussed by Alfken (1926). Following Spinola, Smith (1854:424–425) listed all three species of *Manuelia* as *Halictus*. Sichel (1867:146) described as new “*Halictus* (*Augochlora* Smith) *chrysurus*”; it is apparently a synonym of *H. gayi*. Correctly recognizing the male of *Corynura gayi* as a bee, he also erected a new genus, *Rhopalictus*, to include “*Corynogaster gayi* Spinola” (p. 301, no. 1) and others. Spinola did not mention *Corynogaster* and we must assume that Sichel meant Spinola’s *Corynura gayi* of the same page and number. This was also the interpretation of Herbst (1917) and is supported by the fact that Sichel recognized the difference between the *Halictus gayi* and the *Corynura gayi* of Spinola. Eickwort (1969), in listing *Corynogaster*, noted “*lapsus* for *Corynura*?” *Rhopalictus* is a synonym of *Corynura* although its type species is *C. flavofasciata* Spinola, not *C. gayi*.

Until 1896 the use of the specific name *gayi* for two unrelated bees, one a xylocopine incorrectly placed in *Halictus*, the other a true halictid, had not resulted in confusion of the two. However, while correctly listing *Halictus posticus* and *H. gayatinus* under *Halictus*, Dalla Torre (1896) placed *H. gayi* in *Corynura* and gave the reference as *Halictus* (*Corynura*) *gayi* Spinola, “p. 208 n. 10 & p. 301 n. 1.” Placement of the *Corynura gayi* and the *Halictus gayi* of Spinola as the same species by Dalla Torre, without the recognition that they were different species (indeed they are different families), began a long line of confused nomenclature. Dalla Torre further listed *Rhopalictus gayi* Sichel (“p. 146, n. 1”) as a synonym (the reference should have been to no. 3). As shown above, *Rhopalictus* is concerned only with *Corynura*, not with *Manuelia*.

Alfken (1904:141), recognizing that they are long-tongued bees not related to *Halictus*, placed *Halictus gayi*, *H. posticus*, and *H. gayatinus* in *Ceratina*. Friese (1910) concurred by redescribing *H. gayatinus* as *Ceratina herbsti*. Vachal (1905) erected a new genus, *Manuelia*, in honor of M. Manuel-J. Rivera, for the three species. Vachal did not mention Alfken’s transfer, but arrived at the same general conclusion, namely, that these species are near *Ceratina*. Cockerell (1905) listed *Halictus posticus* and *H. gayatinus* with the comment that Alfken placed them in *Ceratina* and Vachal erected a new genus for them. He incorrectly placed *H. gayi* as a synonym of *Rhopalictus gayi*, i.e., *Corynura gayi* Spinola (p. 301, no. 1), but Cockerell objected to Dalla Torre’s association of *Corynura* with this species. On the other hand, Friese (1916:554) listed *Halictus gayi* (Spinola p. 208), but his description indicates that he had *Corynura gayi* (Spinola p. 301) and he could not distinguish his specimens from *Halictus rubellus* Haliday, a species of *Corynura*.

Sandhouse (1943), apparently following Dalla Torre (1896), designated *Halictus* (*Corynura*) *gayi* Spinola as the type species of each of the following generic names: *Corynura*, *Corynogaster*, and *Manuelia*. She listed the last two as synonyms of the first. The combination “*Halictus* (*Corynura*) *gayi* Spinola,” however, involves two different species (and families) of bees described by Spinola on different pages. To avoid further confusion, we regard *Halictus* (*Corynura*) *gayi* Spinola used by Dalla Torre (1896) and Sandhouse (1943) as a meaningless combination. It is not possible to say whether Sandhouse designated *Halictus gayi* Spinola or *Corynura gayi* Spinola as the type species of the three generic names concerned. Therefore she did not designate valid type species for these genera. The type of *Corynura* was designated

by Alfken before Sandhouse's work, but for the other genera we designate type species here, using Sandhouse's format:

Corynura Spinola (= *Corynogaster* Sichel)

Historia fisica y politica de Chile . . . por Claudio Gay, Zool., vol. 6, p. 296, 1851. Two species.

Type species.—*Corynura gayi* Spinola, 1851, *Ibid.*, p. 301. (By designation of Alfken, 1926, Deutsche Entom. Zeitschr., 1926: 146.)

(*Corynogaster* Sichel) = *Corynura* Spinola

Novara-Expedition. Zoologischer Theil, vol. 2, Hymenoptera, Fossoria et Mellifera. Suppl. p. 146, 1867. Two species.

Type species.—*Corynura gayi* Spinola, 1851, Historia fisica y politica de Chile . . . por Claudio Gay, Zool., vol. 6, p. 301. (Present designation.)

Manuelia Vachal

Bull. Soc. Ent. France, p. 25, 1905. Three species.

Type species.—*Halictus gayi* Spinola, 1851, Historia fisica y politica de Chile . . . por Claudio Gay, Zool., vol. 6, p. 208. (Present designation.)

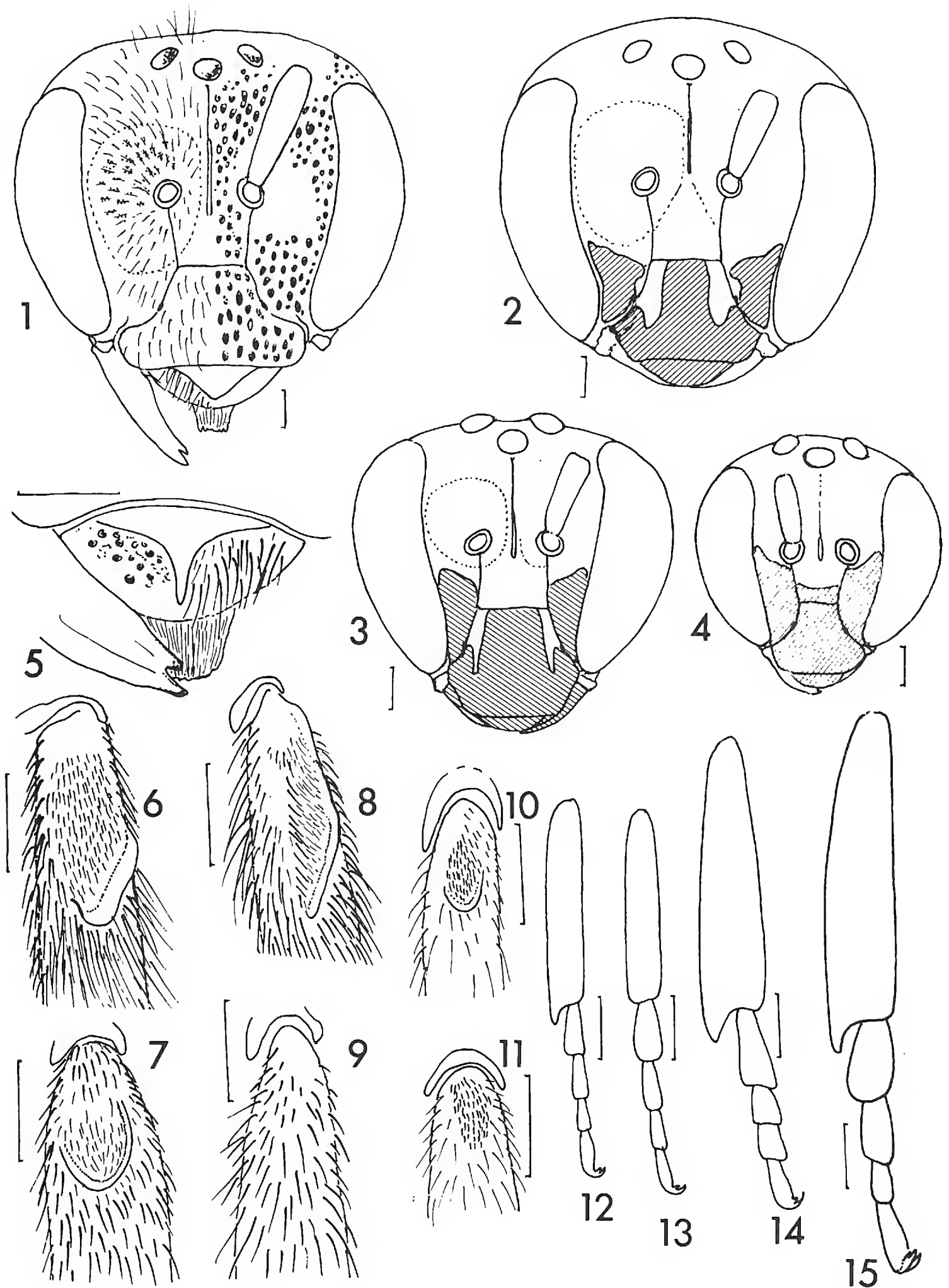
Sandhouse also lists *Halictus gayatinus* Spinola as the type species of "*Presbia* Spinola." In his discussion of the possible generic relationships of *H. gayatinus*, Spinola states (p. 209) that this species does *not* belong to "*Presbia* Illig." Like Sandhouse, we have been unable to discover Illiger's publication of *Presbia* and we regard this name as a nomen nudum. Therefore *H. gayatinus* is not the type species of a genus *Presbia* Spinola, as indicated by Sandhouse.

Genus *Manuelia* Vachal

Description.—Many specific characters are indicated in this description in order to show the variability within the genus. Characters not relating to all three species are marked with the abbreviated names of the species that possess them, as follows: ga = *M. gayi*, po = *M. postica*, and gt = *M. gayatina*. Other characters are indicated in Table 1 and in the illustrations. Some important features are italicized. Terga and sterna are abbreviated T and S and numbered as metasomal structures. Features resembling Ceratinini are annotated "(C)"; those resembling Xylocopini, "(X)," and special features of *Manuelia*, "(M)." An asterisk indicates that variation exists so that the statement of similarity, while generally true, breaks down in certain cases.

Female.—Body slender, 4.9–8.5 mm long (C). Color dull metallic blue (ga, similar to *Pithitis unimaculata*) or black with apical segments reddish (po) or not (gt); legs, tegula, mandible tending to be brownish, tergal margins not depigmented. *No pale maculations* (X*). Wings grayish hyaline, veins and stigma dark brown to black. Pilosity sparse, not hiding surface except fringe of lateral lobe of pronotum and (ga) area on each side of pygidial plate; predominantly whitish to pale yellow, ferruginous on T6 (ga, po).

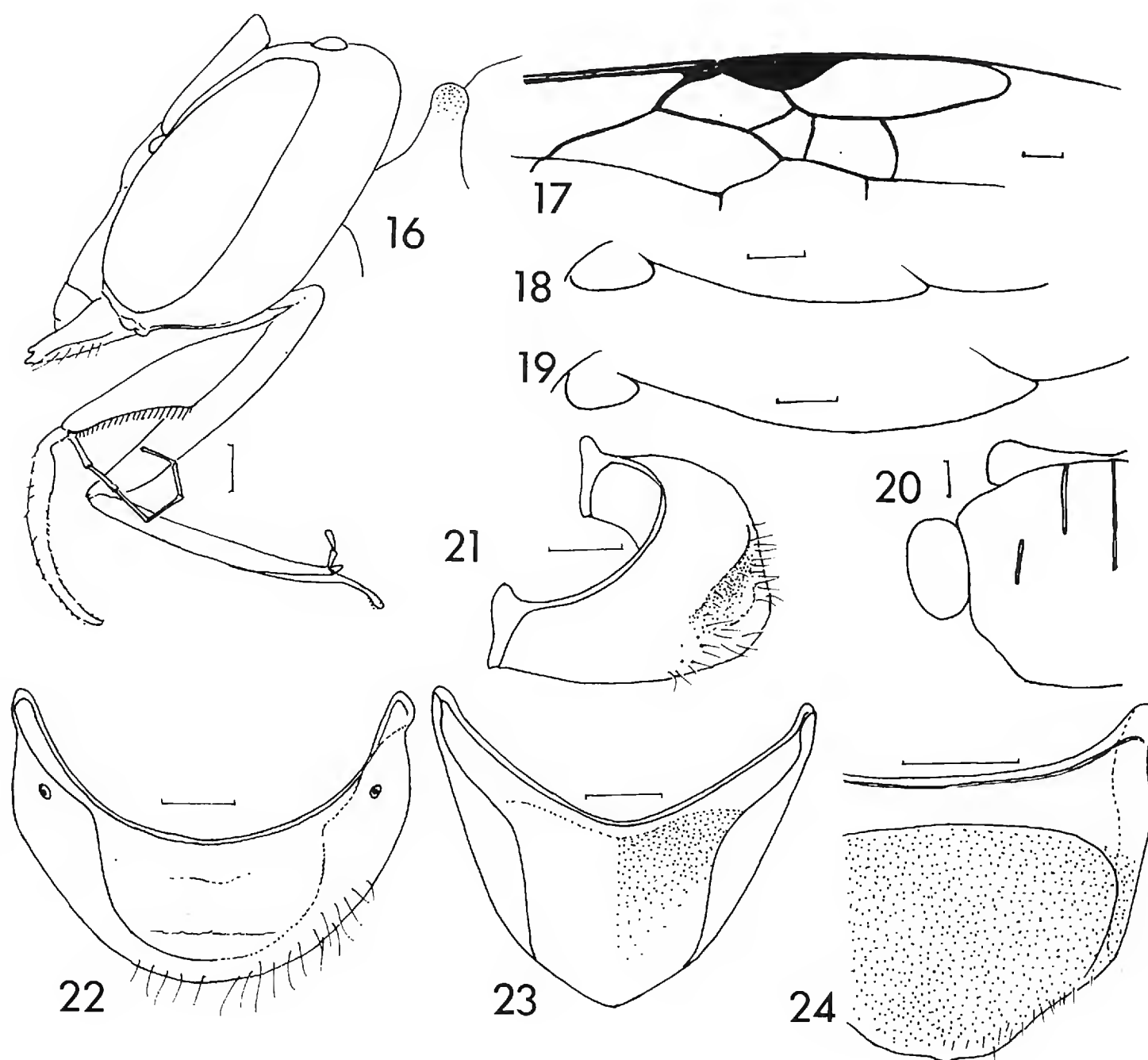
Head (Figs. 1–4, 16) slightly wider than long, more elongate than in most *Ceratina* and *Xylocopa* but less so than in *Braunsapis*. Outer and inner orbits convergent below, more so than in most *Ceratina* and *Xylocopa*. Antennae slightly above middle of eyes. Vertex seen frontally gently convex. Preoccipital and paraocular carinae absent. *Circumalveolar depression wide*, from antennal base down nearly to level of lower margin of supraclypeal area, up an equal distance, and laterally nearly to inner orbit in its median one third. Antennocellar triangle much larger than ocellar triangle. Supraclypeal area above with narrow frontal carina, extending upward as



Figures 1-15. 1. Face of *Manuelia gayi*, female. 2-4. Faces of males, *M. gayi*, *postica*, and *gayatina*; shaded areas are yellow. 5. Labrum of female, *M. postica*. 6-11. Bases of left hind tibia, even numbers, females, odd numbers, males; 6, 7. *M. gayi*; 8, 9. *M. postica*; 10, 11. *M. gayatina*. 12-15. Hind tarsi; 12, 13. *M. gayatina*, female, male; 14, 15. *M. gayi*, female, male. In these and all other illustrations, the scale line = 0.25 mm.

linear, shallow frontal sulcus nearly attaining anterior ocellus. *Clypeus flat*, its upper half contrasting with gently convex, raised supraclypeal area. Lower margin of clypeus straight, extending beyond lower end of eye; lower lateral part only obliquely and briefly bent backward at side of labrum; lateroclypeal carina represented by weak ridge. *Lateral clypeal margin mildly concave, giving shape of clypeus neither typically inverted T form as in Ceratina nor hourglass form as in allodapines (X*)*. Tentorial pit at upper third of clypeus (X). Upper margin of clypeus nearly straight (ga, gt) or gently convex (po); summit of clypeus about as wide as paraocular area at same level. Mandibular axis slightly behind ocular axis. Malar area linear, much shorter than scape width. Gena (Fig. 16) narrower than eye, moderately convex, seen laterally not declivous immediately behind summit of eye. Labrum (Figs. 1, 5) in repose at right angle to clypeal surface, about twice as broad as long, semicircular, apex with wide tuft of long, dense simple orange-brown hairs (M but resembling X). Labrum *basally with triangular, slightly elevated, hairless smooth "disc" as in some Xylocopa (X*)*. Mandible tapering from base, not abruptly narrowed as in *Ceratina* (X). Mandible *apically bidentate* (Figs. 1, 5, 16), fringed beneath with long, white or yellowish simple hairs. Maxillary palpus 6-segmented, *reaching nearly to apex of galea (X)*, segments approximately equal in length, progressively more slender apically (Fig. 16). Galea six or more times as long as broad (C). Stipes with comb of moderate strength (C). Mentum over five times as long as wide (C). Flabellum with posterior surface smooth, setal row in middle to near apex of flabellum (C). Proboscidal fossa with sclerotic roof (C). *Antenna relatively long*, much longer than in *Ceratina*, surpassing middle of mesoscutum (M). *Scape relatively short* (Figs. 1–4), attaining lower margin of anterior ocellus (about as in *Ceratina*), about 4 times as long as wide (C). *Flagellum* (Figs. 25–30) 2.5 (ga), 2.7 (gt) or 3.0 (po) times as long as scape (M). First flagellomere as long as or shorter than pedicel (C).

Mesosoma generally smooth and polished, partly coriaceous (especially in ga), punctures rather sparse and coarse. Pronotum not carinate. Prosternal apophyseal arms with apices separate (C) (fused in *Xylocopa*). Mesoscutum anteriorly not carinate, *notaulus strong, parapsidal sulcus shorter than in Ceratina, Braunsapis, and Xylocopa*, less than half length of tegula which is fairly large, only slightly shorter than half scutal length (Fig. 20). Metasternum projecting considerably behind lower condyle of hind coxa (X). *Wings apically pubescent, not papillate (C)*. *Stigma broad* (Fig. 17), shorter than costal margin of marginal cell (only slightly so in po) (C). Marginal cell broad with apex rounded, apart from wing margin (C). Submarginal cell 2 distinctly and 3 slightly (or much in gt) shorter than 1 (C). Recurrent veins 1 and 2 respectively near to transverse cubitals 2 and 3. Basal vein slightly apical to cu-v. *Jugal lobe* (Figs. 18, 19) *less than one fifth as long as vannal lobe (M)*. Hamuli 7–10; hamular sinus as deep as wide (C). Fore coxa with apical hairy spine short (C*) (long in gt). Strigilis as in *Ceratina* and *Braunsapis* (C). Arolia large; claws bifid. Fore and mid tibial spines acute, hind tibia without spine (C). Fore and midtibial spurs normal (as in *Ceratina* and *Braunsapis*) (C). Tibial scopa of sparsely plumose (often trifid) hairs (C), moderately developed (ga, po. Fig. 31) or sparser (gt, Fig. 32). Hind tibial spurs microserate, apically gently (gt, Fig. 32) or rather strongly bent (ga, po. Fig. 31). *Basitibial plate distinct* (Figs. 6, 8, 10), simple (C), with short white hairs basally. *Hind basitarsus produced* as bluntly pointed process beyond base of second tarsal segment (X) (Figs. 12, 14). Coxae, trochanters, and femora with white plumose or

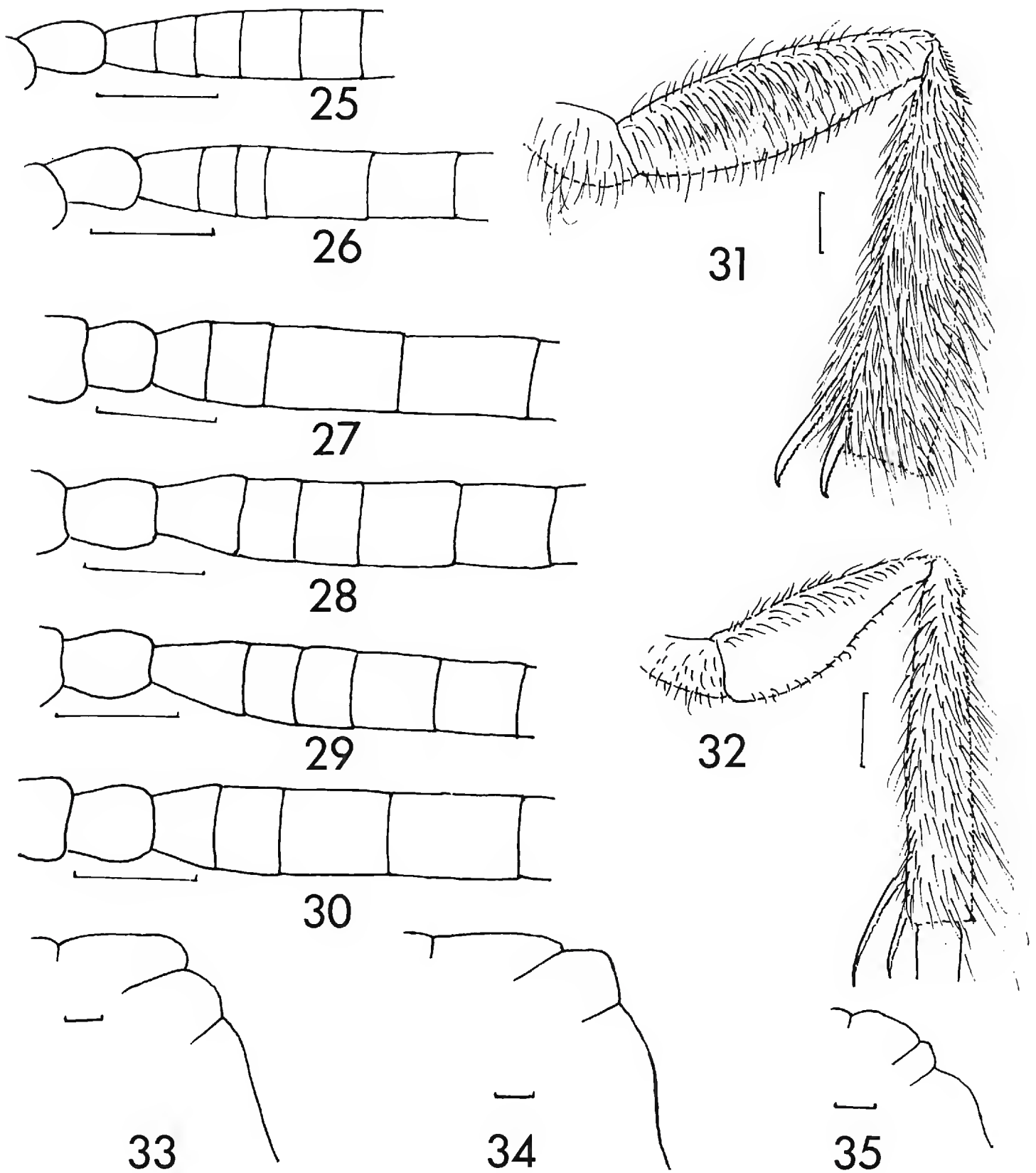


Figures 16–24. 16. Lateral view of head and mouthparts, *Manuelia gayi* female. 17. Part of forewing of same. 18, 19. Posterior basal margins of hind wings, *M. gayi* and *postica*. 20. Pronotum and scutum, *M. gayi* female. 21, 22. T7, male, *M. gayi*, dorsolateral and ventral views. 23, 24. S6, male, inner view, *M. gayi* and *M. gayatina*.

simple hairs; fore and mid tibiae and tarsi with abundant, white to yellowish, mostly simple hairs; apex of second trochanter and base of second femur each with a mesal patch of dense, short, erect, white, simple hairs.

Metasoma widest at middle. Metasomal terga transversely microlineolate and dully polished, punctures rather sparse, coarser on apical terga. T1 basally oblique, basal part not sharply declivous or differentiated. Graduli 2–5 laterally not much extending posteriorly beyond spiracles; apical terga not flattened as in allodapines. Sterna without recognizable glandular areas (X); ventral hairs sparse, not forming scopa. T6 not slanting down apically, *with narrow, spine-like, apically upraised, dorsally flattened pygidial plate* (X) *surrounded with dense plumose hairs* (pygidial fimbria) (X) (Fig. 57) which become longer and sparser laterad.

Male (differences from female only).—Face with yellow markings (Figs. 2–4). Inner orbits below more convergent in po and gt (Figs. 3, 4). Head (and other parts,



Figures 25–35. 25–26. Pedicel and base of flagellum, *Manuelia gayatina*, female and male. 27, 28. Same, *M. postica*. 29, 30. Same, *M. gayi*. 31, 32. Outer side of hind leg of female, *M. postica* and *gayi*. 33–35. Profiles of posterior part of thorax and propodeum of females, *M. gayi*, *postica*, and *gayatina*.

too) generally less coriaceous and more polished than in female. Labrum uniformly gently convex and punctate. Mandible bidentate (ga) or simple (po, gt). Scape not attaining anterior ocellus.

Legs slender, without special modifications, hind tibia and basitarsus with white plumose hairs, in ga densely hairy, suggesting female scopa. Basitibial plate with edge strong but less developed than in female (ga, Fig. 7) or absent (po, Fig. 9, gt Fig.

11), the plate represented by gentle swelling. Hind tibia with two apical spurs (C). Hind basitarsus apically produced as in female in ga and po, not in gt (Figs. 13, 15).

Metasomal T7 directed downward, apical margin broadly rounded, slightly raised along margin so that disc is depressed (Figs. 21, 22); apparent apex of T7 formed by a short, wide, thin, shelf-like, subapical extension with true apex recessed beneath. *S6 apically rounded, without subapical modification as in Ceratina* (X); gradulus reduced, shown merely by different coloration in ga (Fig. 23) or present in gt and po (Fig. 24). *S7 short, transverse*, with elongate lateral arms and no apical process or lobes (Figs. 43, 47, 56) (M). *S8 with sclerotized vessel-like main body, robust lateral apodeme and hollow, apical, sparsely hairy process* (Figs. 41, 42, 48, 49, 54, 55) (M). Gonocoxite robust with wide, dorsal emargination, ventroapically not produced. Volsella absent but “cuspis” (? sense of Marikovskaya, 1975) distinct, small, with fine hairs in ga and po (Figs. 44, 50) but not in gt (Fig. 39). *Gonostylus unornamented, semisclerotized, not fused with gonocoxite* (C*). Penis valve stout, not rod-like, sclerotized, basal bridge strongly sclerotized. Spatha absent (though ventral side of penis weakly sclerotized in po, Fig. 44) or present in gt (Figs. 39, 40).

The “cuspis” is similar to that of Euglossini and may be homologous to some of the anthophorine structures so labelled by Marikovskaya (1975). In addition to those structures, which may not be homologous among themselves, there are other structures in the same vicinity such as the ventroapical plate of the gonocoxite in Allodapini (Michener, 1975) and even the squama between the gonocoxite and gonostylus of Bombini. Further investigation of these structures is needed in order to reliably determine the homologies.

Biology.—Claude-Joseph (1926) described the nesting biology of *M. gayatina* and *M. gayi*. Unfortunately he provided no data by which one might judge the reliability of his statements. For example one does not know how many nests he examined. However, he obviously examined several and perhaps many for each species. As with the morphological characters, the biological ones differ considerably between the two species that have been studied.

The nests are branching burrows in dead stems or rotting wood, sometimes utilizing abandoned beetle burrows (Jaffuel and Pirion, 1926). *M. gayatina* nests in dry stems or twigs; in spring females may clean and reuse old nests or construct new burrows in dead stems of brambles (*Rubus?*). A female does not enter at a broken end of a stem as do females of *Ceratina* and Allodapini. Instead, she cuts into the side of a stem, then makes one branch burrow going down, the other up. Occasionally one bee uses the lower branch, another the upper, with common use of the entrance, but usually there is only one bee per nest entrance. In about a month the first generation emerges and is composed of both sexes. Claude-Joseph (1929) noted that both sexes return to the old galleries for the night. The females of this generation may select, in addition to bramble, dry twigs of wicker, willow, peach, or southern hazel. Toward the end of fall, the second generation metamorphoses, but is said to be composed only of females. The septa between cells are gradually destroyed and the adults move about together in the burrow until spring.

M. gayi makes branching burrows in rotten logs of poplar and weeping willow, starting in November. Each branch is said to be made by one female; obviously there is a common entrance burrow used by several females. Claude-Joseph indicates that up to eight or ten may use one entrance. The burrows enter across the grain of the wood but then turn parallel to the grain. Gazulla and Ruiz (1928) record this species

also nesting in dry stems of zarzamora (*Rubus ulmifolius*); this is as in *M. gayatina*. Apparently there is only one generation per year, for Claude-Joseph indicates that the young grow through December and transform to adults near the end of summer and that both sexes hibernate in their cells until spring. Both sexes may return to their burrows to spend the night (Claude-Joseph, 1929).

The cells of both species are in series in the burrows, separated by partitions made of particles of wood cemented together, evidently as in *Xylocopa* or *Ceratina*. Both upper and lower surfaces of the partitions are illustrated as concave. At least in *M. gayi* the cells are barrel-shaped, narrowed at each end as in *Xylocopa*, rather than cylindrical as usual in *Ceratina*.

The females of *M. gayatina* bring pollen from diverse kinds of flowers to form the elongate firm pollen loaf with a depression in the upper part (or lower part in the upper branch burrow in a vertical stem). The egg is laid in this depression. The food masses are rather similar in shape to those of *Ceratina*, but the egg is evidently on the upper (i.e., toward the nest entrance) rather than the lower part of food. In *M. gayi*, however, the food mass is described and illustrated as a ball occupying the lower end of the cell, with the egg laid on top of it. This is as in many other bees but is unique for the Xylocopinae. The observation needs to be verified.

M. gayatina overwinters as groups of adult females (only), crowded together in the burrows in which cell partitions have been destroyed. This is as in *Ceratina* and *Xylocopa*; such groups have been called prereproductive assemblages by Michener (1985 and in press). In *M. gayi*, however, each adult bee overwinters in its cell with the cell partitions left intact. Overwintering in cells is otherwise unknown in the Xylocopinae and may be an ancestral feature of *M. gayi*, for such behavior is well known in various other bees.

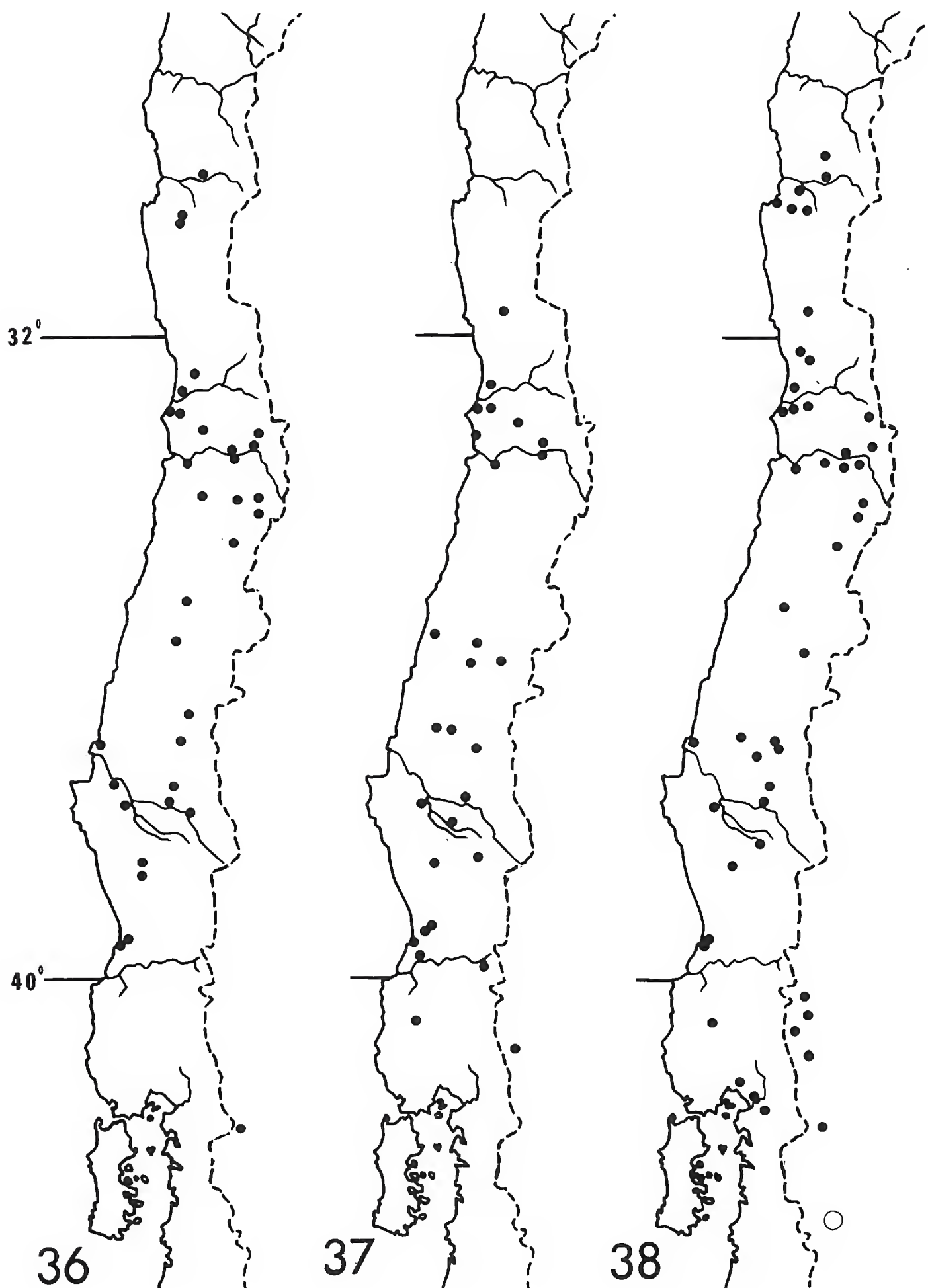
In both species, after hibernation, old burrows are reused while other females excavate new nests. Claude-Joseph believed that in *M. gayatina*, with only females surviving the winter, the first brood is produced parthenogenetically. It is much more likely that the overwintering females mate in the preceding summer or autumn. In view of the longevity now known for other Xylocopinae (Michener, 1985 and in press), it is probable that females of *M. gayatina* live much longer than Claude-Joseph supposed.

Collecting records indicate long seasons of flight. Specimens of all three species have been taken every month from August to March. The rather numerous floral records indicate broad polylecty. There are records of all species from various introduced as well as native flowers. Families reported include the following: Compositae, Cruciferae, Euphorbiaceae, Hydrophyllaceae, Labiatae, Malvaceae, Rosaceae, Scrophulariaceae, Verbenaceae.

Geographical Distribution.—The three species are broadly sympatric in central Chile and the lake district of Argentina. Thus *Manuelia* is characteristic of the Araucanian faunal region (Ringuelet, 1961) which is faunistically so different from the rest of the neotropics that it might be considered a separate faunal realm if it were larger. Among bees such genera as *Diphaglossa*, *Cadeguala*, *Corynura*, and *Neofidelia* are restricted to it. Such large genera as *Alloscirtetica* (Eucerinae) and *Chilicola* (Xeromelissinae) are most abundant in the Araucanian region although extending into other temperate or xeric parts of the neotropics. The Araucanian is also the region inhabited by most of the archaic South American types that show faunal or floral connections with Australia, e.g., Paracolletini among bees and among trees, *Nothofagus* and *Araucaria*. The region also has some faunal

resemblances to Africa, exemplified among bees by the Fideliidae which are found only in Africa and central Chile.

All three species range from rather xeric Coquimbo Province south to moist cool temperate Osorno or Llanquihue Provinces (Figs. 36–38), and from sea level to over



Figures 36–38. Locality records for *Manuelia gayatina*, *postica*, and *gayi*, based on specimens seen by us or by Haroldo Toro of Valparaíso. On the map for *M. gayi* the circle represents unknown localities in Chubut Province, Argentina.

1000 m altitude. While they may attain higher altitudes in the north than in the south, the meager altitude data probably do not show this, for *M. gayi* has been taken at 1400–1600 m altitude at its southernmost known locality in Llanquihue Province. Both *M. gayi* and *postica* have been taken at 1700–2200 m in Santiago Province. Unfortunately most collectors have not recorded altitudes.

There are two locality records that indicate that *Manuelia* also ranges across Argentina. Specimens of all three species in the Snow Entomological Museum are labelled Fundo Malcho, Parral, Córdoba, Argentina. They were taken on various dates in 1956. In the same collection are specimens of *M. gayi* and *gayatina* labelled San Isidro, Buenos Aires Province, Argentina (M. Senkute), also collected on different dates. Could these labels be wrong? Elizabeth Chiappa T. of the Universidad Catolica de Valparaiso writes that there is a Parral, Fundo Malcho, in Chile (Valparaiso area), a finding that suggests bad labelling. Alternatively, might they represent introductions, which could easily occur with nests in wood? There are no old reports of *Manuelia* from eastern or central Argentina, so far as we are aware, e.g., in the works of Holmberg (1903), Friese (1908), and Jörgensen (1912a, b). Recent collections by bee collectors (A. Roig A., R. B. Roberts, and J. F. Neff) at San Isidro and elsewhere in eastern and central Argentina do not include *Manuelia*. We have therefore chosen to regard the records for eastern and central Argentina as probable errors or possible introductions that did not persist, and have omitted these localities from our maps. Future collectors, however, should watch for *Manuelia* in these areas.

The Species of *Manuelia*

The three species of *Manuelia* seem about as different from one another as subgenera in other xylocopine bees. Indeed two of us at one time prepared a manuscript providing a subgeneric name for each species. Such multiplication of genus-group names seems unnecessary, but the distinctiveness of the species should be remembered. Table 1 summarizes the more striking characters including those of the male terminalia which are illustrated, but not included in the specific descriptions.

The characters of the three species are further summarized in the key below. We have not worked out a meaningful cladistic pattern for them because polarity of the specific variables is difficult to determine. For example, for bees in general, a horizontal metanotum and propodeal base like those of most wasps is plesiomorphic relative to the apomorphic slanting or vertical orientations of these surfaces or parts of them, as in *M. postica*. These apomorphies are part of the development of a relatively spherical thorax associated with the rapid flight of many bees. But slender bodies are characteristic of various small bees that nest in narrow burrows in wood or twigs, and such a body form results in reversion to a horizontal metanotum and propodeal base. Examples are *Chelostoma*, *Heriades*, and *Hoplitis* in the Megachilidae; *Hylaeus* and its relatives (especially *Heterapoides*) in the Colletidae; and Ceratinini and Allodapini in the Anthophoridae. Hence the horizontal base of the propodeum of *M. gayatina*, the smallest and most slender species of *Manuelia*, could be primitive features retained from primitive bees or derived features adaptive to life in narrow burrows. Similar problems exist in the interpretation of several other variables.

Table 1. Major characters of *Manuelia* species. Asterisks (*) mark variables common to males and females.

| Variable | <i>gayi</i> | <i>postica</i> | <i>gayatina</i> |
|-------------------------------|--|--|---|
| | Female | | |
| *Coloration | dark metallic blue | black with reddish apical segments | black |
| Lateral margin of labral disc | straight | ----- strongly concave ----- | |
| *Lateral angle of pronotum | protuberant above | not above level of middle of collar | protuberant above |
| *Rear thoracic declivity | beginning at rear edge of scutellum; propodeum straight in profile | beginning in middle of metanotum; propodeum nearly straight in profile | beginning before middle of metanotum but interrupted by horizontal propodeal base |
| Basitibial plate | marginal carina high, erect apically | marginal carina high, oblique apically | marginal carina strong but low |
| | Male | | |
| | | | |
| Mandibular apex | bidentate | ----- simple ----- | |
| Vertex | posterior ocelli in front of summit | ----- posterior ocelli on summit ----- | |
| Flagellomere 3 | ----- much longer than broad, like 4 ----- | | much broader than long, like 2 |
| Apex of hind basitarsus | ----- produced ----- | | not produced |
| Basitibial plate | present | absent, hairs sparse | absent, hairs dense |
| Sternum 6 | gradulus evanescent | ----- gradulus complete ----- | |
| Sternum 7 | apical margin truncate | apical margin gently rounded | apical margin gently pointed medially |
| Sternum 8 | --- basally rounded; apical process basally wide, --- tapering apicad, with sparse hairs | | basally truncate; apical process slender, densely haired |
| Gonobase | wide | narrow | wide |
| Gonocoxite | ----- long, ventrally with “cuspis” but without preapical process ----- | | short, ventrally without “cuspis” but with small preapical process |
| Gonostylus | with sparse but moderately long hairs; base simple | with sparse but moderately long hairs; base bifurcated | with sparse and minute hairs; base simple |
| Penis valves | robust | ----- rather slender ----- | |
| Penis | not sclerotized | ----- partly semichitinous ----- | |
| Spatha | ----- absent ----- | | present |

KEY TO THE SPECIES OF *Manuelia*

1. Entirely black with sparse white pubescence; body length about 5 mm; profile of propodeum curved, with anterior portion horizontal and posterior portion subvertical; metanotum horizontal; anterior coxa with a long median apical spine; true apex of T7 of male without hairs; gonostyli long, equal in length to gonocoxite. *gayatina*
 — Blue or black, at least in female with some caudal integument or hairs orange-brown; body length about 8 mm; profile of propodeum slightly curved or straight, steeply sloping; metanotum subvertical; anterior coxa with small median apical spine; true apex of T7 of male with hairs; gonostyli short, about half length of gonocoxite. 2
2. Black with at least two caudal terga and sterna orange-brown; profile of propodeum slightly curved; curvature of metanotum forming summit of posterior thoracic declivity; labrum of female with basal triangle confluent with subapical margin by a narrow median area; mandible of male without teeth; male without basitibial plate. *postica*
 — Metallic blue, last exposed tergum of female with orange-brown hairs; profile of propodeum straight; posterior margin of scutellum at summit of posterior thoracic declivity, the metanotum declivous; labrum of female with basal triangle elevated apically and separated from subapical margin by a complete transverse punctured area; mandible of male bidentate; male with small basitibial plate. *gayi*

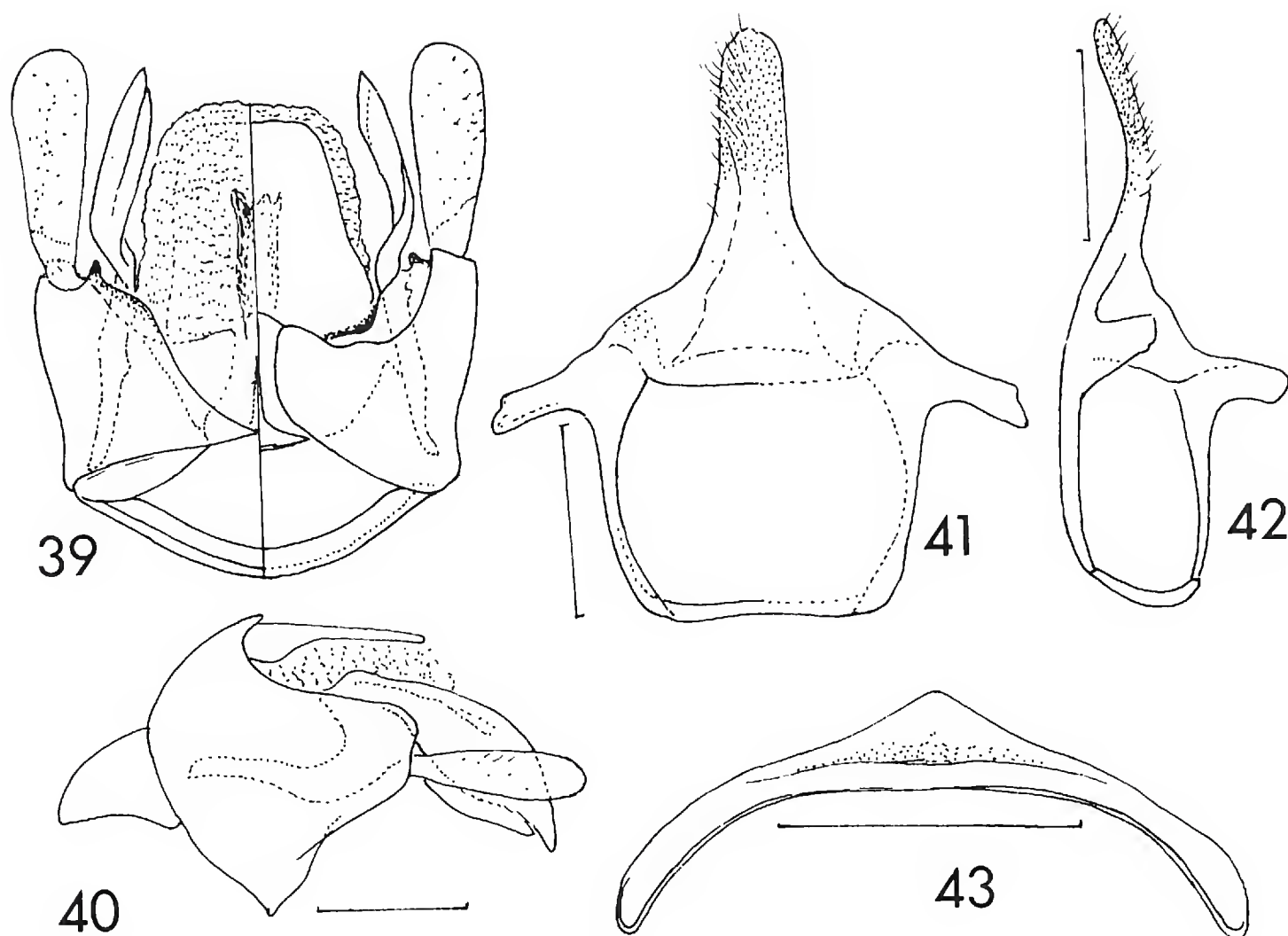
Manuelia gayatina (SPINOLA)

(Figs. 4, 10–13, 24–26, 32, 35, 36, 39–43)

Halictus gayatinus Spinola, 1851:209; Cockerell, 1905:355.*Ceratina gayatina*: Alfken, 1904:141.*Manuelia gayatina*: Vachal, 1905:26; Claude-Joseph, 1926:216; Jaffuel and Pirion, 1926:370; Moldenke and Neff, 1974:9, 29.*Ceratina herbsti* Friese, 1910:703 (new synonym).

A female “typus” of *Ceratina herbsti* Friese in the American Museum of Natural History appears to be a cotype; it is from Concepción, the type locality, collected by Herbst in 1903. Although the synonymy of *herbsti* seems not to have been published, it was recognized long ago for there is a note by Cockerell indicating the synonymy on a specimen in the California Academy of Sciences.

Female.—Average and range of forewing lengths (5 specimens): 4.79 mm; 4.50–5.15 mm. *Head*. Integument shiny dark brown to black; antenna, labrum, mandible black. Circumalveolar depression rather shallow. Subapical margin and basal triangle of labrum shiny and impunctate, confluent by a narrow median area and separated laterad by a transverse punctured area bearing long, yellowish, simple hairs; lateral margin of basal triangle concave. Hypostomal carina low. *Thorax*. Pronotum with lateral angle protuberant above. Thoracic capsule elongate; posterior declivity beginning at scutellar-metanotal suture, scutal-scutellar tangent not touching metanotum; metanotum and anterior dorsal portion of propodeum sloping in same plane, posterior portion of propodeum with steeper slope and clearly not in the same plane as the anterior portion. Integument shiny dark brown to black; anterior dorsal portion of propodeum impunctate and roughened, lateral and posterior portions punctured and with appressed, short, white, plumose hairs; lateral



Figures 39–43. *Manuelia gayatina*, male. 39, 40. Genitalia, ventral, dorsal, and lateral. 41, 42. S8, dorsal, ventral, and lateral. 43. S7.

portions of pronotum and metepisternum with similar vestiture; remainder of thorax punctured throughout, dorsum with erect, white, simple hairs, longer laterally; mesepisternum with sparser, longer, simple to plumose hairs. Tegula brown; number of hamuli (5 specimens): 7. Legs dark brown, paler distally; hairs yellowish distally; scopa sparse. Basitibial plate broad, width about one-half distance from base of tibia to apex of plate, apical edge evenly rounded, strong but low; hind tibial spurs only gently curved apically. *Metasoma*. Elongate ovoid; shiny dark brown to black; T1 and 2 sparsely punctured, remaining terga more densely punctured, with short, ascending to erect, white, simple hairs. T6 with black spine (pygidial plate) flanked by dense, yellowish white, plumose hairs which become longer and sparser laterad. S1–5 with ascending, white, simple or plumose hairs which are longest subapically on each sternum; S6 with appressed to ascending, yellowish, simple to plumose hairs which are dense at apex.

Male.—Forewing length (two specimens): 4.0 mm, 4.4 mm. *Head*. Coloration as in female but the following pale yellow: labrum, paraocular area up to base of antenna, entire clypeus and lower half of supraclypeal area. Mandible simple. Posterior ocelli on summit of vertex. Third flagellomere much broader than long.

Thorax. As in female. Basitibial plate not perceptible. Hind basitarsus not produced at apex. *Metasoma*. Dark brown to black, shiny above, paler and duller beneath; sparsely punctured, especially anteriorly; dorsum and venter with short ascending to erect, white, simple hairs which become longer and frequently plumose laterad. T7 with true apex without hairs. Terminalia as illustrated.

This is the least common of the three species in most collections but the large number of specimens in the collection of Prof. Haroldo Toro in Valparaíso indicates that it is abundant. Probably its small size results in less frequent capture as compared to the larger species. The distribution is shown in Figure 36; the northernmost locality is Vicuña, Coquimbo Prov., the southernmost in Chile is Valdivia, Valdivia Prov. The only locality in western Argentina is El Bolsón, Rio Negro Prov. Altitudes range from sea level to 1100 m at Cabrería, Cordillera Nahuelbuta, Malleco Prov.

Manuelia postica (SPINOLA)

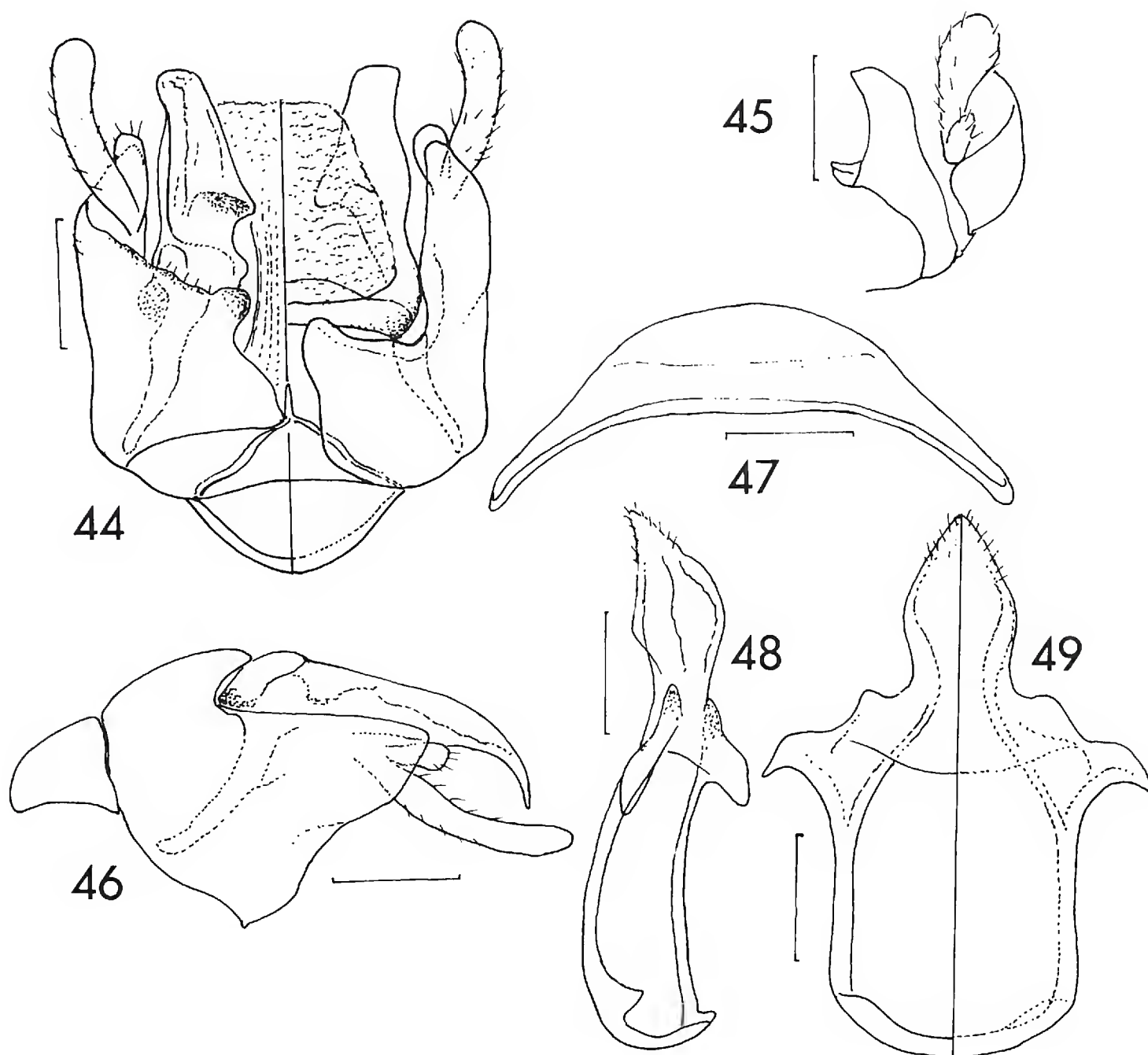
(Figs. 3, 5, 8, 9, 18, 19, 27, 34, 37, 44–49)

Halictus posticus Spinola, 1851:208; Cockerell, 1905:355.

Ceratina postica: Alfken, 1904:141.

Manuelia postica: Vachal, 1905:26; Jaffuel and Pirion, 1926:370; Gazulla and Ruiz, 1928:301.

Female.—Average and range of forewing lengths (64 specimens): 6.92 mm, 6.10–7.60 mm. *Head*. Integument shiny black; antenna, labrum, and mandible black. Circumalveolar depression rather shallow. Subapical margin and basal triangle of labrum shiny and impunctate, confluent by a narrow median area and separated laterally by a transverse punctured area bearing long, yellowish, simple hairs; lateral margin of basal triangle concave. *Thorax*. Pronotum with lateral angle not elevated above level of middle of pronotal collar. Thoracic capsule ovoid; propodeum slightly convex and steeply sloping; metanotum at summit of posterior thoracic declivity, touched by a scuto-scutellar tangent. Integument colored like head; punctures close around margin of scutum, on scutellum and on metanotum, less dense on mesepisternum, sparse on dorsum, absent in triangle at summit of propodeum; surface shiny except propodeum which is finely roughened; surface with short, erect, white, plumose hairs on dorsum, hairs longer laterally and longest ventrally; propodeum and pronotum laterally with additional sparse, long, erect, white, plumose hairs. Tegula black; average and range of hamuli (64 specimens): 8.2, 7–10. Tarsi dark brown, remainder of legs shiny black with yellowish white hairs; scopa moderately developed. Basitibial plate elongate, width about one-third of distance from base of tibia to apex of plate; apex acute, marginal carina high and oblique apically; hind tibial spurs strongly curved at apices. *Metasoma*. Elongate ovoid; T1–3 shiny black, punctured throughout, and with sparse, short, erect, white, simple hairs; coloration of subsequent exposed terga shows variation apparently uncorrelated with geography in the 69 specimens before us: 24 have basal three-quarters of T4 with color and vestiture like preceding terga while the apical quarter and subsequent exposed terga are translucent orange-brown; 43 have this color restricted to fifth and sixth terga; and in the remaining two bees, T5 and 6 are dark and only faintly orange-brown. Hairs on these terga colored like their corresponding terga and longer and denser caudad. T6 with black spine (pygidial



Figures 44–49. *Manuelia postica*, male. 44. Genitalia, ventral, and dorsal. 45. Inner view of gonostylus and adjacent structures (sketch). 46. Genitalia, lateral view. 47. S7, 48, 49. S8, lateral, dorsal, and ventral.

plate) flanked by abundant, ascending, orange brown, simple or plumose hairs which become longer and sparser laterally. Sterna with vestiture like corresponding terga; S6 with apical portion clothed with dense plumose hairs.

Male.—Average and range of forewing lengths (17 specimens): 6.85 mm, 5.85–7.05 mm. **Head.** Coloration as in female but the following areas pale yellow: base of mandible, labrum, paraocular area up to half-way between summit of clypeus and lower margin of antennal socket, and a variable area of clypeus. Sometimes dark color of upper head extends down along lateral portions of epistomal suture to below anterior tentorial pits and mesad from this suture to almost one-third of clypeal width; others show reduction of the dark extensions and expansion of yellow above clypeus. Mandible simple, dark brown apically. Posterior ocelli on summit of vertex. Third flagellomere longer than broad. **Thorax.** Largely as in female. Mesepisternum below scrobal suture with circular patch of appressed, short, white, plumose hairs;

average number and range of hamuli (17 specimens): 7.9, 7–9. Basitibial plate not perceptible. Hind basitarsus with apex produced. *Metasoma*. Shaped as in female; T1–3 and S1–3 shiny black with short, ascending, white, simple hairs; coloration of subsequent exposed terga and sterna varies in 18 males before us: 1 has T4–7 and S4–6 translucent orange-brown; 6 have the basal portions of T4 and S4 black, the apical margins and subsequent segments orange-brown; 8 have T5–7 and S5, 6 orange-brown; 1 has the apical portions of T5 and S5 and subsequent terga and sterna so colored; and two have the apical segments dark with orange-brown colors only faintly expressed. Hairs white on black areas, orange on orange brown areas. T7 with true apex bearing short, orange-brown, plumose hairs. Terminalia as illustrated.

The distribution of this species is shown in Figure 37. In Chile the northernmost locality is Cuesta Cavilolén, Illapel, Coquimbo Prov., and the southernmost is Osorno, Osorno Prov. An Argentine record, Isla Victoria, Neuquén Prov., is slightly farther south than any Chilean locality known to us. Altitudes of collections range from near sea level to 125 m in Cautin Prov., 1500 m in Linares Prov. and 1700–2200 m in Santiago Prov.

Manuelia gayi (SPINOLA)

(Figs. 1, 2, 6, 7, 14–18, 20–23, 29–31, 33, 38, 50–57)

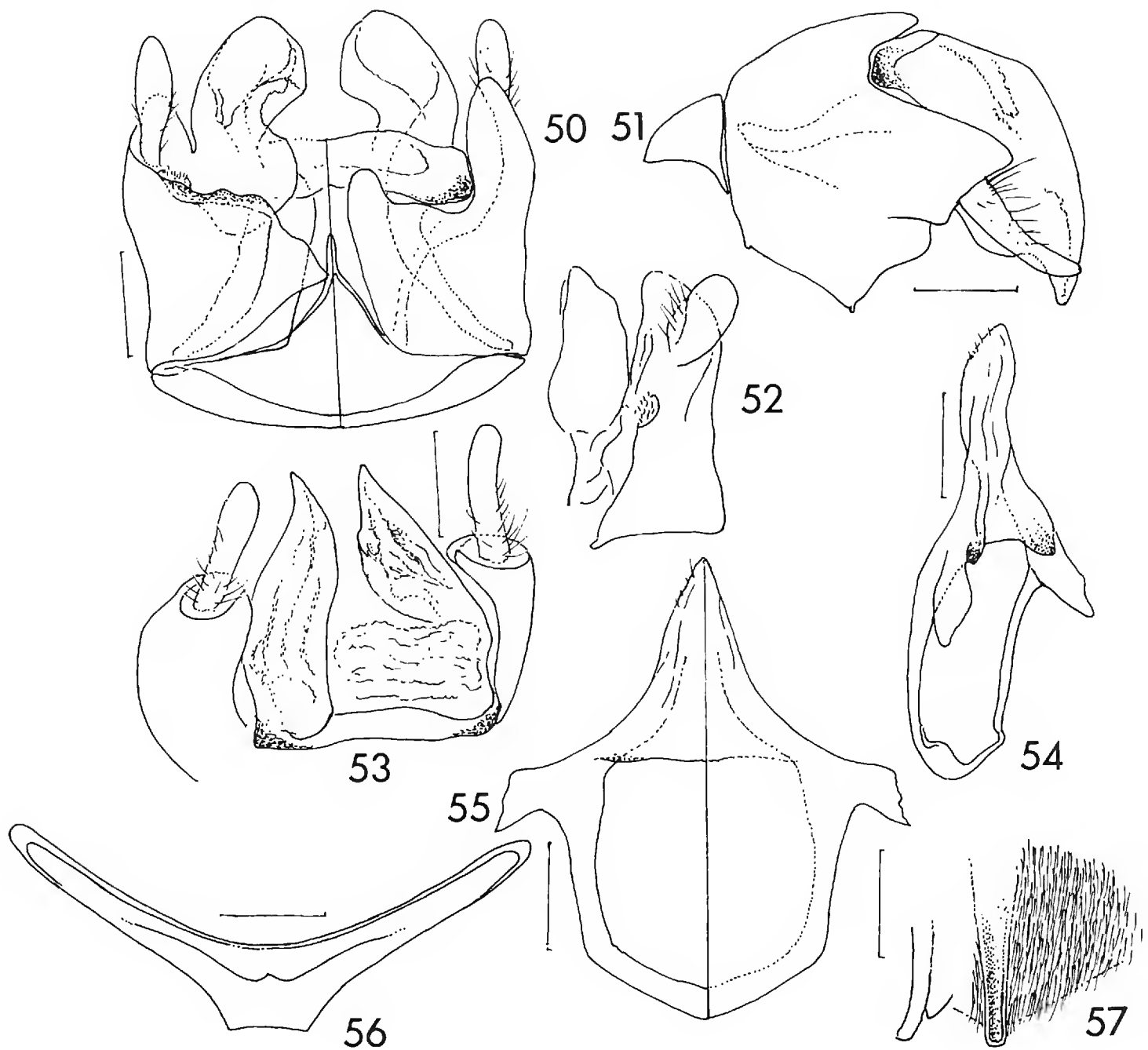
Halictus gayi Spinola, 1851:208.

Corynura gayi: Dalla Torre, 1896:93 (part).

Ceratina gayi: Alfken, 1904:141.

Manuelia gayi: Vachal, 1905:26; Jaffuel and Pirion, 1926:370; Claude-Joseph, 1926:220, 1929:417; Gazulla and Ruiz, 1928:301; Moldenke and Neff, 1974:29; Michener and Brooks, 1984:56, 59.

Female: Average and range of forewing lengths (66 specimens): 6.17 mm, 5.50–6.55 mm. *Head*. Integument shiny metallic blue; scape colored like head, flagellum ruddy brown beneath, brown above; labrum and mandibles black. Circumalveolar depression relatively deep. Subapical margin and elevated basal triangle of labrum shiny and impunctate; lateral margin of basal triangle of labrum straight. Median part of hypostomal carina expanded, almost lamella-like, sloping inward over proboscidal fossa. *Thorax*. Pronotum with lateral angle protuberant above. Thoracic capsule roughly spherical; metanotum and propodeum steeply sloping. Integument colored as head; punctures close around margins of scutum, on scutellum and on metanotum, becoming less dense on mesepisternum, sparse on dorsum of scutum and absent in triangle at summit of propodeum; surface shiny except for propodeum which is finely roughened; pubescence short, erect, white, plumose on dorsum, hairs longer laterally and longest ventrally; propodeum with long, erect, white, plumose hairs which become short and appressed laterally. Tegula brown with bluish reflections; average and range of hamuli (66 specimens): 8.6, 7–10. Tarsi dark brown, remainder of legs brown with bluish reflections; scopa moderately developed. Basitibial plate broad, its width about half distance from base of tibia to apex of plate, apical edge bluntly pointed, marginal carina high, erect apically; hind tibial spurs strongly curved at apices. *Metasoma*. Ovoid; T1–4 colored like head and thorax and bearing on their dorsa short, erect, white, simple hairs which become longer laterally; base of T5 with coloration and vestiture like preceding terga, but apical margin translucent and orange-brown; T6 dark brown with the black spine (pygidial plate) flanked by orange-brown, mossy plumose hairs



Figures 50–57. *Manuelia gayi*. 50, 51. Male genitalia, ventral, dorsal, and lateral. 52. Sketch of dorsal apical view of male gonocoxite, gonostylus, and penis valve. 53. Sketch of dorsal apical view of male genitalia. 54. S8, male, lateral view. 55. Same, dorsal and ventral views. 56. S7, male. 57. Apex of T6, female, dorsal view with lateral view at left.

which grade laterally into longer, white, plumose hairs. S1–5 with less bluish reflections than terga, each clothed subapically with ascending, white, simple hairs; S6 like preceding in color, but with abundant, medio-apical, orange-brown, mossy plumose hairs.

Male.—Average and range of forewing lengths (6 specimens): 5.76 mm, 5.40–6.55 mm. *Head*. Coloration as in female but labrum, most of clypeus, and lower paraocular areas up to level of summit of clypeus light yellow; dark color of head extends down along the epistomal suture to anterior tentorial pit. Mandible bidentate. Posterior ocelli in front of summit of vertex. Flagellomere 3 longer than broad. *Thorax*. Largely as in female. Average and range of hamuli (7 specimens): 8.4, 7–10. Third leg with distinct basitibial plate in position and form similar to that of

female. *Metasoma*. Slightly more elongate than in female; T1–6 with color and vestiture as in T1–4 of female; T7 with median impunctate area and lateral long, white, simple hairs; true apex of T7 bearing short, white, plumose hairs. S1–6 as in female. Terminalia as illustrated.

The distribution of this common species is shown in Figure 38. In Chile the northernmost locality in Vicuña, Coquimbo Prov.; the southernmost is Colegual, Llanquihue Prov. In Argentina the southernmost located collection site is El Bolsón, Rio Negro Prov., but specimens are labelled El Hoyo and El Turbio, Chubut Prov. (New York, Lawrence); the probable vicinity is indicated by a circle in Figure 38. Altitudes of most collections are not given on the labels but range from near sea level to 1400–1600 m (Llanquihue Prov.), 1100 m (Talca Prov.) and 1700–2200 m (Santiago Prov.); in the lake district of Argentina, altitudes are indicated as 650 to 850 m.

Relationships of *Manuelia* to Other Xylocopinae

The anthophorid subfamily Xylocopinae as delimited by Michener (1944, p. 269), Hurd and Moure (1963) and others includes both the large, robust bees of the tribe Xylocopini and the smaller and usually slender forms of the tribes Ceratinini and Allodapini. The last, recently segregated from Ceratinini (Michener, in press), has many derived characters and is not particularly relevant to *Manuelia*. The resemblances of *Manuelia* to Xylocopini (*Xylocopa*, *Lestis*, *Proxycopa*) and to Ceratinini (*Ceratina*, *Pithitis*, *Megaceratina*) have been indicated in the generic description above, using for brevity the letters X (Xylocopini), C (Ceratinini), and M (for special features of *Manuelia*). In that description 22 characters are marked C; 12, X; and 6, M. Thus *Manuelia* is most similar to Ceratinini, but also has numerous features like Xylocopini in spite of its ceratine appearance. A cladistic approach to relationships among tribes of Xylocopinae is presented by Sakagami and Michener (in press).

In some other features, not listed because they are variable and therefore not generic characters of *Manuelia*, this genus is nonetheless intermediate between Xylocopini and most Ceratinini. For example, the declivity of the posterior part of the thorax extends downward vertically from the posterior edge of the scutellum in some Xylocopini while in most Ceratinini and in *Manuelia gayatina* (Fig. 35) the base of the propodeum is more or less horizontal. The situation for the other species of *Manuelia* is shown in Figures 33 and 34.

The nest characteristics of *Manuelia* are similar to those of Xylocopini. The branching burrows and barrel-shaped cells are unlike those of any other small Xylocopinae, but resemble those of Xylocopini.

Since most bees, and more specifically most Anthophoridae, nest in the ground, the Xylocopinae probably arose from ground-nesting forms. Malyshev (1913:55–56) and Hurd (1958:368) attached much importance to the ground-nesting habits and certain anatomical conditions (basitibial and pygidial plates) of *Proxycopa* that also occur in ground-nesting anthophorines but not in other Xylocopinae. Because *Proxycopa* is a member of the tribe Xylocopini, Malyshev regarded that tribe as more closely related to the ground-nesting ancestor than is the Ceratinini. This view is supported by the clustered cells and constructed cell walls of *Proxycopa*, described and illustrated by Gutbier (1915), and by the brood-cell linings secreted by

Dufour's gland also found in *Proxylocopa* but not known in other Xylocopinae (Kronenberg and Hefetz, 1984).

The nesting habits of *Proxylocopa* were assumed by Malyshev and Hurd to be primary, although there are examples in both tribes of flexible behavior which could have led to a return to the ground as a nesting site. In the large carpenter bees, Hurd (1978) cites reports of nests in bricks and other soft substrates, Lucas (1868) noted a nest in a copper tube, and Hardouin (1943) found that an individual of a species presumably unaccustomed to bamboo accepted a bamboo tube offered experimentally. Of the small carpenter bees, allodapines are reported by Brauns (1926) to nest in the ground in the absence of suitable plants or in vacant beetle galleries in wood. While constructed cell walls and linings derived from Dufour's gland are usual in soil-nesting anthophorids, and might seem unlikely to reappear in *Proxylocopa* if it reverted to the soil, the partitions between cells in *Xylocopa* are in reality constructed cell walls that do not extend to the sides of the cell in a wood substrate. Reversion to soil could result in extension of partition-construction to produce cell walls. Less likely, probably, would be reversion to production of the hydrocarbon-rich hydrophobic cell lining. Thus while the nests of *Proxylocopa* offer a basis for considering the genus as similar to the ancestral Xylocopinae, there is the possibility that nesting in the ground is an adaptation to desertic environments lacking plants for nesting. Independently, Hurd (in personal communication to Daly) entertained the same explanation. Furthermore, Maa (1954) considered the species of *Proxylocopa* to be closely related on the basis of morphology; such similarity does not suggest the antiquity to be expected of ancestors of the other Xylocopinae. *Proxylocopa* is noteworthy for its close resemblance to other genera of the tribe Xylocopini.

Although *Manuelia* shares its nesting pattern with the Xylocopini, *Ceratina* and *Pithitis* are quite different in their nesting activities and social organization (Michener, in press), giving little indication of ground-nesting ancestry.

In the majority of anatomical features the Ceratinini rather than the Xylocopini show the most plesiomorphic features, as judged by Michener's (1944:228–229) list: short first flagellar segment, horizontal metanotum, propodeum with horizontal basal area, large pterostigma, long notaulus, relatively long second abscissa of vein M + Cu in the rear wing, long jugal lobe, and hairy wings. The Xylocopini show more specialized conditions of the same variables. Some ceratinine characters of the wings and thorax may relate to the general body size and shape, associated with nesting in small burrows. Nevertheless, other characters, presumably not related to size and slenderness, also indicate the more primitive anatomy of the small carpenter bees. For example, male Ceratinini have two hind tibial spurs and, in *Manuelia* and *Ceratina* (*Euceratina*), have gonostyli, while the large carpenter bees have only one tibial spur and no gonostyli. The basitibial plate is near the base of the tibia in females of ground-nesting bees; Ceratinini have the plate usually in this position when it is present, while only *Proxylocopa*, among the Xylocopini, has it in this location. Wille (1958) found the dorsal circulatory vessel to be straight in the Ceratinini, a condition considered by him to be primitive among the bees. *Xylocopa* possesses a specialized condition with the thoracic portion arching between the longitudinal muscles and the petiolar portion coiled.

In view of the primitive features occurring in members of both tribes (Ceratinini

and Xylocopini), we cannot agree that the Xylocopini is closer to the stem of the subfamily than Ceratinini. Moreover, we do not think that *Proxyllocopa* is particularly close to the ancestral Xylocopini; undoubted specialized features of *Proxyllocopa* include the reduced notauli. The ancestor for all modern members of the subfamily Xylocopinae should combine the nesting pattern of the Xylocopini with the primitive anatomical features of both Ceratinini and the Xylocopini.

It seems reasonable to suppose, as did Malyshev, that the ancestor nested in relatively thick pieces of dead plant tissue (soft or rotten wood). The ancestor of the large carpenter bees continued nesting in the thicker pieces of wood. Once the outer layer has been broken, this medium places little restriction on the dimensions or pattern of the nest. There was probably a trend of increasing body size and more powerful jaws, together with the changes in the thorax and wings which impart the specialized facies to the modern tribe Xylocopini. The nesting habits, however, remained largely unaltered. The smaller forms of the ancestral stock could nest in small beetle burrows and slender stems and consequently there was the trend to smaller body size and slender form which led to the modern Ceratinini.

We believe that *Manuelia* is a surviving remnant of the early small carpenter bees. Moreover, it is the most primitive of the subfamily Xylocopinae and nearer than any other form to the phyletic dichotomy which separated the tribes Ceratinini and Xylocopini. The restriction of the species to Central Chile and Argentina, the fact that the genus is made up of three species fully as different as subgenera elsewhere among bees, together with the anatomical and biological relations enumerated above, support the conclusion that *Manuelia* is a relict genus. In view of its presumed antiquity, *Manuelia* exhibits an interesting use of introduced plants both for provisions and as nesting substrates. This is not surprising, however, since most Xylocopinae are polylectic feeders and seem to select nesting sites according to their physical characteristics without regard to the kind of plant concerned.

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Nests of *Callanthidium* from Block Traps (Hymenoptera: Megachilidae)

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Abstract.—The nesting habits of *Callanthidium formosum* (Cresson) are described for the first time. Nests were obtained from block traps set at 2000–3000 m in northern Utah. Information on nest construction, cocoon formation, sex ratio, adult weights, and mortality is presented. Additional information is presented on the adult weights, cell lengths, and nest associates of *Callanthidium illustre* (Cresson).

Species of *Callanthidium* are among the largest members of the tribe Anthidiini, and our two species are marked with bright yellow integumental bands that contrast with their brownish-black body color. Many adults have been collected from a variety of flowers (Hurd et al., 1979), but nests are less commonly found and only those of *C. illustre* (Cresson) have been reported (Johnson, 1904; Hicks, 1929; Parker and Bohart, 1966). Recent biological studies using block traps (Parker, 1985a) have added information on nests of *C. illustre* and *C. formosum* (Cresson), and in this paper the nesting habits of *C. formosum* are described for the first time. Additional data are presented on sex ratios and adult weights of both species.

METHODS

One-meter stakes were driven partially into the soil and the block traps attached near the top of the stake with the holes facing southeast. The trap blocks (see Parker 1985a for details of trap design) were set out in May and recovered in November of the same year. The blocks were then taken apart and the layers split with a knife to expose the nest contents. Each nest was measured, described, and photographed; samples of pollen were removed to identify floral resources. A radiograph (Stephen and Undurraga 1976) was made of intact nests that had been removed from the block traps. Individual cell contents were placed and stored in 000 gelatin capsules, labeled and held at 3° C to break overwintering diapause. During March of the next year, the capsules were placed in a 27° C incubator, and when the adults emerged they were weighed alive, killed, mounted and identified.

C. formosum

Nesting Sites.—All nests were recovered from block traps set at higher elevations (2000–3000 m) in Logan Canyon, Farmington Canyon and along the southwestern shore of Bear Lake in northern Utah. The predominant shrubs and trees at these locations included junipers, mahogany, scrub maple, boxelder, sagebrush and ceanothus; perennial and annual forbs were abundant and diverse.

Nest Construction.—Twelve nests containing 36 cells were recovered from 10 mm diameter borings and a 2-cell nest from an 8 mm boring. The number of cells/nest

ranged from 1 to 4 and averaged 3.2 (SD 1.2). The average length of male cells was 15.4 mm (SD 1.0 mm, $n = 7$) and this figure for female cells averaged 13.6 mm (SD 1.0 mm, $n = 7$). These differences between sexes and average lengths of cells were significantly different ($P < 0.004$).

The plant source of the cotton-like fibrillose material used to line the cells was undetermined. Cells were constructed from fibers that were formed into pouch-like chambers that held the provisions. These chambers were 7–8 mm wide and 11–13 mm long. The cells were separated initially by 4–5 mm thick partitions of fibers, but the partitions were compacted during cocoon formation to 1–2 mm. Above the last cell the nest was plugged with fibrillose material that averaged 34.0 mm (SD 14.3 mm long, $n = 4$). Most nests were capped with an entrance plug of small white pebbles stuck together with masticated leaf pulp (Fig. 1). Plugs averaged 6.0 mm (SD 1.4 mm thick, $n = 4$), were disc-shaped and were placed at the entrance to the nest.

Provisions.—The cup-shaped mixture of pollen and nectar (Fig. 1) was tacky when probed. The composition was about 60% mint and 40% legume pollens. The host egg was laid across the top of the provision.

Cocoon.—The mature larva initiated formation of the cocoon by flattening the fecal material and remaining provisions against the cell walls (except at the upper rim) and then lining the walls with a shellac-like layer of silk; this layer had a cone-shaped and hollow nipple at the top. Inside this layer, the second layer was barrel-shaped (see radiograph) and was formed from strands of whitish silk deposited in a cross-hatched pattern; this internal layer was brown. Beneath the nipple, the second layer was formed into a mat-like pad from coarse, brownish silk strands. A third layer of coarse, whitish silk strands that resembled cellophane covered the entire inner surface of the cocoon, including the underside of the nipple. Average length of cocoons from which males emerged was 12.3 mm (SD 0.8 mm) long, and 8.1 mm (SD 0.3 mm) wide and those from which females emerged averaged 11.3 mm (SD 0.5 mm) long and 7.1 mm (SD 0.2 mm) wide. These size differences were significantly different ($P < 0.001$).

Overwintering.—All cells contained prepupae in diapause when examined in November and all surviving overwintering prepupae pupated and emerged when incubated in March.

Adult Weights and Sex Ratio.—Average weight of males was 142.9 mg (SD 10.4 mg, range 130.3–160.5 mg, $n = 7$) and females averaged less, 113.8 mg (SD 18.5 mg, range 91.3–139.3 mg, $n = 7$). The observed and expected sex ratios (see Torchio and Tepedino 1980 for methods of calculation) were identical: 1.26 females: 1 male. There was a significant relationship between cell length and individual weight among females ($r = 0.78$, $n = 7$, $P < 0.04$) but not in males ($r = 0.51$, $n = 7$, $P < 0.24$). Placement of the sexes within cell series differed from most wood-nesting bees because males were in the bottom cells and females were above. Some nests, however, had all male or all female cells (Fig. 1).

Mortality.—Mortality of immature stages from unknown causes averaged 14.3% of the total cells. No nest associates were found nor were any of the nests superseded by other aculeates.

C. illustre

Nesting in this species has been described by several authors. Johnson (1904) reported *C. illustre* nesting in clay banks in Denver, Colorado. Hicks (1929) reported

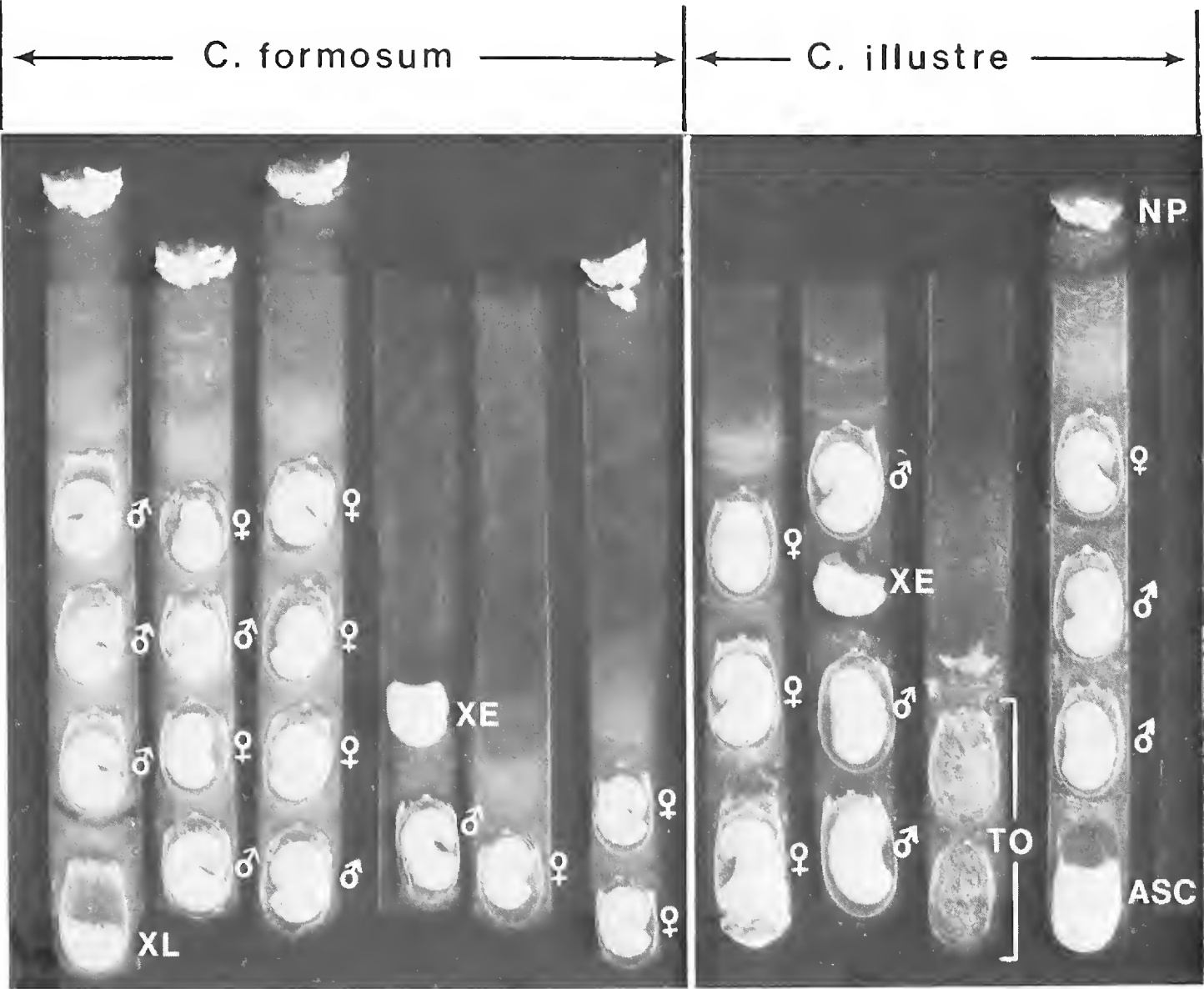


Fig. 1. Radiograph of nests of *Callanthidium formosum* and *C. illustre* illustrating placement of cells, form of the cocoon and nest entrance plugs. XL=dead larva, XE=dead egg. TO=*Trichodes ornatus* predation, ASC-*Ascospaera* parasitism, NP=nest entrance plug.

that this bee nested in old, dead yucca flower stalks near Pasadena, California; he described their nests, adult activity and possible nest associates. Parker and Bohart (1966) reported nests in holes in wood (block traps). Grigarick and Stange (1968) summarized the biology and included photographs of the nest and cocoon. Four additional nests were obtained recently from trap blocks placed near Santa Clara in southern Utah.

All nests were made in 10 mm diameter holes. The 4 nests, containing 13 cells, averaged 3.2 cells/nest (range of 2–4 cells). Cells were separated by 3.3 mm (SD 1.6 mm) of fibrillose plant parts. One nest was finished and had a vestibule of fibrillose material 20 mm long; it was capped with a 5 mm thick plug of masticated plant parts and pebbles.

Cell size and adult weights varied considerably. Average length of cells of males was 17.2 mm (SD 1.6 mm, n = 5) and average length of female cells was 19.0 mm (SD 2.6 mm, n = 4); these averages, however, were not significantly different ($P < 0.24$). Although male bees were heavier (average weight of males was 205.1 mg, SD 25.4

mg, $n=5$; females 185.2 mg, SD 34.1 mg, $n=4$), weights were not significantly different ($P < 0.35$). There was a significant correlation between cell length and adult weight in both sexes ($r = .91$, $P < 0.003$ for males; $r = .96$, $P < 0.04$ for females). Average length of cocoons from which males emerged was 14.2 mm (SD 0.8 mm) and average width was 8.7 mm (SD 0.4 mm); average length of cocoons from females was 13.8 mm (SD 0.5 mm) and average width was 8.3 mm (SD 0.3 mm). One nest had males below and a single female above, one contained males, and another contained only females.

One cell contained a bee larva infected with the fungus, *Ascosphaera* sp., and two other cells were destroyed by a larva of the clerid beetle, *Trichodes ornatus* Say.

DISCUSSION

The placement of sexes within *Callanthidium* nests differed from the usual pattern in xylophilous nesting bees in that females were at the bottom and males were at the top (Krombein, 1979). Males of Anthidiine genera such as *Callanthidium*, *Anthidium* and *Dianthidium* are larger and weigh more than females (Alcock, 1977; Alcock et al., 1977; Frohlich and Parker, 1985). Thus, placement of the male sex first in cell series appears to be a response to the nontypical mating system exhibited by many anthidiine bees (Thornhill and Alcock, 1983).

Hicks (1929) reported that *C. illustre* females used resin and an undetermined substance for the final cap on nests. None of the nest entrance plugs of either species reported here contained resin. The material was masticated plant parts mixed with pebbles, dirt, or other organic debris.

This is the first report of *Ascosphaera* attacking *Callanthidium*. Recent trap-nesting studies have yielded many new host records (unpublished data) for this important disease (chalkbrood), and it appears that the disease may be spreading from commercially managed populations of the alfalfa leafcutting bee, *Megachile rotundata* (Fab.) (Parker, 1985b), to populations of native bees (Parker and Frohlich, 1983; Youssef et al., 1985).

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Observations on the Prey and Nests of *Podalonia occidentalis* Murray (Hymenoptera: Sphecidae)

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Abstract.—*Podalonia occidentalis* Murray is evidently a specialist on last instar larvae of tent caterpillars (*Malacosoma* spp.) (Lasiocampidae), as evidenced by records from New Mexico, Nevada, California, Alberta, and numerous records reported here from north central Colorado. Nests are shallow and typical of other *Podalonia* species, but much variation in details of nesting behavior was noted. Four species of miltogrammine flies were reared from nests, the four together causing a 75% destruction of the wasps' eggs at this locality.

It is a pleasure to dedicate this paper to that avid and versatile entomologist E. Gorton Linsley, whose 1956 paper on *Cerceris californica* (with J. W. MacSwain) is a small classic of its kind. Sphecology is the worse for his fascination with wasps' "fuzzy relatives," the bees, and with longhorned beetles and diverse other insects. I spent only a few days with "Gort" in the field, but they were enough to charge my batteries for some time to come.

The present report concerns sphecid wasps of the genus *Podalonia*. Most species of this genus prey on cutworms (Noctuidae), which they exhume from the ground and use to provision a shallow nest dug nearby (reviews in Murray, 1940; Bohart and Menke, 1976; see also O'Brien and Kurczewski, 1982; Steiner, 1983). There are, however, at least two species of this genus that capture hairy caterpillars that live well above ground. The best known of these is *P. valida* (Cresson), which is a specialist on "woolly bears" of the genus *Estigmene* (Arctiidae) (Steiner, 1974, 1975). I have many records from north central Colorado that indicate exclusive use of saltmarsh caterpillars, *E. acrea* (Drury), in this area. A second species, *P. occidentalis* Murray, has been the subject of a brief report by Murray (1940). Near Santa Fe, New Mexico, these wasps were found "working with much effectiveness on the tent caterpillar" in the month of June. Williams (1928) reported *Podalonia violaceipennis* (Lepeletier) preying upon tent caterpillars at 1980 m in the Sierras of California. He found 11 nests in close proximity and believed that all were made by one female. The species of *Podalonia* have often been confused in the past, and it seems quite possible that Williams was dealing with *occidentalis* rather than *violaceipennis*.

There are three previously unpublished records of *P. occidentalis* preying upon *Malacosoma*. R. M. Bohart (personal communication) has collected females carrying tent caterpillars at Sagehen Creek, Nevada, where there was a large population of the wasps in 1974, following an outbreak of tent caterpillars in previous years. M. F. O'Brien has sent me two additional records of *P. occidentalis* based on museum specimens (personal communication). A female in the Canadian National Collections, from Pincher, Alberta, was collected by R. W. Salt on 9 July 1941 with a

Malacosoma larva; and four females in the University of Michigan Museum of Zoology, from Crowley Lake, Mono Co., California, were collected by L. Bezark on 8 June 1976 "carrying tent caterpillars."

The observations reported here were made between 16 and 23 June 1985 and between 12 and 30 June 1986, at three sites 2–5 km apart, all about 23 km west of Livermore, Larimer Co., Colorado, at an elevation of about 2300 m. In this area western tent caterpillars, *Malacosoma californicum* (Packard) (Lasiocampidae) are extremely common, especially on bitterbrush, *Purshia tridentata* (Pursh). The active period of *P. occidentalis* appears to correspond closely with the time when tent caterpillars reach the final instar and leave their tents to feed individually. I did not observe prey capture in the field but several times saw females carrying prey from areas where caterpillars were feeding on *Purshia* bushes. Without exception prey carriage and nest construction occurred during the morning hours, between 0840 and 1115 Mountain Daylight Time. Both males and females were frequent visitors to the flowers of miner's candle, *Cryptantha virgata* (Porter), which blooms in abundance during the active period of the wasps.

The three study sites were all along trails or little-used dirt roads, either in tracks or in bare places along the roadside. In every case there were infested *Purshia* bushes not far away. It was common to see males patrolling these sites, flying back and forth in a weaving pattern 5–15 cm above the ground. Occasionally a male descended upon a female that was active at a nest, but contact was broken off immediately. I saw only one copulation. In this case a female walked along a road with a male astride her, holding her in the neck region with his mandibles. He extruded his genitalia briefly before flying off after about 20 seconds. I did not see the initial union of the pair, which may have occurred many seconds or minutes earlier. R. M. Bohart (personal communication) observed about 40 males forming a struggling ball around a female along a dusty road at Sagehen Creek, Nevada. This occurred during a period of unusual abundance of *Podalonia occidentalis*.

I observed stinging of the prey twice. On 12 June, at 0950, a female was seen carrying a caterpillar along a road. She dropped the prey and disappeared for three minutes; when she returned she stung the prey seven times (even though it appeared already well paralyzed). She mounted the prey obliquely over its back and stung it along the midventral line, beginning at the thorax and moving back slightly each time, covering most of the length of the abdomen. Essentially this same behavior was observed in a terrarium, where a female *Podalonia* had been placed with tent caterpillars.

Females carry their prey forward over the ground, holding it venter up, the wasp grasping the caterpillar with her mandibles on the first or second abdominal segment and straddling it. Since the caterpillars are much longer than the wasp, they extend a considerable distance in front of and behind the wasp. In four instances the wasp was seen to proceed to a plot of more or less bare, friable soil and then deposit her prey while she searched for a place to dig. In one instance a female, with much apparent effort, pulled her prey into a weed 2 cm off the ground. She then walked about and scraped the soil here and there, returning to her prey in 18 minutes and again in 29 minutes, each time moving it slightly. Finally, 33 minutes after entering the site, she started a nest 2.5 m away from the prey. Nest construction required only 10 minutes, and the female then returned to the prey and carried it directly to the edge of the hole. She then entered and pulled the prey in head first. She emerged within a few

seconds and began filling the burrow by scraping in soil from the edge of the hole. Filling was complete in 3.5 minutes, and the female then rested in the shade of a plant and cleaned herself for 3 minutes before flying off.

Similar behavior was observed on three other occasions, although in each case the prey was left on the ground in the shadow of plants or within a grass clump. In two instances, a wasp was seen to leave a caterpillar under a plant and not return for several hours. In one case the caterpillar was eventually carried off by several ants (*Formica* sp.).

In contrast, there were three other occasions when it was clear that the wasp prepared her nest first, leaving it open and provisioning it much later. In each case a female was seen completing a nest in the morning, but the nest was not provisioned and closed until the morning of the following day. Two of these instances occurred late in the active season (21–22 June) when most tent caterpillars had spun their cocoons. In one case the caterpillar was undersized and bore several eggs of Tachinidae; evidently it had been unable to attain full size and pupate. Thus it appears that when females are unable to obtain prey during a morning hunting period, they proceed to dig a nest, leaving it open and filling it later. I found two nests that were never filled.

Nests are shallow and are dug with rapid thrusts of the fore legs, small pebbles being pulled out with the mandibles. The burrow is about 1 cm in diameter and is oblique, terminating in a horizontal cell about 2.5 cm in length at a depth of from 2 to 6 cm (mean 3.9 cm, $n = 14$). Since the cell is shorter than the prey, the latter is coiled in a broadly C-shaped posture, lying on its side. The egg measures 2.5 mm in length and is laid vertically on the uppermost side of the abdomen, its anterior end attached firmly to the prey, the posterior end extending ventrally free from the prey. Of 11 eggs recorded, seven were attached at an intersegmental membrane, three between A2 and A3, two between A3 and A4, and two between A4 and A5. Four others were attached toward the middle of the segment, three on A3 and one on A4.

Following oviposition, the female fills the burrow rapidly from soil at the periphery of the entrance. In five of nine closures observed, much of the soil was taken from a shallow quarry close beside the entrance; in three of these cases there were two such quarries. The quarries varied from 0.5 to 2.0 cm in depth and from 2 to 4 cm in distance from the entrance. Presumably these quarries are homologous to the accessory burrows that have been described in a variety of digger wasps (Evans, 1966). A portion of the mound at the nest entrance is usually left intact, and nests (especially those with quarries) can sometimes be spotted in the absence of the wasp. Closures are not always completed level with the soil surface; in one case the top 1.5 cm of the burrow was left unfilled.

The egg hatches in about two days and full larval development requires eight to 10 days. However, of 12 nests in which the egg was recovered, nine contained maggots that quickly destroyed the egg and later the prey. Four different species of Miltogramminae (Sarcophagidae) were involved, maggots numbering two to 12 per nest. In order of abundance the flies were:

Hilarella hilarella (Zetterstedt), 14 flies from 4 nests

Sphenometopa sp. nr. *nebulosa* (Coquillett), 10 flies from 3 nests

Taxigramma heteroneura (Meigen), 2 flies from 1 nest

Senotainia trilineata (Wulp), 2 flies from 1 nest

Flies emerged from 22 to 32 days following the date of larviposition. Oddly, I rarely saw these flies in the field; only on one occasion did I see a satellite fly perched on a stone 15 cm from a female that was digging a nest. Others have noted that *Hilarella* is an especially prevalent parasite of species of *Podalonia* (Murray, 1940; O'Brien, 1983).

Podalonia occidentalis appears to be a specialist on *Malacosoma*, and the wasps disappear from the field when the tent caterpillars have pupated. On one occasion I placed a female in a terrarium with several *Malacosoma* larvae; she stung one of them (as described above) but failed to lay an egg or bury the prey. On a second occasion I placed a *Podalonia* female in a terrarium with two *Malacosoma*, two unidentified "woolly bears" (Arctiidae), and two cutworms (Noctuidae). She stung one of the *Malacosoma* but failed to attack the others. These experiments are far from conclusive, but so far as they go they do tend to support evidence from the field, where 17 prey records were obtained, all involving *M. californicum*.

DISCUSSION

Despite the host specificity of *Podalonia occidentalis*, many aspects of its behavior seem unusually variable. Both prey and nests were sometimes abandoned; nests were sometimes incompletely filled; some nests were filled with quarries (either one or two) and others lacked quarries; egg position varied considerably. The most striking variation was in the prey-nest or nest-prey dichotomy. This behavioral difference is often considered a fundamental one, most *Podalonia* (and many other more generalized wasps) taking prey before they make a nest (for reviews see Evans and West-Eberhard, 1970; Iwata, 1976). However, such variation has been reported in at least two other species of *Podalonia* (Myartseva, 1963 [cited in Bohart and Menke, 1976]; Tsuneki, 1968). *P. valida* females regularly dig the nest before obtaining prey (Steiner, 1975; personal observations). *P. valida* is unusual in that females make a series of nests in a restricted territory that is defended against intrusion by other females. There was evidence that *P. occidentalis* females return again and again to the same general area to nest, but nests were not closely clumped and there was no evidence of territorial behavior. *Podalonia* appears to be a genus in transition with respect to whether the prey is taken before nest building (as it is in the genus *Prionyx*, a member of the same subfamily) or whether the nest is dug first (as it is in the closely related genus *Ammophila*).

The incidence of parasitism by miltogrammine flies (75%) is possibly the highest ever recorded for a digger wasp. Since *P. occidentalis* nests earlier in the season than most digger wasps, its inability to avoid the attacks of miltogrammines may permit these flies to build up populations that are able to exploit species that nest later in the summer (species of *Ammophila*, *Philanthus*, and other genera, in fact occurred in these same study sites). The great abundance of tent caterpillars might seem to compensate for the high incidence of parasitism, but in fact I have no evidence that females ever provision more than one nest a day, and they are restricted to the brief period when tent caterpillars are in the final instar. The impact of *P. occidentalis* on the natural control of these pests appeared negligible in the study area.

ACKNOWLEDGMENTS

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**Biosystematic Studies of Ceylonese Wasps, XVIII:
The Species of *Trachepyris* Kieffer (Hymenoptera: Bethylidae:
Epyrinae)¹**

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Abstract.—*Pristobethylus* Kieffer, 1905, and *Acanthepyris* Kieffer, 1910, are new synonyms of *Trachepyris* Kieffer, 1905. *Epyris serricollis* Westwood, *Pristobethylus indicus* Muesebeck, *P. crenaticollis* Kieffer, *P. semiserratus* Kieffer and *Acanthepyris ceresensis* Turner are new combinations in *Trachepyris*, and *T. haemorrhoidalis* Kieffer is confirmed as a member of the genus. *Trachepyris indicus* and *T. haemorrhoidalis* occur in Sri Lanka where they parasitize larvae of Tenebrionidae.

A major problem with Kieffer's large works on bethylid classification (e.g., 1904–1906, 1914) is that he relied greatly on differences and did not give equal significance to similarities. Evans was obliged to synonymize some 20 of Kieffer's genus-level names in his studies of New World Bethylidae. The same pattern is beginning to emerge in the Old World bethylid fauna. During my revisionary study of the Ceylonese Bethylidae, I became aware that *Pristobethylus* Kieffer, 1905, and *Acanthepyris* Kieffer, 1910, were synonymous. Later, while sorting the extensive bethylid collection made in Egypt by Priesner, I realized that *Trachepyris* Kieffer, 1905 (*in* Kieffer and Marshall, 1904–1906), was the senior synonym of these three names.

These relationships were apparently sensed in part by two earlier workers on Bethylidae. Turner (1928) must have subconsciously recognized the close relationship of *Acanthepyris* and *Pristobethylus*, for he described two species in the former genus, one of which was later transferred, correctly in the Kiefferian sense, to *Pristobethylus* by Benoit (1957). Earlier, Benoit (1952) suggested that *Acanthepyris* and *Trachepyris* were probably synonymous but did not make the synonymy and did not mention this surmise in the 1957 paper.

***Trachepyris* Kieffer**

Trachepyris Kieffer, 1905 (Jan): 107 (type-species, *Trachepyris spinosipes* Kieffer, original designation and monotypic).

Pristobethylus Kieffer *in* Kieffer and Marshall, 1905 (Nov): 248 (type-species, *Epyris serricollis* Westwood, original designation and monotypic). NEW SYNONYMY.

Epyris subg. *Acanthepyris* Kieffer, 1910: 103 (type-species, *Epyris (Acanthepyris) hildebrandti* Kieffer, monotypic). NEW SYNONYMY.

Acanthepyris Kieffer, 1914: 401 (raised to generic rank).

¹The preceding number in this series is "XVII: A revision of Sri Lankan and South Indian *Bembix* Latreille (Hymenoptera: Sphecoidea: Nyssonidae)" with J. van der Vecht, *Smithson. Contrib. Zool.*, 451:1–30, 36 figs., 1987.

Trachepyris females are unusual among the Bethylidae in the structure of the mandible and antennal scape, and in the presence of a rake of stout bristles on the fore tarsus. The mandible (Figs. 11–13) in dorsal view is somewhat flattened, rounded at the apex, and has along the inner margin a strong inwardly directed tooth, beneath which are modified sensilla chaetica (Figs. 14–18). The upper surface of the scape (Figs. 5–7) is rather flattened and smooth, margined below by a row of close short setae and above by a row of more scattered setae. The fore tarsal rake (Figs. 1–3) consists of stout setae along the outer margin, three on the basitarsus and one each at the apices of the second and third segments.

The sensilla chaetica adjacent to the large tooth on the inner mandibular margin are greatly enlarged and bizarrely modified. Their shape and position suggest that they may have a fossorial function.

The stout setae of the fore tarsal rake obviously function in excavation of soil. Possession of a tarsal rake is rare in the bethylids, for so few genera have fossorial habits. *Disepyris* Kieffer has such a rake (Fig. 4) but it is composed of much longer, more slender bristles than the short stout setae of *Trachepyris*.

Kieffer separated *Pristobethylus* from most Bethylidae because the pronotum of the type-species is margined anteriorly and laterally by a scalloped carina. Essentially, this carina is the only noteworthy difference between females of *Pristobethylus* and *Acanthepyris*. The significance can be gauged by the fact that the lateral carina is complete in *serricollis*, *crenaticollis* (Kieffer) and *ceresensis* (Turner) but present on only the anterior half in *semiserratus* (Kieffer) and *indicus* (Muesebeck). The posterolateral angles of the head have a short scalloped carina in *serricollis*, *ceresensis* and *indicus*; this was not noted in the descriptions of *crenaticollis* and *semiserratus*. The fore-going species of *Pristobethylus* are all new combinations in *Trachepyris*.

The radial vein is short in *Trachepyris spinosipes* and the costal vein bears a row of extraordinarily long setae. These venational characters are subject to variation in species assigned originally to *Acanthepyris* and *Pristobethylus* and do not warrant separation of *Trachepyris* from the other two genera.

Treatment of these three assemblages of species as the *spinosipes*, *serricollis* and *hildebrandti* species-groups is consistent with the treatment of similar groups in *Holepyris* and other genera of Epyrinae. The *hildebrandti* group is the most generalized and the *spinosipes* group the most specialized.

The *spinosipes* group is known from Algeria and Egypt. The other two groups are primarily Ethiopian but each has one species in the Indian subcontinent.

Diagnosis.—Small wasps, 2.5–6.2 mm long; body black, apex of abdomen and appendages sometimes red or brown. Head of female flattened, posterior margin straight to emarginate; female mandible (Figs. 11–18) somewhat flattened above, curved, apex bluntly rounded, inner margin with large subapical tooth and modified sensilla chaetica beneath and a smaller median tooth or two, male mandible relatively slender, with large apical tooth and three to four small teeth above it; clypeus narrow, with rounded median lobe and less prominent lateral lobes, ecarinate medially; antenna 13-segmented, arising from beneath frontal lobes, scrobes not carinate, female scape (Figs. 5–7) above somewhat flattened, mostly smooth, margined below by short stout setae and above by longer setae, male antenna relatively long, first and second flagellar segments subequal in length; malar space absent; female eye not prominent, not hairy, not extending close to vertex,

male eye more prominent. Pronotum longer than scutum, anterior and lateral margins of disk carinate or not, posterior submarginal groove lacking, collar depressed; scutum with distinct notauli and parapsidal furrows; scutellum with pair of separated pits at base; mesopleuron with small pit below hind wing and curved sulcus near lower margin; propodeal disk margined by a carina laterally and posteriorly and with several discal carinae; posterior propodeal surface with median carina on at least upper half; female fore femur somewhat to moderately broadened; female fore tarsus (Figs. 1–3) with rake of stout bristles, three on basal segment and one each at apices of second and third, male with weak tarsal rake; female mid tibia spinose on outer surface; tarsal claw with inner tooth (Figs. 8–10); female forewing (Figs. 25–27) with enlarged stigma, radial vein of variable length, basal vein meeting subcosta only slightly basad of stigma, transverse median vein sometimes with short stub. Abdomen somewhat depressed apically; male subgenital plate (Figs. 22–24) with apical margin rounded or lobate, base with a median stalk; aedeagus relatively broad, shorter than digitus, cuspis biramous, paramere relatively narrow, with or without long apical setae (Figs. 19–21).

Behavior.—Little was known previously as to the host preferences of species of *Trachepyrus*. When Kieffer described *haemorrhoidalis*, he noted that the unique type was captured while dragging a “chenille,” 8 mm long, on the sand of a dry stream bed. Considering our prey records discussed below, it is probable that this “caterpillar” was actually the larva of a tenebrionid beetle.

P. B. Karunaratne captured a female *haemorrhoidalis* at Palatupana Tank, 22 June 1978, dragging by its head end a slender paralyzed tenebrionid larva, 13.5 mm long, belonging to an unknown genus of Tenebrionidae.

We obtained three host records for *indicus* at Ma Villu near Kondachchi; all were slender larvae of a genus and species of Tentyriinae (Tenebrionidae). T. Wijesinhe collected two females on 19 September 1979, each with a slender paralyzed larva, 11.5 and 15.2 mm long respectively. L. Jayawickrama collected a female on 18 September 1980 walking with a paralyzed larva, 6 mm long. She held the head end of the larva in her mouth and the posterior section of the host body was over her back.

I watched *indicus* females in January 1979 hunting on the beach at Palatupana between the dunes and the high tide mark. The wasps crawled swiftly over the sand, occasionally taking short flights just above the surface. They examined the basal rosette of leaves of small prostrate plants. Their larval hosts were presumably on the roots of such plants. The stout spatulate setae of the fore tarsal rake would enable the wasp to dig readily through the friable soil to reach a host larva. However, I did not observe digging behavior by any of the wasps. The transport of host larvae noted above indicates that the host is probably interred in a burrow separate from the site where it was captured.

Behavioral data are unavailable for other species of *Trachepyrus*. Inasmuch as females of all species have similarly shaped mandibles and fore tarsal rake, I presume that they too have tenebrionid larvae as hosts for which they search in sand or other friable soil.

Collection data within Sri Lanka indicate that *haemorrhoidalis* is more widely distributed than *indicus*, occurring in both the Dry Zone and Wet Zone at altitudes of 10 to 700 m with an average annual rainfall not over 2400 mm. The latter species is restricted to sandy areas in the Dry Zone from sea level to 100 m with an average annual rainfall not exceeding 1100 mm.

KEY TO *Trachepyris* OF THE INDIAN SUBCONTINENT

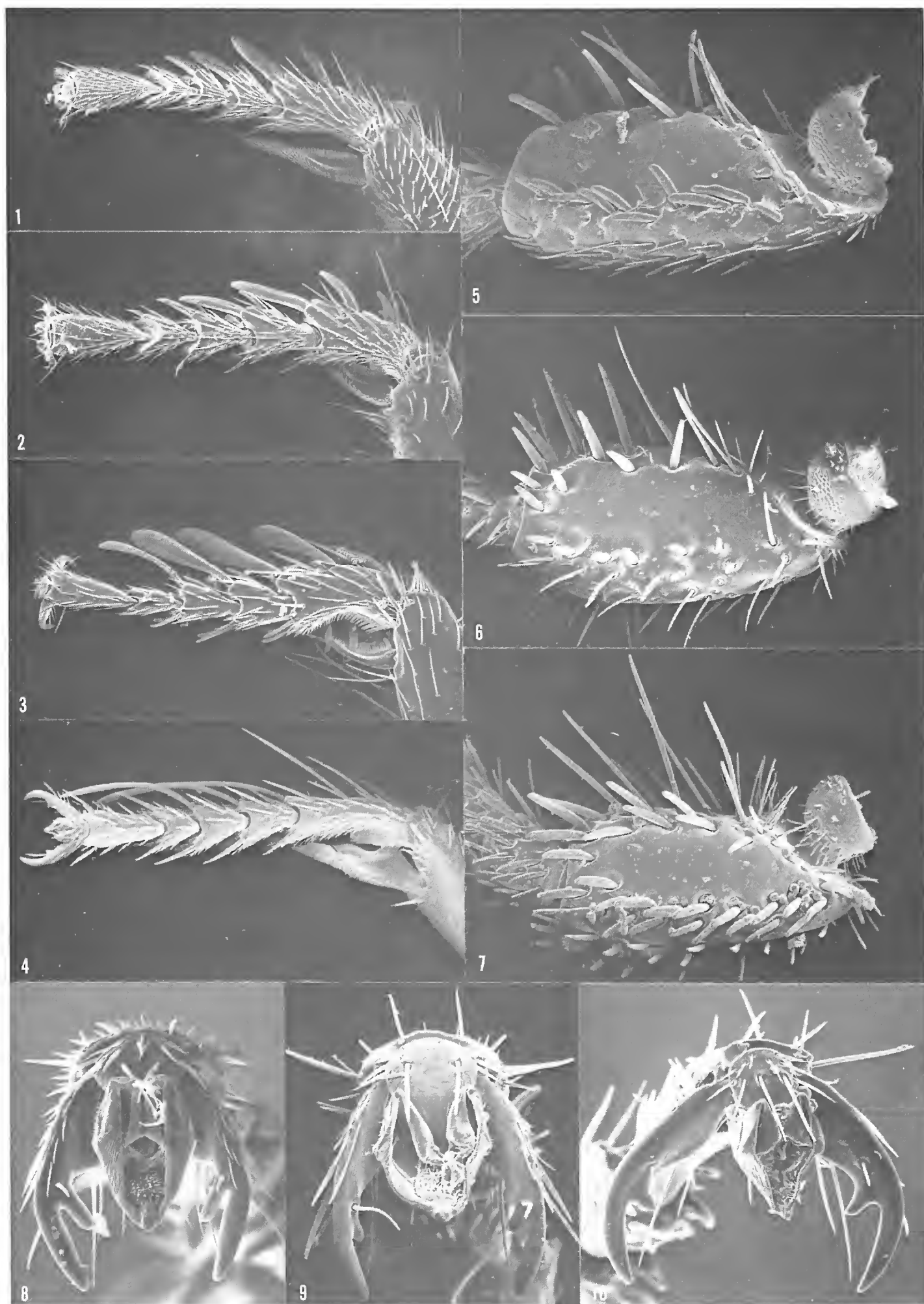
- Pronotal disk not carinate anteriorly and laterally, surface with moderate sized punctures separated by 2–3X diameter of puncture; costa with short setae only (Fig. 25); head not carinate posterolaterally; female fore femur broader, 2.2X as long as wide; male legs except coxae light red; apex of paramere with several long setae, cuspis clavate at apex (Fig. 19) *haemorrhoidalis* Kieffer
- Pronotal disk with scalloped carina anteriorly and on basal half of lateral margin, surface with only a few scattered moderate sized punctures; costa with longer setae interspersed among shorter (Fig. 26); head posterolaterally usually with short scalloped carina; female fore femur more slender, 2.4X as long as wide; male legs dark brown, tarsi lighter; apex of paramere with only short setae, cuspis slender (Fig. 20) *indicus* (Muesebeck)

Trachepyris haemorrhoidalis Kieffer
Figures 1, 5, 8, 11, 14, 19, 22, 25

Trachepyris haemorrhoidalis Kieffer, 1911: 230–231 (♀; Karachi, Pakistan, E. Comber; holotype in British Museum (Natural History)).
Acanthepyris haemorrhoidalis Kieffer, 1914: 404.—Kurian, 1954: 275.

Female.—Length 4.7–5.8 mm. Black, mandible, scape, flagellum beneath, tegula, fore and mid femora and all tibiae occasionally, tarsi, and last two or three abdominal segments red; wings slightly infumated, stigma medium brown, veins lighter. Head with length 0.86X width, not carinate posterolaterally, posterior margin slightly incurved; large tooth on inner margin of mandible subapical in position (Fig. 11); four modified sensilla chaetica beneath subapical tooth (Fig. 14); front delicately alutaceous, scarcely impressed anteriorly in middle, moderately punctate, those anteriorly separated by half a puncture diameter, becoming sparser posteriorly and separated by twice or more a puncture diameter, least interocular distance 0.7X head width and 1.5–1.6X eye length; ocelli small, front angle 90°, posterior ocelli separated by half a diameter from posterior margin of head, ocellocular distance 1.4–1.5X width of ocellar triangle. Thoracic dorsum delicately alutaceous, propodeal disk glossy; pronotal disk without marginal carinae, punctures of moderate size, separated by half a puncture’s width along anterior margin, dispersed by two or more puncture widths elsewhere; scutum with a few small punctures in middle; median length of propodeal disk 0.6X width, enclosed median area twice as wide at base as at apex, quinquecarinate, median and lateral carinae stronger, reaching discal apex, intermediate carinae weaker and sometimes not reaching apex, surface between carinae with transverse carinules; median carina on upper three-fourths of posterior surface; fore femur relatively broad, 2.2X as long as wide; costa with short setae only (Fig. 25); transverse median vein with stub.

Male.—Length 4.4–4.8 mm. Coloration as in female except abdomen black and legs except coxae light red. Head with length 0.9X width, posterior margin slightly incurved, not carinate posterolaterally; front glossy, moderately punctate, closely so anteriorly, punctures separated by once or twice diameter of puncture posteriorly, least interocular distance 0.55X head width and subequal to eye length; ocellocular distance 1.1X width of ocellar triangle. Thorax shining; pronotal disk without



Figures 1–10. *Trachepyrus* and *Disepyrus* females. 1–4. Fore tarsus: 1, *T. haemorrhoidalis* Kieffer (X45); 2, *T. indicus* (Muesebeck) (X84); 3, *T. spinosipes* Kieffer (X67); 4, *D. rufipes* Kieffer (X73). 5–7. Scape: 5, *T. haemorrhoidalis* (X134); 6, *T. indicus* (X101); 7, *T. spinosipes* (X134). 8–10. Claws: 8, *T. haemorrhoidalis* (X224); 9, *T. indicus* (X280); 10, *T. spinosipes* (X280).

anterior and lateral carinae; median length of propodeal disk 0.6X width, enclosed median area quinquecarinate, lateral carinae converging strongly toward apex, none of carinae reaching apex; costa and subcosta with short setae only; transverse median vein with stub. Genitalia and subgenital plate (Figs. 19, 22); apex of paramere with several long setae; cuspis clavate at apex.

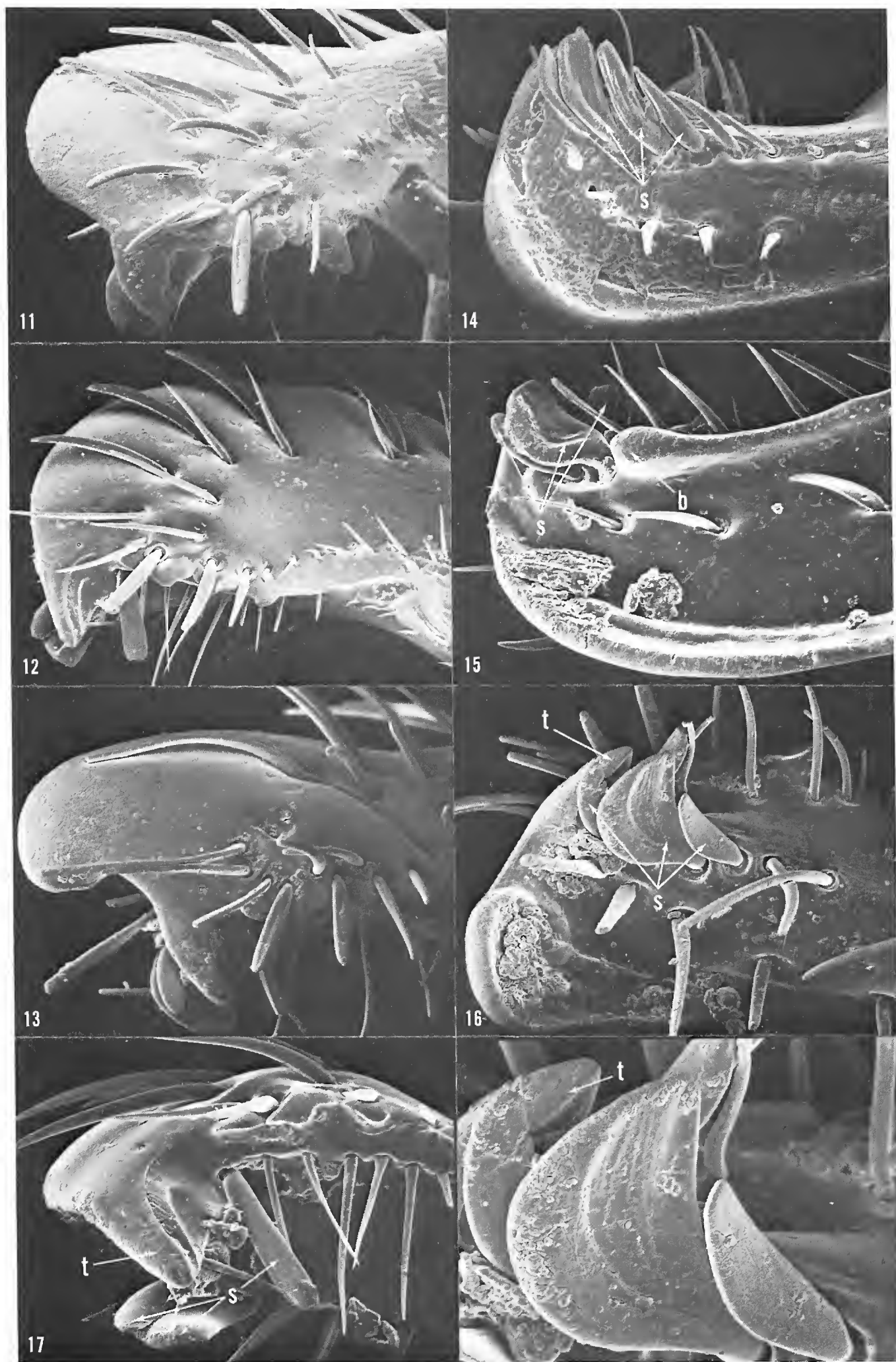
Specimens examined.—SRI LANKA. NORTHERN PROVINCE. Mannar District: 0.5 mi NE Kokmotte Bungalow, Wilpattu Natl. Pk., 21–25 May 1976, ♂; Ma Villu, Kondachchi, 16–19 Sep 1980, ♂. NORTH CENTRAL PROVINCE. Anuradhapura District: Padaviya, Irrigation Bungalow or Antiquities Site, 180 ft, 2–8 Nov 1970, ♂; 18, 21 May 1976, 1 in Malaise trap, 2♂; 20–23 July 1978, Malaise trap, ♀. CENTRAL PROVINCE. Kandy District: Udawattakele Sanctuary, Kandy, 2100 ft, 16–31 Aug and 1–17 Sep 1976, 2♀. WESTERN PROVINCE. Colombo District: Colombo Museum Gardens, 50 ft, 23, 28 Mar and 13–15 Apr 1977, ♀, 2♂. SABARAGAMUWA PROVINCE. Ratnapura District: Panamure, 500 ft, 15–21 Oct 1970, 2♀. UVA PROVINCE. Badulla District: Ulhitiya Oya, 15 mi NNE Mahiyangana, Malaise trap, 5–6 Sep 1980, 3♂. Monaragala District: Angunakolapelessa, Malaise trap, 8–9 Oct 1980, ♂. SOUTHERN PROVINCE. Hambantota District: Palatupana Tank, 10–20 m, 27–29 Sep 1977 and 22 June 1978, 2♀.

***Trachepyrus indicus* (Muesebeck), NEW COMBINATION**

Figures 2, 6, 9, 12, 15, 17, 20, 23, 26

Pristobethylus indicus Muesebeck, 1934: 233–225, Fig. 1 (♀; Chowghat, Malabar, India, K. P. A. Menon; holotype in U. S. National Museum).—Kurian, 1954: 273.

Female.—Length 4.0–6.2 mm. Black, mandible, scape, flagellum beneath, tegula, occasionally fore and mid femora and all tibiae, tarsi, and last one to three abdominal segments red, basal segments of legs usually brown; wings slightly infumated, stigma dark brown, veins much lighter. Head with median length 0.78–0.92X width, posterolaterally usually with short scalloped carina, posterior margin strongly emarginate; large tooth on inner margin of mandible apical in position (Fig. 12), with a broad cutting edge dorsally (Fig. 17); two modified sensilla chaetica beneath apical tooth, third modified sensillum chaeticum displaced to base of apical tooth (Fig. 17) by rounded boss along inner margin (Fig. 15); front delicately alutaceous, with short median groove anteriorly, moderately punctate, punctures anteriorly separated by half a puncture diameter, becoming much sparser on rest of lower half of front and virtually absent on upper half; least interocular distance 0.7X head width and 1.5–1.8X eye length; ocelli small, front angle about 135°, posterior ocelli separated by half a diameter from posterior margin of head, ocellocular distance 1.0–1.1X width of ocellar triangle. Thoracic dorsum delicately alutaceous, propodeum glossy; pronotal disk with scalloped carina anteriorly, extending half distance to apex laterally, with widely dispersed punctures of moderate size; scutum with only a few small punctures posteriorly in middle; median length of propodeal disk 0.6–0.7X width, enclosed median area quinquecarinate, only median carina reaching discal apex, sides converging strongly toward apex, area between carinae with irregular transverse carinules; median carina on upper half of posterior surface; fore femur 2.4X as long as wide; costa with longer setae interspersed among shorter (Fig. 26); transverse median vein with short stub.



Figures 11–18. *Trachepyrus* female mandibles. 11–13. Apical half, dorsal: 11, *haemorrhoidalis* Kieffer (X236); 12, *indicus* (Muesebeck) (X201); 13, *spinosipes* Kieffer (X372). 14–16. Apical half, ventral: 14, *haemorrhoidalis* (X236); 15, *indicus* (X248); 16, *spinosipes* (X395). 17. Apical half, oblique, *indicus* (X378). 18. Modified sensilla chaetica, ventral, *spinosipes* (X944). (t=tooth, s=modified sensilla chaetica; b=mandibular boss.)

Male.—Length 2.5–4.5 mm. Coloration similar to female except abdomen entirely black, legs and antennae rarely light red. Head with median length 0.8X width, posterolaterally rounded or slightly irregular from a few punctures, posterior margin not so deeply emarginate as in female; front glossy, with scattered small punctures, somewhat more sparsely so on posterior half; least interocular distance 0.64–0.68X head width and 1.3–1.5X eye length; ocellocular distance 1.1–1.2X width of ocellar triangle. Thorax shining; pronotal disk with scalloped carina anteriorly and laterally halfway to apex, weaker than in female; median length of propodeal disk 0.7–0.8X width, enclosed median area tri- or quinquecarinate, only median carina reaching apex, lateral carinae converging strongly toward apex, area with irregular transverse carinules; costa with longer setae interspersed among shorter; transverse median vein without stub. Genitalia and subgenital plate (Figs. 20, 23); apex of paramere with short setae; cuspis slender.

Specimens examined.—SRI LANKA. NORTHERN PROVINCE. Mannar District: Ma Villu, Kondachchi, 19 Sep 1979, 2♀, 2♂; 16–19 Sep 1980, ♀, ♂; 11–12 Apr 1981, ♂. UVA PROVINCE. Badulla District: Ulhitiya Oya, 15 mi NNE Mahiyangana, on or in leaf litter on sand, 5–6 Sep 1980, ♂. Monaragala District: Mau Aru, 10 mi E of Uda Walawe, 100 m, 24–26 Sep 1977, ♀. SOUTHERN PROVINCE. Hambantota, 10 ft, 28 Oct 1970, 2♀. Palatupana, near Wildlife and Nature Protection Society Bungalow, 0–50 ft, 8–10 Mar 1972, 2♀, 2♂; 20–22 June 1978, Malaise trap, ♀; 18–21 Jan 1979, 5♀.

INDIA. KERALA, Chowghat, Malabar, 29 May 1931, caught on sand, ♀ (holotype). MADRAS. Karikal, Tanjore, 17 Aug 1951, 2♀.

Trachepyrus spinosipes Kieffer

Figures 3, 7, 10, 13, 16, 18, 21, 24, 27

Trachepyrus spinosipes Kieffer, 1905: 107.—Kieffer in Kieffer and Marshall, 1906: 413 (♀; Algeria: Ismailia, Ain Sefra; type series in Paris Museum).—Kieffer, 1914: 406.

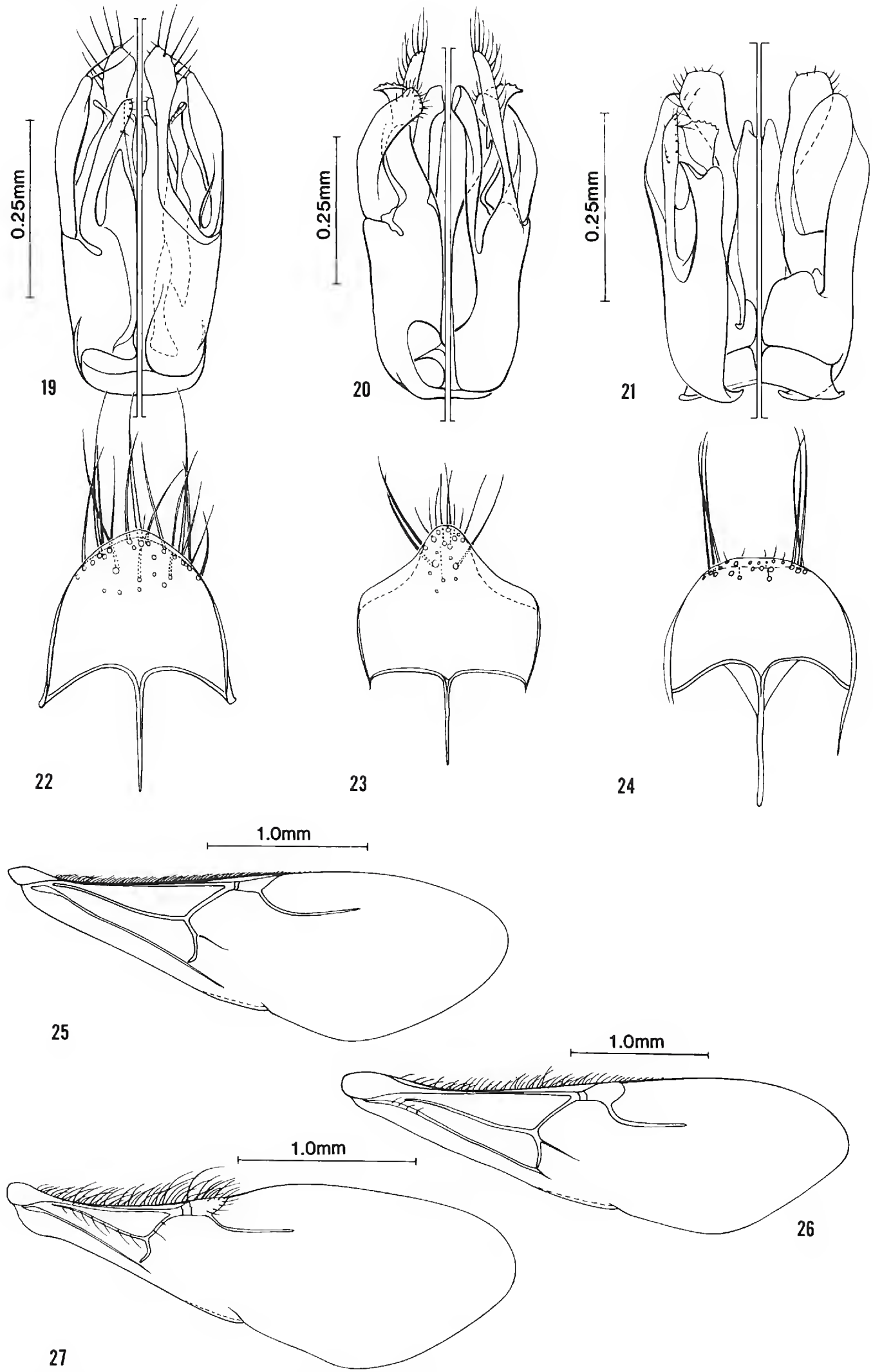
I have examined a series of 18 females and a single male from 10 localities in Egypt. A description is withheld for a revisionary study of Egyptian Bethyridae.

ACKNOWLEDGMENTS

I am pleased to dedicate this paper to E. Gorton Linsley, an occasional wayfarer in entomological areas other than biosystematics of bees and long-horned beetles. Gort is a dedicated naturalist, always interested in elucidating the complex, sometimes arcane relationships between his solitary bees and their nest associates. His detailed pioneer work with J. W. MacSwain (1957) on the interactions of *Stylops pacifica* Bohart with its ground-nesting host bee *Andrena complexa* Viereck afforded valuable insights a few years later in my observations on the trap-nested solitary eumenid, *Euodynerus foraminatus apopkensis* (Robertson), and its stylopid parasite, *Pseudoxenos hookeri* (Pierce).

I am grateful to P. B. Karunaratne, T. Wijesinhe and L. Jayawickrama, technicians with the Smithsonian's Ceylon Insect Project, for their assistance in the field and for the host records they obtained.

I thank T. J. Spilman and J. R. Dogger, Systematic Entomology Laboratory, U. S. Department of Agriculture, for identifying the tenebrionid larvae. M. C. Day,



Figures 19–27. *Trachepyrus* species. 19–21. Male genitalia, ventral at left, dorsal at right: 19, *haemorrhoidalis* Kieffer; 20, *indicus* (Muesebeck); 21, *spinosipes* Kieffer. 22–24. Male subgenital plate, ventral: 22, *haemorrhoidalis*; 23, *indicus*; 24, *spinosipes*. 25–27. Female right forewing: 25, *haemorrhoidalis*; 26, *indicus*; 27, *spinosipes*.

British Museum (Natural History), and C. O'Toole, Oxford University, furnished helpful information on the types of *haemorrhoidalis* and *serricollis* respectively. I am indebted to my friend and mentor for many years, Carl F. W. Muesebeck, for his thorough review of the manuscript.

The line drawings are by George L. Venable, Department of Entomology, Smithsonian Institution (SI). Beth Norden (SI) made the painstaking preparations of specimens for the scanning electron microscope and assisted in the photography; Susan G. Braden (SI) made the micrographs.

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**A New Mexican Species of *Linsleyella* Chemsak
(Coleoptera: Cerambycidae)**

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University of California, Berkeley

The purpuricenine genus *Linsleyella* Chemsak (1984) previously contained three species, *virens* (Bates), *ricei* Chemsak, and *Michelbacheri* Chemsak. The new species described below is one of the many with longitudinal eburneous vittae, which indicates that this characteristic spans a number of genera.

It is a pleasure to dedicate this paper to E. Gorton Linsley, friend and colleague. Christine Jordan prepared the illustration.

***Linsleyella virgulata*, NEW SPECIES
(Figure 1)**

Male.—Form small to moderate sized; integument dark metallic blue-green, appendages metallic; pubescence pale, long, erect. Head small, front irregularly punctate, with numerous long, erect, dark hairs; vertex coarsely, confluent punctate, long, erect hairs moderately dense; antennae longer than body, basal segments shining, moderately coarsely, confluent punctate, erect and subdepressed setae numerous, segments from sixth opaque, densely clothed with very short, appressed pubescence, third segment longer than first, fourth shorter than third, slightly longer than first, eleventh segment acute at apex. Pronotum broader than long, sides usually subangulate behind middle; disk convex, moderately coarsely, subconfluent punctate, often with a longitudinal, median, glabrous callus; pubescence long, erect; prosternum rather finely, transversely punctate, moderately densely clothed with long, pale, erect pubescence; mesosternum subopaque at sides; metasternum deeply, separately punctate at middle, sides subopaque, densely clothed with pale, depressed pubescence, long, suberect hairs numerous. Elytra more than 2½ times as long as broad, sides slightly tapering toward middle; each elytron with an eburneous longitudinal vitta near suture, extending from basal margin to near apical margin and another, narrower pair at sides behind humeri but not extending to apex; punctures between vittae coarse, subconfluent, epipleura subopaque; pubescence long, erect; apices sinuate truncate, inner angles dentate. Legs slender; femora confluent punctate, pubescence long, erect, hind pair extending almost to elytral apices; tibiae moderately clothed with subdepressed hairs. Abdomen finely, densely punctate at sides, middle almost glabrous; last sternite subtruncate at apex, shallowly emarginate at middle. Length, 8–12 mm.

Female.—Form more robust. Antennae shorter than body, segments from sixth enlarged. Legs with femora shorter. Abdomen with last sternite broadly subtruncate, shallowly emarginate at middle. Length, 8–13 mm.

Holotype male, allotype (California Academy of Sciences) from 4 miles SW Morelos Canada, Puebla, Mexico, 20 September 1977 (J. Chemsak, A. & M. Michelbacher). Paratypes include: 26 males, 17 females, same data; 14 males, 21

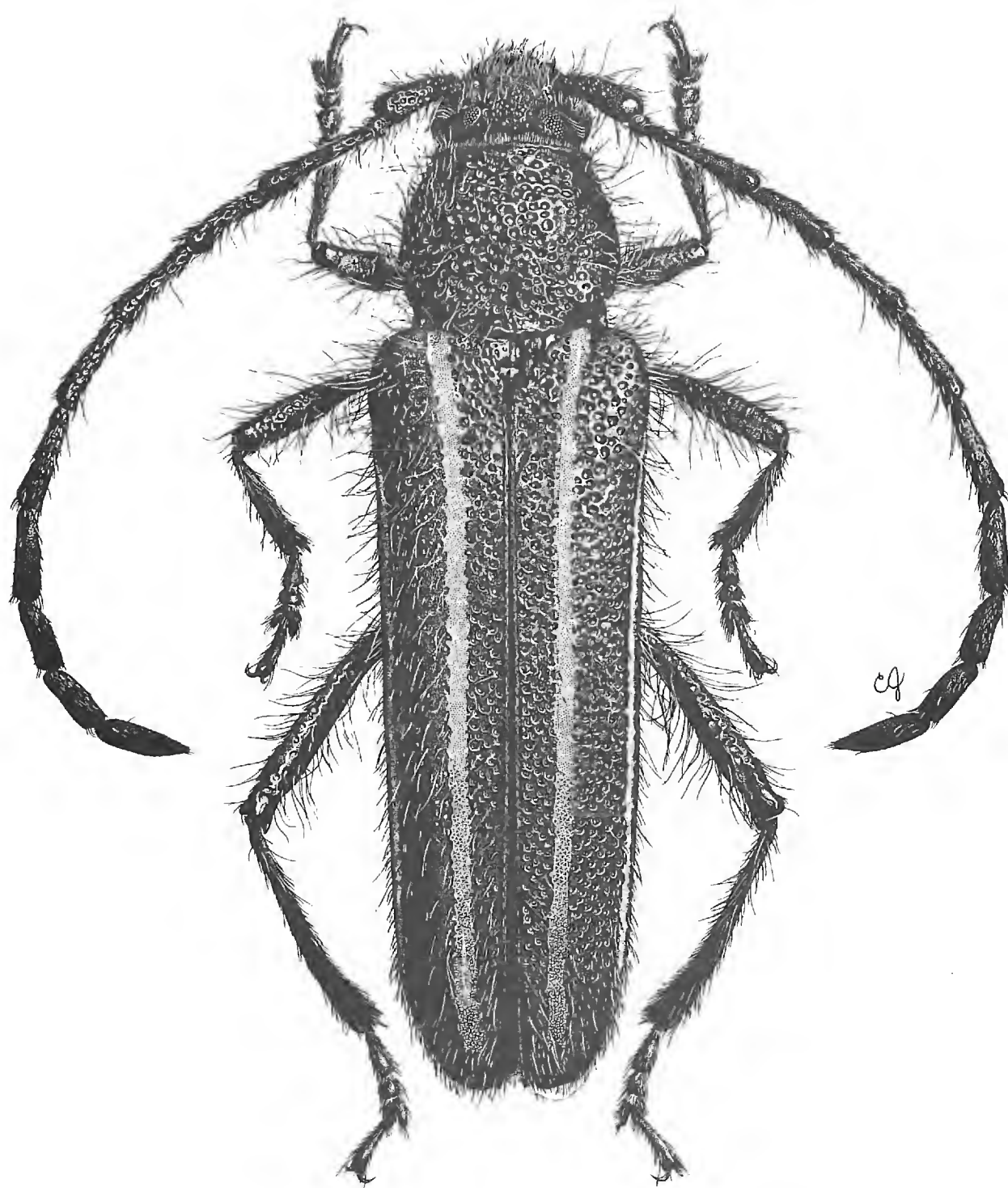


Figure 1. *Linsleyella virgulata* Chemsak, ♀.

females, 7 km SE Morelos Canada, 4 October 1975 (J. Chemsak, J. Powell, T. Eichlin, T. Friedlander); 2 males, 7 km SE Morelos Canada, 4–10 July 1974 on *Selloa glutinosa* flowers. (J. Chemsak, J. Powell, E. G. Linsley); 2 males, 1 female, Tehuacan, Puebla, Mexico, 17 October 1941 (DeLong, Good, Caldwell & Plummer).

The eburneous vittae of the elytra make this species distinctive from other known *Linsleyella*. The coloration is fairly uniform within the type series although a little variation is evident in the thickness of the yellowish vittae. In males the discal pair tend to be broader anteriorly and in females the bands are somewhat narrow.

Adults were mostly collected on flowers of *Selloa glutinosa* at the type locality.

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A New Genus and Species in the Tribe Macrotomini (Coleoptera: Cerambycidae) from Costa Rica

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Abstract.—A single new Cerambycid genus and species from Costa Rica is described and figured: *Parastrongylaspis linsleyi* (Macrotomini).

The genus and species described below, and proposed in conjunction with ongoing studies of the cerambycid fauna of Monteverde, Costa Rica, and its environs by F. T. Hovore, is so far unique to that locality.

Parastrongylaspis, NEW GENUS

Form stout, convex. Head with front short, concave; vertex with median line carinate; mandibles stout, arcuate; genae usually apically produced, parallel; palpi nearly equal, apical segment of maxillary pair slightly larger, truncate at apex; eyes large, moderately coarsely faceted; antennal tubercles prominent, divergent; antennae 11 segmented, moderately robust and slightly longer than body in male, less robust and shorter than body in female, serrate, scape short, compressed, outer segments finely longitudinally striolate, flattened, third segment about twice as long as scape, longer than fourth to tenth segments, eleventh segment of males longest, appendiculate. Pronotum wider than long, convex, lateral suture not expanded nor crenulate, hind angles spinose, disk uneven; prosternum narrow, intercoxal process slender, strongly arcuate, with apex rounded, coxal cavities open behind, strongly angulate externally; mesosternal process moderately slender, coxal cavities open to epimera; metasternum with episternum broad, sides subparallel. Scutellum cordate, moderately large, convex, asperate. Elytra nearly $2\frac{1}{2}$ times as long as width across humeri, sides subparallel, apices widely rounded, with sutural angle dentate. Legs moderately stout; trochanters of male deeply excavated ventrally, with excavation densely pubescent; femora linear, tibiae feebly arcuate, distally expanded and apically spined; tarsi with third segment moderately expanded, cleft to base, metatarsi with first segment longer than following two together. Abdomen normally segmented.

Type species.—*Parastrongylaspis linsleyi* NEW SPECIES

This genus resembles *Strongylaspis* Thomson, and presumably bears a close relationship to that neotropical genus. It may be easily separated by the flattened, serrate antennae and modified trochanters of the male, and by the lack of lateral crenulations of the pronotum. The species of *Strongylaspis* which occur north of South America have received little attention from modern systematists, with the exception of *S. corticaria* Erichson, which is quite abundant in collections, and has been redescribed by Linsley (1962) and de Zayas (1975).

Parastrongylaspis linsleyi Giesbert, NEW SPECIES

(Fig. 1)

Male.—Form moderately large, robust. Integument dark yellow brown, head, pronotum, and appendages reddish brown. Head moderately closely granulate and granulate-punctate, with fine, long, suberect golden pubescence on front and vertex; median line feebly cariniform, slightly darkened; antennal tubercles moderately prominent; antennae moderately robust, usually exceeding elytral apices by one or two segments, scape somewhat flattened, moderately coarsely punctate, sparsely pubescent, segments 3 to 11 serrate, somewhat flattened, finely longitudinally striolate and glabrous, third segment nearly twice as long as scape, about $1\frac{1}{4}$ times as long as fourth, segments 4 to 10 subequal, eleventh segment slightly longer than third, appendiculate. Pronotum wider than long, convex, sides straight, tapering anteriorly, with a small stout spine at each posterior angle; disk with an indistinct oblique cicatrix on each side before middle; surface granulate, moderately densely clothed with long, fine, erect, golden hairs not obscuring surface. Scutellum convex, widely rounded behind, bearing distinct, transverse, cicatrix-like asperites, and fringed with fine golden hairs. Elytra parallel sided, strongly convex anteriorly, less so toward apices, which are widely, separately rounded with sutural angle dentate; surface moderately densely granulate, granules becoming less distinct toward apices, with indistinct fine, short, subdepressed pubescence. Underside granulate, with sternum densely clothed with fine, erect golden pubescence; abdomen with pubescence less dense, terminal sternite widely emarginate at apex. Legs with trochanters scaphiform, ventrally modified into a deep, cup-like excavation filled with long pale hairs; femora sublinear, somewhat compressed, moderately sparsely punctate and pubescent, distally asperate beneath; tibiae asperate, finely pubescent, feebly curved, flattened, and widened distally, with outer apical angle acuminate. Length 17–28 mm.

Female.—Form similar to male. Head with antennal tubercles somewhat less prominent; antennae moderately slender, subserrate, reaching at most to apical $\frac{1}{3}$ of elytra, segments from fifth striate. Abdomen with apex of terminal sternite feebly bilobed, deeply emarginate in middle. Legs with ventral surface of trochanters shallowly excavated, and bearing dense, fine, erect hairs. Length 21–28 mm.

Types.—*Holotype* male, *allotype* (California Academy of Sciences), and 19 *paratypes*, from Monteverde, Puntarenas prov., COSTA RICA, with the following data: 1 male, 1 female, 3–5 June 1974 (E. Giesbert); 1 male, 1–3 June 1978 (E. Giesbert); 6 males, 4 females, 26 May–4 June 1984 (E. Riley, D. Rider, D. LeDoux); 1 male, 22–24 May 1985 (F. Hovore); 1 male, 5 May 1980 (W. A. Haber); 1 male, 5 April 1981 (Haber); 1 male, 1 female, 24–28 May 1985 (Haber); 1 female, 17–20 May 1985 (J. Chemsak); 3 males, 9–12 June 1986 (Hovore, Giesbert).

Remarks.—The combination of the peculiar modification of the male trochanters, with the distinctly pubescent pronotum and serrate antennae, most noticeably in the male, is unique among the known Central American macrotomine fauna.

I would like to thank F. T. Hovore and J. E. Wappes for providing specimen data from their fine personal collections, and J. A. Chemsak for data from the collection at the Essig Museum of Entomology, Berkeley, California, as well as his review of the manuscript.

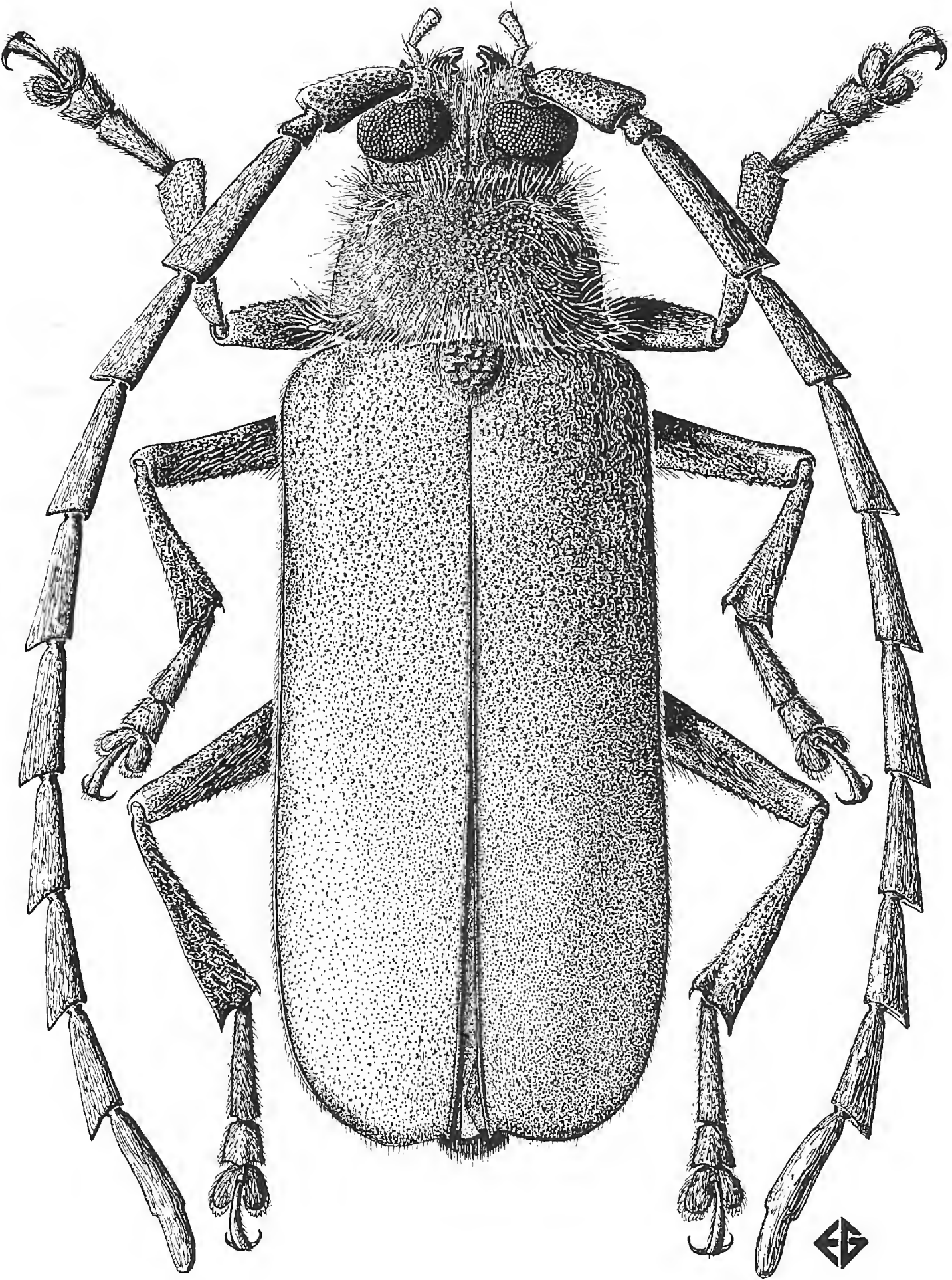


Figure 1. *Strongylaspis linsleyi* Giesbert, male.

It is a pleasure to dedicate this handsome species to my friend E. Gorton Linsley in recognition of his lifetime of devotion to the study and to the students of entomology.

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Linsley, E. G. 1962. The Cerambycidae of North America. Part II. Taxonomy and Classification of the Parandrinae, Prioninae, Spondylinae, and Aseminae. University of California Publications in Entomology 19:1-102.

Zayas, F. de. 1975. Revision de la familia Cerambycidae (Coleoptera: Phytophagoidea). Habana. 433 pp.

PUBLICATIONS RECEIVED

The Sucking Lice of North America. An Illustrated Manual for Identification. By Ke Chung Kim, Harry D. Pratt, and Chester J. Stojanovich. The Pennsylvania State University Press, University Park and London. xii + 241 pp., figs. 1-203, pls. 1-76. Available from The Pennsylvania State University Press, 215 Wagner Building, University Park, Pennsylvania 16802. Price \$39.50 clothbound. ISBN 0-271-00395-2. Publication date given as 23 December 1986. Copy received by PCES at CAS on 31 December 1986.

This volume, dedicated to the late Professor Gordon F. Ferris recognizes 76 species of Sucking Lice as occurring in North America, from a total of currently approximately 500 described world species. The authors estimate the world Anopluran fauna at about 1,000 species.

Chapters on Collecting and Preparation Techniques, Morphology and Diagnostic Characters, Biology and Immature States, Public Health and Veterinary Importance precede the Synopses of North American Anoplura, while chapters on Parasite-Host List, Host-Parasite List, References, and Index complete the volume.

In addition to illustrations occupying a full page plate for each species, each couplet to the keys to the families, genera and species of the North American Anoplura is finely and helpfully illustrated (a total of 190 figures). This would certainly meet with the approval of Ferris. The majority of the illustrations were prepared by Mr. Stojanovich, who in 1951 collaborated with Professor Ferris in the publication of "The Sucking Lice." This latter publication is still available from the Pacific Coast Entomological Society for the nominal price of \$10.00.

—Paul H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

A New Genus and Species of Cerambycidae from Costa Rica [Coleoptera]

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91321

Preparation of a faunal inventory of the Cerambycidae of the Monteverde Cloud Forest and surrounding environs revealed a number of undescribed taxa. The following new genus and species are presented at this time to make the name available for the Monteverde study, and to pay tribute to E. Gorton Linsley, a friend and source of professional guidance and inspiration to me for many years.

Gortonia, NEW GENUS

Form elongate, cylindrical. Head with front vertical, subquadrate, with a narrow, moderately deep, transverse impression parallel to the clypeal margin; genae broad, slightly produced laterally; palpi very short, terminal segments elongate, subcylindrical, bluntly rounded at apices; mandibles stout, broad at base, apices acute, narrowly emarginate internally; eyes finely faceted, moderately deeply emarginate, upper lobes small, widely separated on vertex, lower lobes large, rounded; antennal tubercles slightly elevated, obtuse, divergent, directed posteriorly; antennae 11 segmented, slender, scape stout, subconical, shorter than third segment, segments 3 to 8 subequal in length in male, slightly decreasing in length in female, intermediate segments feebly expanded and dentate externally at apices. Pronotum with sides evenly rounded or with a very feeble indication of a median lateral tubercle, basal margins narrowly expanded laterally over elytral humeri; discal surface smooth, broadly convex, feebly depressed medially; prosternum broad, evenly convex, prosternal process narrow, arcuately declivous behind in male, more evenly rounded and slightly expanded apically in female, coxal cavities feebly angulated externally, open behind by about the width of the apex of the prosternal process; mesosternal process about twice as broad as that of procoxae, feebly convex, evenly arcuate between coxae, occasionally tuberculate anteriorly in females; metepisternum narrow, sides tapering posteriorly. Elytra elongate, narrow, only slightly tapering apically, surface metallic, shining; apices evenly, separately rounded to suture. Scutellum subchordate, apex acute. Legs with profemora moderately stout, gradually expanded apically, mesofemora nearly twice as long as profemora, less strongly expanded apically, feebly carinate on inner and outer surfaces at apical one-half, metafemora very elongate, sinuate, extending to or beyond elytral apices in both sexes; tibiae slender, straight, metatibiae longest, with two apical spurs; posterior tarsi slender, elongate, first segment longer than following two together, third segment cleft almost to base. Abdomen normally segmented, female with setal brush.

Tribal placement: Purpuricenini, near *Eriphus* Serville.

Type species: *Gortonia linsleyi*, NEW SPECIES

The elongate, cylindrical form, long posterior legs, long, slender antennae, smooth, unarmed prothorax, and metallic elytra distinguish *Gortonia* from all other purpuricenine genera. Superficially, *Gortonia* resembles an elongated *Batyle* Thomson, but structurally appears to be more closely related to *Purpuricenopsis* Zajciw, *Axestoleus* Bates, *Zenochloris* Bates, and *Eriphus* Serville. From *Purpuricenopsis* it differs by the feebly dentate antennal segments, evenly rounded and unarmed elytral apices (emarginate-dentate in *Purpuricenopsis*), unarmed femoral apices, and longer posterior tarsi. (Comparisons with *Purpuricenopsis* are based upon Zajciw's (1969) generic key and redescription of the genus.) The genus *Eriphus* may contain polyphyletic elements, with both metallic and non-metallic species, exhibiting a variety of pronotal shapes. From *Eriphus* sensu stricto, *Gortonia* differs immediately by the unarmed prothorax, densely pubescent, metallic elytra, with the apices separately rounded, long, slender antennae, and shorter, more quadrate front. *Zenochloris* Bates, which appears to differ from *Eriphus* primarily by the metallic coloration of its species, may be distinguished from *Gortonia* by the other characters enumerated above for the separation of *Eriphus*. *Axestoleus* differs by the non-metallic coloration, stouter body form, truncate elytral apices, shorter antennae, shorter legs, and callouses on the pronotal disk.

Eriphus prolixus Bates resembles *G. linsleyi* in general body form, and may belong in *Gortonia*; however, I have seen only a color transparency of the type specimen, and generic assessment must await examination of the underside and appendages.

***Gortonia linsleyi*, NEW SPECIES**

(Figure 1)

Male.—Form moderate-sized, dorsal surface of body very feebly depressed; integument black, prothorax and basal three-fourths of anterior femora reddish-orange, pronotal disk usually with dark infuscation medially and at sides on the apical one-half, median marking often in shape of narrow, inverted triangle, elytra metallic greenish-gray; body pubescence mostly pale, black on elytral apices and portions of antennae, meso- and metatibiae. Head coarsely, sparsely, transversely punctate on neck and vertex, genae with a few large punctures, front densely, finely, irregularly punctate, densely clothed with short, fine, posteriorly-appressed pubescence, longitudinal midline moderately-deeply impressed between antennal tubercles; eyes with upper lobes separated on vertex by about the diameter of antennal scape, lower lobes large, about one-third taller than genae; genal apex slightly produced laterally, rounded, with narrow emargination medially at mandibular insertion; antennae surpassing elytral apices by about four segments, scape robust, densely, finely punctate, finely setose, second segment moniliform, about as long as wide, segments 3 to 5 distinctly, thinly fringed internally with black, suberect hairs, distal segments with a few scattered erect hairs internally, all segments sparsely clothed with short, very fine, appressed pubescence, segments 3 to 7 feebly expanded and dentate externally at apices, segments 3 to 8 subequal in length, segment 9 slightly shorter, segment 10 shortest, segment 11 subequal in length to segment 9, sinuate, curved outward, Pronotum slightly wider than long, base and apex constricted, base with a narrow, transverse sulcus, apex about

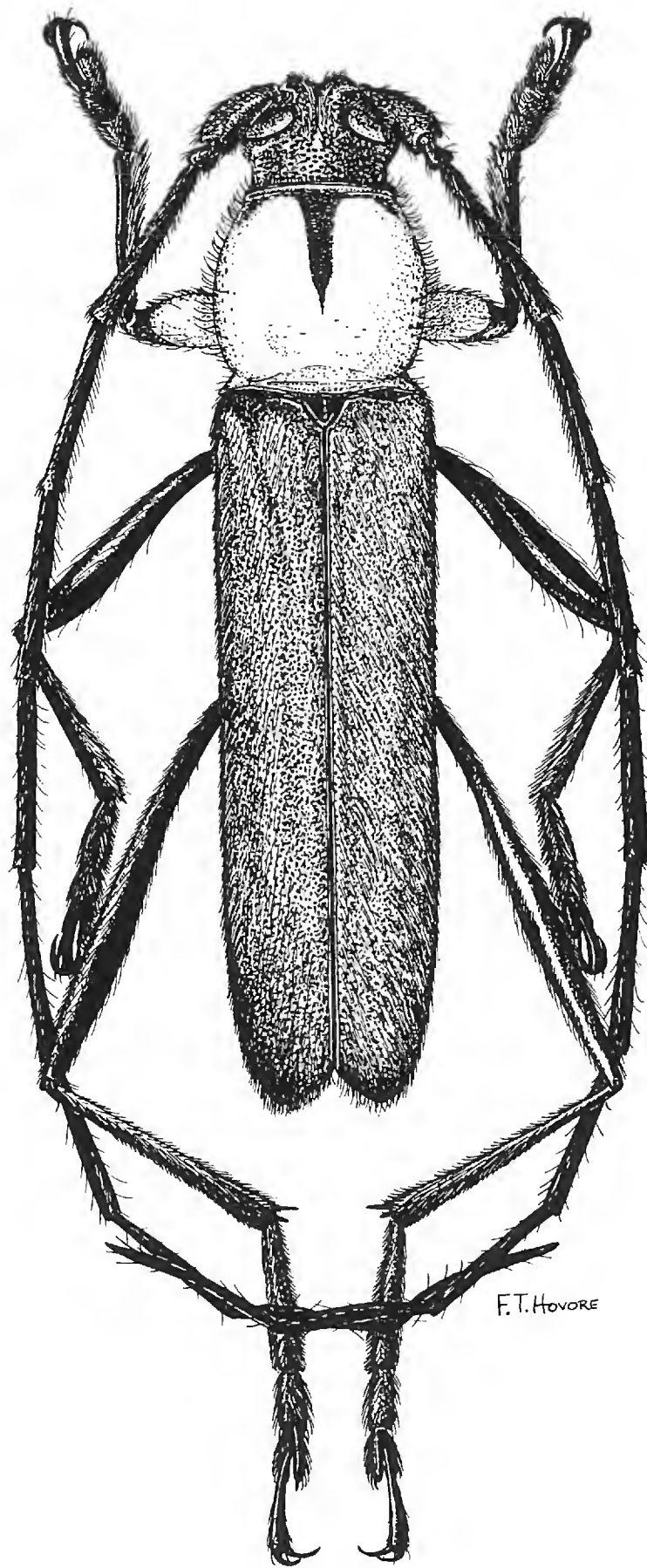


Figure 1. *Gortonia linsleyi* Hovore, male.

one-third narrower than base, median lateral tubercle evident only as a small, impunctate, tumid area, discal surface nearly glabrous, microscopically alutaceous-punctate, with scattered larger, seta-bearing punctures, sides with fine punctures and large, irregularly-shaped or elongate punctures intermixed, thinly clothed with fine, short, erect pubescence, a few longer hairs present on basal two-thirds; prosternum coarsely, sparsely, irregularly punctate, finely, moderately-densely pubescent; meso- and metasternum densely, minutely punctate,

densely clothed with fine, suberect pubescence. Elytra more than three times longer than humeral width, surface densely, moderately to coarsely punctate, punctures becoming shallower, less defined, confluent apically, densely clothed with pale, recumbent pubescence which does not obscure the surface, hairs at apex of elytra longer, coarser, black; apices separately rounded. Legs with profemora densely, minutely punctate-pubescent, meso- and metafemora moderately to coarsely punctate and pubescent. Abdomen densely, minutely punctate, densely clothed with long erect pubescence, apical margins of sternites narrowly glabrous and impunctate; second and fifth sternites subequal in length; apex of fifth sternite and fifth tergite each broadly rounded or feebly truncate, fringed with long pale hairs. Length: 9–14 mm.

Female.—Coloration similar to that of male, form slightly more robust; elytra very slightly shorter; pronotal infuscation lacking; antennae surpassing elytral apices by about two and one-half segments, segments beginning with third decreasing slightly in length, tenth shortest, apical segment straight; pronotal disk more lightly punctate than in male, sides nearly glabrous, punctate areas only feebly indicated by surface irregularities; abdomen with fifth sternite nearly twice as long as second, apex of fifth sternite and fifth tergite each broadly rotundate-truncate, feebly emarginate medially, fringed with long pale hairs. Length: 12–15 mm.

Holotype male, allotype (California Academy of Sciences) and 19 paratypes (14 males, 5 females) from COSTA RICA, Puntarenas Province, 6 km S Santa Elena, 9–12 June 1986, on blossoms of *Croton* sp. (F. T. Hovore). Additional paratypes (9 males, 3 females), all topotypical: 5 males, 3 females, 5–7 June 1980 (E. F. Giesbert, J. E. Wappes); 1 male, 6–7 June 1983 (E. F. Giesbert); 2 males, 1 female, 18 May 1984 (F. T. Hovore, R. L. Penrose); 2 males, 9 June 1986 (E. F. Giesbert). A single male specimen, not designated as paratypical, is at hand from PANAMA, Panama Province, Bayano district, 3–5 km W Ipeti, 19 May 1985, on blossoming tree. Aside from its smaller size (9 mm), this specimen does not differ significantly from topotypical material.

Variation in the type series is minimal. Some individuals have a pronounced bluish tint to the elytra, and most males possess the dark median pronotal macula. In a few individuals this macula is reduced to a vague apical patch, while in others it extends posteriorly to the base of the disk. The normally reddish profemora are heavily infuscated with black in a few males, and appendage length appears to be somewhat allometric; larger individuals possess relatively longer antennae and legs.

It is my great pleasure to dedicate this new genus and species to E. Gorton Linsley, Professor Emeritus, University of California, Berkeley.

ACKNOWLEDGMENTS

I am grateful to R. L. Penrose (California Department of Food and Agriculture) and J. A. Chemsak (University of California, Berkeley) for reviewing the manuscript; and to E. F. Giesbert for specimen data and color slides of cerambycid type specimens.

LITERATURE CITED

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Ovaries, Ovarioles, and Oocytes in Parasitic Bees (Hymenoptera: Apoidea)

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Abstract.—Ovarian features of parasitic bees including the number of ovarioles per ovary, the number and size of mature oocytes, and the morphology of mature oocytes are explored. Included are data from 44 species representing approximately 8 separately derived cleptoparasitic lineages within the Apoidea. The number of ovarioles of parasitic Halictidae and Megachilidae is 3 per ovary, as is characteristic of non-parasitic Colletidae, Andrenidae, Halictidae, Melittidae, and Megachilidae. In the anthophorid/apid lineage, which has 4 ovarioles per ovary as a plesiomorphic condition, the Nomadinae tend to have increased numbers of ovarioles, with 5 ovarioles per ovary seeming to be the most common condition. In two other parasitic lineages of the Anthophoridae (Melectini and Ctenioschelini), only *Ericrocis lata* with 5 ovarioles has an increase from the plesiomorphic state. In the Apidae, *Psithyrus* consistently exhibits an above normal number of ovarioles.

Cleptoparasitic bees in all families tend to have a larger number of mature oocytes in their ovaries at a given time than do solitary bees, and these oocytes tend to be smaller than are those of solitary bees. Mature oocytes of the Nomadinae show considerable variation in structure from one another and from the oocytes of non-nomadine bees, as illustrated by *Nomada*, *Ammobates* and *Triepeolus*.

INTRODUCTION

Rozen (1986a) published a survey of the number of ovarioles in various taxa of bees, and realized, as had Iwata (1955, 1960, 1964, 1965) and Iwata and Sakagami (1966) before, that the number of ovarioles and other ovarian characteristics of bees have phylogenetic, taxonomic and adaptive significance. Cleptoparasitic bees especially seem replete with variable ovarian features. The works of these authors suggested that interesting patterns of variation exist from one parasitic lineage to another and that at least some of the variation may be explained in terms of the mode of life of the bees. To explore these matters more broadly, we collected, preserved in fixative and examined as many additional parasitic taxa as possible. Using both recently collected specimens and information from the literature, this paper reports on the number of ovarioles of different cleptoparasitic lineages, on the number and size of their mature oocytes and on other aspects of the morphology of the oocytes of the Nomadinae.

With great pleasure we dedicate this article to Dr. E. Gorton Linsley, one of the great systematists of cleptoparasitic bees (as well as many other groups of insects). The second author remembers with fondness being required to undertake the life

history study of one species of bee as part of his dissertation research by his major professor, Gort Linsley. This simple requirement led the second author to 35 years of digging holes both shallow and deep in most of the continents of the world in search of biological data about, and immature stages of, solitary and parasitic bees. Gort Linsley more than anyone else taught him that the data base for systematics was far greater than the specimen on a pin.

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We thank Dr. George C. Eickwort, Cornell University, for reviewing this manuscript.

MATERIALS AND METHODS

Original observations reported in this paper are based upon dissections of specimens that either were fixed and preserved in Kahle's solution prior to dissection (*Epeolus zonatus* from the Cornell collection and all of the AMNH specimens except *Triepeolus* sp. R) or were dissected as freshly killed specimens and subsequently fixed in Kahle's solution (all other Cornell material). The internal organs of specimens that have been preserved prior to dissection are somewhat brittle and more difficult to dissect without damaging structures one wishes to observe. New material reported in this paper deals with 25 species in 16 genera and 3 families of cleptoparasitic bees.

Because we compare our observations with the large data set previously gathered by Iwata (1955, 1960, 1965) and Iwata and Sakagami (1966), we use their definitions of stages of oocyte development and their measurement of body size. We repeat the definitions of their terms used in this paper: (1) EGG LENGTH (E) is the length (to the nearest 0.1 mm) of "the largest oocyte in the ovaries"; (2) MESOSOMAL WIDTH (M) is the "distance between the outer extremities of the tegulae" (mean value if more than one specimen was available); (3) EGG INDEX is the ratio E/M; and (4) MATURE OOCYTES are all oocytes in Iwata's (1955) categories A or B, defined as follows:

Category A: "mature oocytes, the nutritive cells of which have quite disappeared. In certain species the mature oocytes diminish their sizes a little to take their proper shapes."

Category B: "nearly mature oocytes, the nutritive cells of which begin to collapse. Generally they attain the maximum size proper to each species, but have not yet taken their proper shapes."

We count all oocytes tallied by Iwata as category A or B as mature oocytes because we were not confident that we could reliably distinguish between the two categories in our specimens. (Iwata worked primarily with fresh rather than preserved material, and his definitions of four discrete categories of developing oocytes were formulated in the framework of a survey of the oocytes of all Hymenoptera, rather than bees alone. The distinctions may be more apparent and significant in other Hymenoptera than they are in bees.)

The statistical tests used in this paper to analyze the number of mature oocytes in parasitic bees are Mann-Whitney U Tests (where sample sizes are adequate, P-values are based upon a standardized normal distribution of the U statistic). A

non-parametric statistical test is used because distributions are decidedly non-normal. Data for solitary species are all from Iwata (1955, 1960, 1965) or Iwata and Sakagami (1966). Data for parasitic species are from Iwata (13 species) and the present study (18 species).

RESULTS

Number of ovarioles.—In most families of bees (Colletidae, Andrenidae, Halictidae, Melittidae, and Megachilidae; unknown for the Stenotritidae, Oxaeidae, and Ctenoplectridae), there are 3 ovarioles per ovary (indicated by the notation 3:3 in Table 1), regardless of whether the bees are solitary, parasitic, subsocial, or social (Iwata and Sakagami, 1966; Rozen, 1986a). The present study corroborates this pattern for cleptoparasitic species in the Halictidae and Megachilidae (no cleptoparasitic bees in the other families for which data are available) (Table 1). In the Anthophoridae and Apidae, the presumed plesiomorphic condition is 4 ovarioles per ovary (i.e., 4:4 in Table 1). A notable exception is the subfamily Nomadinae, all of whose members are cleptoparasitic. Ovariole number appears to be more variable within the Nomadinae than in most other bees. It differs not only from species to species, but among individuals within a species, and sometimes even between ovaries within an individual (Table 1). Despite this variability, the number of ovarioles is almost always higher than the common anthophorid/apid condition of 4:4, and within the Nomadine 5:5 seems to be the most common condition.

We have examined four species of cleptoparasitic anthophorids that are not in the subfamily Nomadinae. Three species have the common anthophorid condition of 4 ovarioles per ovary, but *Ericrocis lata* has 5 ovarioles per ovary (Table 1).

Within the Apidae, an increase in ovariole number has been reported in five species of the socially parasitic genus *Psithyrus* (Cumber, 1949). The exact number of ovarioles is extremely variable, ranging from 6 to 18 per ovary (Table 1). By contrast, *Bombus*, the presumed sister group of *Psithyrus*, possesses the plesiomorphic number 4. (Queens in the related advanced eusocial genus *Apis* are remarkable among bees for their large number of ovarioles. Snodgrass (1956) estimated that *Apis mellifera* queens have 160 to 180 ovarioles per ovary.)

The fact that both *Psithyrus* and *Ericrocis lata* have more than 4 ovarioles (the plesiomorphic anthophorid/apid number) suggests that selection pressure for increased number of ovarioles has independently played a role in three separate groups in the anthophorid/apid line. We suspect, as did Iwata (1955, 1964) and Iwata and Sakagami (1966), that increased number of ovarioles functions to increase the total number of eggs that an individual can deposit. It also permits a greater number of mature oocytes to be ready for deposition within a short time period as pointed out below.

Number of mature oocytes.—Cleptoparasitic bees in all families tend to have a larger number of mature oocytes in their ovaries at a given time than do solitary bees. The difference is statistically significant, whether one tallies the total number of mature oocytes or the number of mature oocytes per ovariole (Table 2). The pattern also holds up if one divides the cleptoparasitic species into two subgroups on the basis of whether they have the same number of ovarioles as their non-parasitic relatives or an increased number of ovarioles. In comparing these two subgroups, we find that those species with an increased number of ovarioles have a significantly higher total

Table 1. Number of ovarioles and size and number of mature oocytes in various taxa of cleptoparasitic bees. Definitions of terms and notations are given in the text.

| Taxon | Egg Index | Total Number Mature Oocytes | Mature Oocytes per Ovariole | Number of Ovarioles | Number of Specimens Examined | Reference |
|---|-----------|-----------------------------|-----------------------------|------------------------|------------------------------|-------------------|
| Halictidae | | | | | | |
| <i>Sphecodes esakii</i> | 0.36 | 9 | 1.50 | 3:3 ^a | 2 | Iwata, 1955 |
| <i>Sphecodes japonica</i> | — | 4 | 0.67 | 3:3 ^a | 2 | Iwata, 1955 |
| <i>Sphecodes</i> sp. <i>A</i> | 0.57 | 6 | 1.00 | 3:3 | 1 | present study |
| <i>Sphecodes</i> sp. <i>B</i> | 0.76 | — | — | 3:3 | 1 | present study |
| Megachilidae | | | | | | |
| <i>Dioxys pacificus</i> | 0.74 | 2 | 0.33 | 3:3 | 2 | present study |
| <i>Stelis</i> sp. | 0.61 | 2.67 | 0.44 | 3:3 | 3 | present study |
| <i>Euaspidis basalis</i> | 0.53 | 3.5 | 0.58 | 3:3 ^{a,c} | 3 | Iwata, 1955, 1960 |
| <i>Coelioxys (Rhinocoelioxys)</i> sp. | 0.41 | — | — | prob. 3:3 | 1 | present study |
| <i>Coelioxys yanonis</i> | — | 2 | 0.33 | 3:3 ^a | 1 | Iwata, 1955 |
| <i>Coelioxys fenestratus</i> | 0.54 | 18 | 3.00 | 3:3 ^a | 1 | Iwata, 1955 |
| <i>Coelioxys brevis</i> | 0.40 | 5 | 0.83 | 3:3 ^a | 1 | Iwata, 1955 |
| <i>Coelioxys</i> sp. (138) | — | 9 | 1.50 | 3:3 ^a | 1 | Iwata, 1955 |
| <i>Coelioxys decipiens</i> | — | 4 | 0.67 | prob. 3:3 ^b | 1 | Iwata, 1965 |
| Anthophoridae | | | | | | |
| Anthophorinae | | | | | | |
| <i>Thyreus japonicus</i> | 0.85 | 3.5 | 0.438 | 4:4 | 2 | Iwata, 1955 |
| <i>Zacoscma maculata desertorum</i> | 0.74 | 6 | 0.75 | 4:4 | 1 | present study |
| <i>Mesoplia</i> prob. <i>rufipes</i> | 0.74 | 4 | 0.50 | 4:4 | 1 | present study |
| <i>Ericrocis lata</i> | 0.77 | 2 | 0.20 | 5:5 | 1 | present study |
| Anthophoridae | | | | | | |
| Nomadinae | | | | | | |
| <i>Neolarra (Neolarra) californica</i> | 0.33 | 13.75 | 1.325 | 5:5 | 3 | present study |
| | | | | 5:6 | 1 | present study |
| <i>Neolarra (Neolarra)</i> sp. | — | — | — | 5:5 (or 5:4) | 1 | present study |
| <i>Neolarra (Phileremulus) vigilans</i> | — | 11 | 1.10 | 5:5 | 1 | present study |
| <i>Holcopasites calliopsidis</i> | — | — | — | 5:6 | 1 | present study |
| <i>Ammobates carinatus</i> | 0.47 | 6 | 0.50 | 6:6 | 1 | present study |
| <i>Oreopasites</i> sp. <i>A</i> | 0.49 | 7 | 0.74 | 5:4 | 1 | present study |
| | | | | 5:5 (or 6:4) | 1 | present study |
| <i>Oreopasites vanduzeei</i> | — | — | | approx. 11 total | 1 | Rozen, 1986a |
| | | | | prob. 5:5 | 1 | Rozen, 1986a |
| <i>Kelita chilensis</i> | 0.30 | 7 | 0.70 | prob. 5:5 | 1 | Rozen, 1986a |
| | | | | 5:5 | 1 | present study |
| <i>Epeolus zonatus</i> | 0.53 | 8.5 | 0.85 | 5:5 | 2 | present study |
| <i>Epeolus scutellaris</i> | 0.76 | 6.33 | 0.45 | 7:7 | 4 | present study |
| <i>Epeolus</i> sp. | 0.56 | 4 | 0.40 | 5:5 | 1 | present study |
| <i>Epeolus japonicus</i> | 1.00 | 6.5 | 0.54 | 6:6 | 2 | Iwata, 1955 |
| <i>Triepeolus pectoralis</i> | 0.62 | 5 | 0.50 | 5:5 | 1 | present study |

continued

Table 1. continued

| Taxon | Egg Index | Total Number Mature Oocytes | Mature Oocytes per Ovariole | Number of Ovarioles | Number of Specimens Examined | Reference |
|---|-----------|-----------------------------|-----------------------------|---------------------|------------------------------|---------------|
| <i>Triepeolus</i> sp. R | 0.49 | 2 | 0.20 | 5:5 | 1 | present study |
| <i>Centrias articulata</i> | 0.28 | — | — | 5:5 | 3 | present study |
| <i>Nomada banksi</i> | 0.30 | 15.5 | 1.55 | 5:5 | 3 | present study |
| <i>Nomada vicina</i> | 0.39 | 8 | 0.80 | 5:5 | 1 | present study |
| <i>Nomada illinoiensis</i> | — | — | — | 5:4 | 1 | present study |
| | | | | 5:5 | 1 | present study |
| <i>Nomada</i> (“ <i>Gnathias</i> ”) sp. | — | — | — | 5:5 | 1 | present study |
| <i>Nomada pyrifera</i> | 0.50 | 14.5 | 1.45 | 5:5 | 2 | Iwata, 1955 |
| <i>Nomada</i> sp. nr. <i>glabella</i> | 0.38 | 8.67 | 0.90 | 5:5 | 2 | Iwata, 1955 |
| | | | | 5:4 | 1 | Iwata, 1955 |
| <i>Nomada japonica</i> | 0.39 | 21.125 | 2.15 | 5:5 | 6 | Iwata, 1955 |
| | | | | 4:4 | 1 | Iwata, 1955 |
| | | | | 6:5 | 1 | Iwata, 1955 |
| Apidae | | | | | | |
| <i>Psithyrus barbutellus</i> | — | — | — | 10:10 | 1 | Cumber, 1949 |
| | | | | 10:12 | 1 | Cumber, 1949 |
| | | | | 6:7 | 1 | Cumber, 1949 |
| | | | | 8:9 | 1 | Cumber, 1949 |
| <i>Psithyrus bohemicus</i> | — | — | — | 14:13 | 1 | Cumber, 1949 |
| <i>Psithyrus campestris</i> | — | — | — | 7:8 | 1 | Cumber, 1949 |
| | | | | 6:7 | 1 | Cumber, 1949 |
| <i>Psithyrus rupestris</i> | — | — | — | 18:15 | 1 | Cumber, 1949 |
| | | | | 15:13 | 2 | Cumber, 1949 |
| | | | | 16:14 | 1 | Cumber, 1949 |
| | | | | 12:14 | 1 | Cumber, 1949 |
| <i>Psithyrus vestalis</i> | — | — | — | 10:10 | 1 | Cumber, 1949 |

^aSpecies included in Iwata’s Table IV (A), comprising “Anthophila with three pairs of ovarioles.”
^bIwata’s Fig. 50 shows a single ovary which clearly has only 3 ovarioles.
^cIwata (1960) explicitly lists number of ovarioles (for a single specimen) as 3:3.

number of mature oocytes, but they do not produce more oocytes per ovariole (Table 2).

Hence different lineages of parasitic bees have independently undergone an increase in the number of mature oocytes in their ovaries at a given time. This may reflect that parasitic bees produce more eggs in their life span than do solitary bees and that as a result a larger number of eggs are ready for deposit in a short interval. However, it is also likely that there is selective advantage for parasitic bees to be able to oviposit in rapid succession. Unlike a female solitary bee that must construct and provision a cell before each oviposition, a female cleptoparasite may find, and therefore must be ready to lay eggs in, more than one host cell in a short time period.

Size of mature oocytes.—Iwata and Sakagami (1966) reported that the mature

Table 2. Comparison of numbers of mature oocytes in parasitic vs. solitary bees.

| | Total Number of Mature Oocytes | Mature Oocytes per Ovariole | Sample Size |
|--|--|---|--|
| 1) Solitary Bees | $\left\{ \begin{array}{l} 2.17 \\ U_s = 320 \\ Z = 3.913 \\ P < 0.001 \end{array} \right.$ | $\left\{ \begin{array}{l} 0.34 \\ U_s = 725 \\ Z = 5.16 \\ P < 0.001 \end{array} \right.$ | $\left\{ \begin{array}{l} 26 \\ U_s = 678.5 \\ Z = 4.41 \\ P < 0.01 \end{array} \right.$ |
| 2) Cleptoparasitic Bees | | | |
| a) With Unchanged Number of Ovarioles | $\left\{ \begin{array}{l} 7.18 \\ 5.62 \end{array} \right.$ | $\left\{ \begin{array}{l} 0.86 \\ 0.90 \end{array} \right.$ | $\left\{ \begin{array}{l} 31 \\ 14 \end{array} \right.$ |
| b) With Increased Number of Ovarioles | $\left\{ \begin{array}{l} U_s = 170 \\ Z = 2.02 \\ P < 0.05 \\ 8.46 \end{array} \right.$ | $\left\{ \begin{array}{l} U_s = 124 \\ Z = 0.198 \\ P = 0.84 \\ 0.84 \end{array} \right.$ | $\left\{ \begin{array}{l} 17 \end{array} \right.$ |

oocytes of cleptoparasitic bees tend to be smaller than those of solitary species. Our observations corroborate this pattern, as shown in Figure 1 (which combines data from the present study and Iwata and Sakagami’s study). It also appears that the distribution of egg sizes is relatively symmetrical in solitary species but decidedly asymmetrical and weighted toward smaller egg sizes in cleptoparasitic bees.

The egg index proposed by Iwata and Sakagami is a measure of oocyte size relative to overall body size. They suggested such a measure because they expected that oocyte size would vary with body size in a regular manner. Indeed, when maximum oocyte length is plotted against mesosomal width, both parasitic and non-parasitic species show a positive linear relationship between the two variables (Fig. 2. $r^2 = .758$ for parasites; $r^2 = .748$ for solitary species). Within the lower ranges of body sizes, parasitic species of a given size seem consistently to have smaller oocytes than solitary species of the same size. Such a trend is not apparent among larger bees in our sample.

Morphology of oocytes of the Nomadinae.—As has been noted by others (Iwata, 1960; Rozen, 1986a), mature oocytes of Nomadinae show remarkable variation in structure from one another and from the oocytes of non-nomadine bees. Figures 3–5 illustrate the oocyte features of some of the bees that we examined. The nipple-like structure on the anterior end of the oocyte of *Nomada vicina* (Fig. 3) was found also on two other *Nomada* seen by us but not on a fourth species; Iwata (1960) depicted nipples in two of the three species he studied. We presume that the corrugations that predominate on one side of the oocytes of *Ammobates* (Fig. 4) and *Oreopasites* (Rozen, 1986a, Fig. 1) permit the eggs to bend U-shaped as they are inserted into the cell walls of the hosts, as seems characteristic of the Ammobatini (Rozen, 1986b) with the exception of *Pseudodichroa* (Rozen and Michener, 1968). The completely annular corrugations of *Triepeolus pectoralis* oocytes (Fig. 5) and of the eggs of some other species in the same genus (Bohart, 1966) may allow for the expansion of the egg as it absorbs water in the cell wall of the host. We believe that oocytes of other

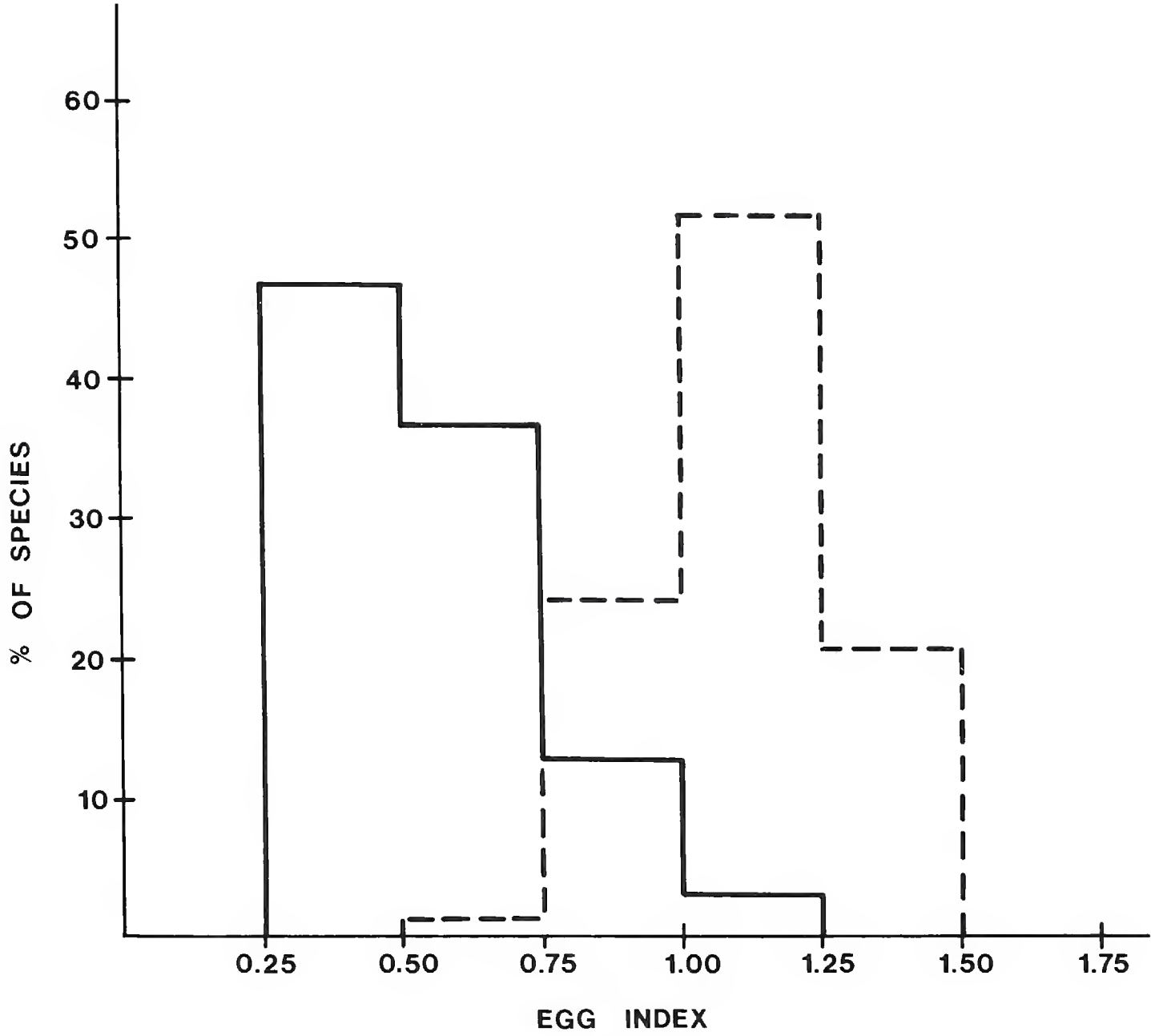


Figure 1. Frequency distributions for oocyte size (expressed as the EGG INDEX, or ratio of length of mature oocyte to mesosoma width) in cleptoparasitic bees (solid line) and solitary bees (dashed line).

Nomadinae will also be distinctive in shape and that shape will be correlated with the mode of oviposition of the taxon.

MATERIAL STUDIED

Sphecodes sp. A, 2 mi E of Apache, Cochise Co., Arizona, 9 May 1986 (J. G. Rozen). *Sphecodes* sp. B, 3 mi SW of Rodeo, Hidalgo Co., New Mexico, 5 May 1965 (J. G. Rozen). *Dioxys pacificus* Cockerell, 2 mi E of Apache, Cochise Co., Arizona, 9 May 1986 (J. G. Rozen). *Stelis* sp. A, Cienega Ranch, Hidalgo Co., New Mexico, 13 May 1986 (J. G. Rozen). *Coelioxys* (*Rhinocoelioxys*) sp., near Chetumal, Quintana Roo, MEXICO, 12 October 1986 (G. C. Eickwort). *Zacosmia maculata desertorum* Cockerell, 2 mi E of Apache, Cochise Co., Arizona, 9 May 1986 (J. G. Rozen). *Ericrocis lata* (Cresson), 1 mi E of Douglas, Cochise Co., Arizona, 21 August 1986 (J. G. Rozen). *Mesoplia* prob. *rufipes* Perty, Hollis Reservoir, near Valencia, TRINIDAD, 3 March 1968 (J. G. Rozen). *Ammobates carinatus*

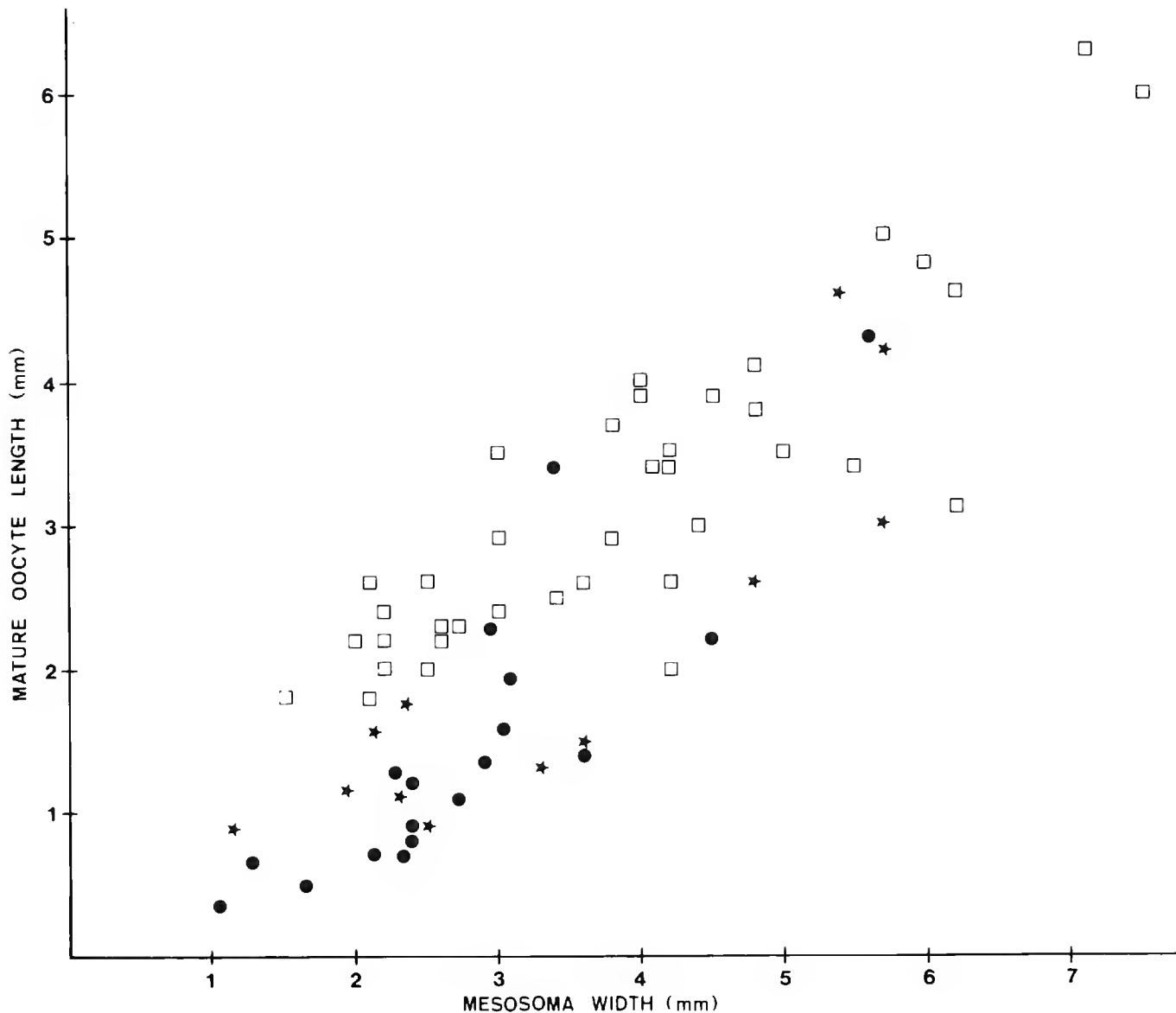


Figure 2. Scatter plot of mesosomal width versus length of mature oocytes in various species of bees. □ = solitary; ★ = cleptoparasites with same number of ovarioles as non-parasitic relatives; ● = cleptoparasites with increased number of ovarioles.

Morawitz, 10 km S of Skhirate, MOROCCO, 29 April 1968 (J. G. Rozen & E. Suissa). *Oreopasites* sp. A, 4 mi E of Willcox, Cochise Co., Arizona, 5 September 1986 (J. G. & B. L. Rozen), from nesting area of *Nomadopsis meliloti* (Cockerell). *Kelita chilensis* (Friese), Peñuelas, Valparaíso Prov., CHILE, 28 October 1969 (J. G. Rozen). *Triepeolus* sp. R, 11 mi S of Animas, Hidalgo Co., New Mexico, 20 August 1986 (J. G. Rozen). *Triepeolus pectoralis* (Robertson), Cornell Campus, Ithaca, Tompkins Co., New York, 3 September 1985 (B. Alexander). *Epeolus scutellaris* Say, Cornell Campus, Ithaca, Tompkins Co., New York, 1–5 September 1985 (B. Alexander). *Epeolus* sp., 4 mi E of Willcox, Cochise Co., Arizona, 8 May 1986 (J. G. Rozen). *Holcopasites calliopsidis* (Linsley), Van Natta sand pit, Ithaca, Tompkins Co., New York, 11 July 1985 (B. Alexander). *Neolarra* (*Neolarra*) *californica* Michener, Cienega Ranch, Hidalgo Co., New Mexico, 10 May 1986 (J. G. Rozen). *Neolarra* (*Phileremulus*) *vigilans* (Cockerell), 19 mi SW of Apache, Cochise Co., Arizona, 29 August 1986 (J. G. & B. L. Rozen), from nesting site of *Perdita lenis* and *Perdita* sp., *Neolarra* (*Neolarra*) sp., 4.8 mi SW of Rodeo, Hidalgo

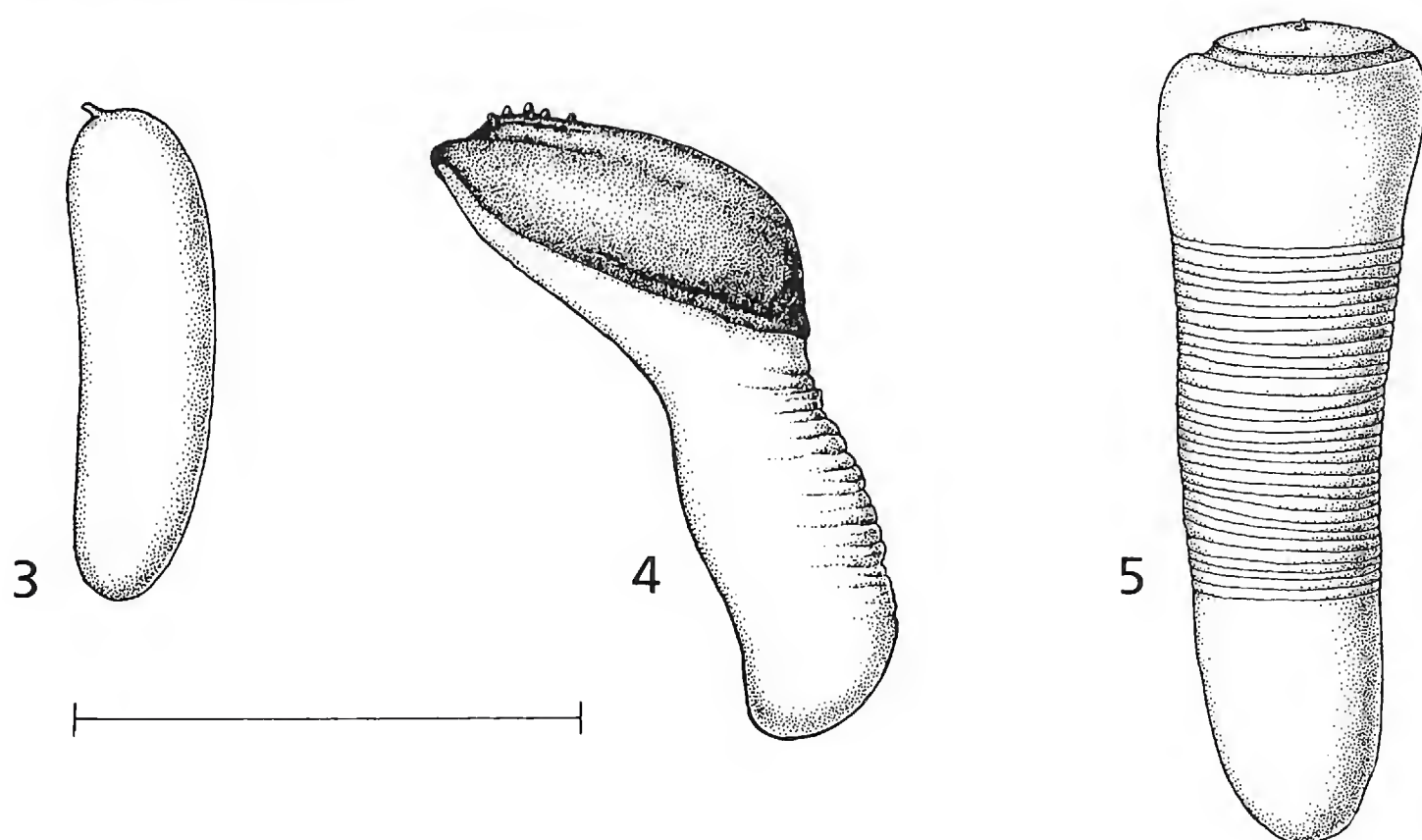


Figure 3–5. Mature oocytes of Nomadinae, anterior end at top. 3. *Nomada vicina*. 4. *Ammobates carinatus*. 5. *Triepeolus pectoralis*. Scale = 1.0 mm.

Co., New Mexico, 1 September 1975 (J. G. Rozen), from *Perdita mentzeliae* nest #7. *Centrias articulata* (Smith), Cornell campus, Ithaca, Tompkins Co., New York, 11 July 1985 (B. Alexander). *Nomada banksi* Cockerell, Van Natta sand pit, Ithaca, Tompkins Co., New York, 22, 29 September 1985 (B. Alexander). *Nomada vicina* Cresson, van Natta sand pit, Ithaca, Tompkins Co., New York, 23 September 1985 (B. Alexander). *Nomada* sp. (perhaps *illinoensis* Robertson), Cornell campus, Ithaca, Tompkins Co., New York, 15 May 1986 (B. Alexander). *Nomada* (“*Gnathias*”) sp., near Junius Ponds, 6 mi NW of Waterloo, Seneca Co., New York, 18 May 1986 (B. Alexander).

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A Revision of the Bee Genus *Aztecathidium* (Hymenoptera: Megachilidae)

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Abstract.—The exclusively Mexican bee genus *Aztecathidium* is revised and the three known species separated in a key. One new species, *A. tenochtitlanicum*, is described from the State of Jalisco. Distribution data for the two previously known species are provided. Distinctive morphological features of each species are illustrated.

This paper is dedicated to my friend and colleague, E. Gorton Linsley, the first live-bee systematist I was privileged to meet, more than 35 years ago. Thank you, Gort, for your kindness and encouragement!

INTRODUCTION

The higher classification of the New World anthidiine bees was reviewed by Michener (1948) and the component genera separated by a key. The Mexican genus *Aztecathidium* was subsequently described by Michener and Ordway (1964) for two previously undescribed species. A third species, heretofore undescribed, has prompted the present study.

MATERIAL EXAMINED

Specimens used in this study are from the following collections: Estación Biológica Chamela, Universidad Autonoma de México (CHAM); Natural History Museum of Los Angeles County (LACM); Snow Entomological Collection, University of Kansas (UKAN); USDA Bee Biology and Systematics Laboratory, Utah State University (UTSU).

SYSTEMATICS

Aztecathidium has been adequately described by Michener and Ordway (1964), and there is no need to repeat that description. The few known species are moderate-sized, sparsely hairy bees, and the body is more or less elongate and parallel-sided. Two of the species are principally reddish with more or less defined yellowish areas on the head and body; they resemble the species of *Paranthidium*, subgenus *Mecanthidium* Michener (1942). The third species, described below, is black and has sharply contrasting yellow markings.

Aztecathidium differs from *Mecanthidium* in possessing a sharply carinate (almost flange-like) preoccipital ridge across the top of the head and down the side to the hypostomal carina; the mandibles of both sexes have one or two teeth on the cutting margin; the clypeus, especially of the female, is protuberant; the pronotal lobes are carinate; the last metasomal tergum of the male is bilobed. In

Mecanthidium the preoccipital ridge is weak and present only across the top of the head; the mandibles of both sexes are without teeth on the cutting margin (except in the male of one species, which has a single tooth); the clypeus, in profile, is weakly convex; the pronotal lobes are lamellate; the last metasomal tergum of the male is protuberant and blunt.

In Michener's (1948) key to the New World anthidiine genera, *Aztecantidium* runs to *Allanthidium*, from which it differs by the depressed tergal margins, the completely carinate preoccipital ridge, the presence of an anterior mesepisternal carina, and the lack of a row of pits across the base of the propodeum.

The type species of *Aztecantidium* is *A. xochipillium* Michener and Ordway.

KEY TO SPECIES OF AZTECANTIDIUM

- 1a. Male tergum 4 with short lateral tooth or angle and emargination of tergum 7 as wide as deep or wider (Figs. 4, 6); apex of female labrum concave and clypeus moderately protuberant and rounded in profile (Figs. 3, 5) 2
- b. Male tergum 4 without lateral tooth or angle and emargination of tergum 7 deeper than wide (Fig. 2); apex of female labrum tridentate and clypeus strongly protuberant and angulate in profile, with biarcuate carina (Fig. 1) *cuauhtemocum*
- 2a. Male tergum 7 with lateral margins mainly convex and apical lobes broad (Fig. 6); female clypeal profile evenly convex from base to summit of apical declivity (Fig. 5); both sexes principally reddish, with limited blackish areas and obscure yellowish marks *xochipillium*
- b. Male tergum 7 with lateral margins mainly concave and apical lobes narrow (Fig. 4); female clypeal profile convex at base, concave toward apical declivity and distinctly elevated at declivity (Fig. 3); both sexes black with yellow maculations *tenochtitlanicum*

Aztecantidium cuauhtemocum Michener and Ordway

Figures 1–2, 7–9

Aztecantidium cuauhtemocum Michener and Ordway, 1964: 75; ♂ ♀.

The type series was collected 2 mi S Tzitzio, 4450 feet elevation, Michoacán, 29 July 1962 (M. G. Naumann), on Leguminosae, and all four specimens are in the UKAN collection. I have seen a paratype of each sex. No additional specimens have been available for study.

Both sexes of this species are easily recognized by the figures and the characteristics cited in the key. The female is especially characterized by the biarcuate, strongly protuberant clypeal carina and the tridentate labral apex. The male is less obviously distinct, but lacks a lateral tooth on metasomal tergum 4 and the emargination of tergum 7 is deeper than wide. Both sexes are largely ferruginous bees, with obscure yellowish marks, especially on the face and the metasomal terga.

Aztecantidium tenochtitlanicum, NEW SPECIES

Figures 3–4, 10–12

Diagnosis.—Both sexes black and yellow, scutellum weakly bilobed. Female labrum emarginate and clypeus moderately protuberant and with small preapical tubercle in profile (Fig. 3). Male metasomal tergum 4 angulate or subdentate at side, emargination of tergum 7 wider than deep and apical lobes relatively narrow (Fig. 4).

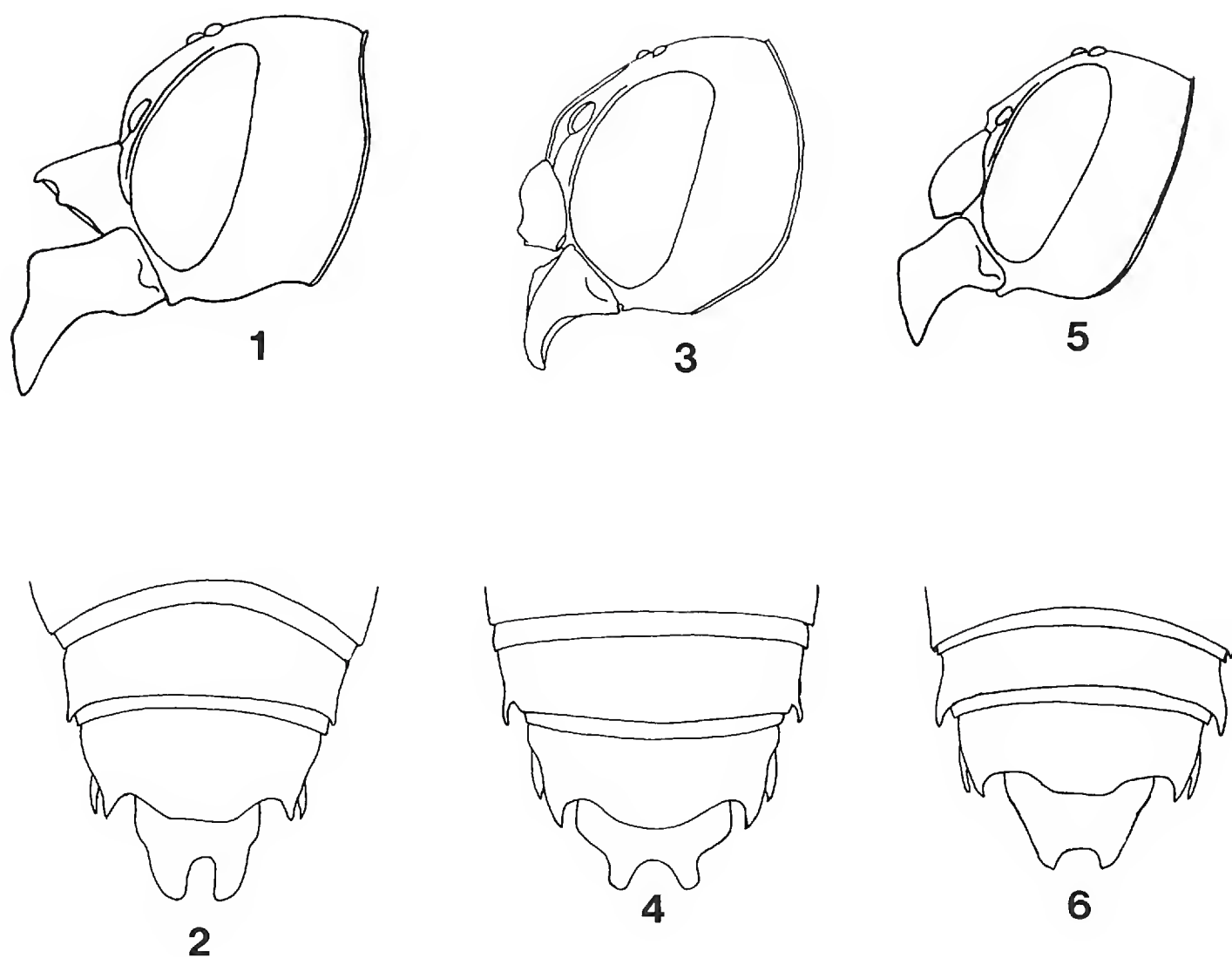


Fig. 1-6. Lateral view of female head and apical male metasomal terga, respectively, of : 1-2, *Aztecantidium cuauhtemocum*; 3-4, *A. tenochtitlanicum*; 5-6, *A. xochipillium*.

Description male holotype.—Measurements (mm): head width 4.67; head length 3.85; wing length 11.3; total length 16.1.

Paratypes.—head width 4.29–4.68; head length 3.33–3.87; wing length 10.2–11.3; total length 12.3–16.3.

Head and body black, the following yellow: clypeus, except narrow black band along apical margin; paraocular area, ending broadly at about mid-level between base of clypeus and antennal socket; spot adjacent to inner upper eye margin at level of anterior ocellus; broad stripe on either side of anterior margin of mesoscutum and short, narrow stripe adjacent to tegula; broad posterior stripe on scutellum; small anterior spot on tegula; outer apical spot on metacoxa; large lateral spot on tergum 1; tergum 2 with preapical bar across middle one-third and with very narrow preapical stripe extending to large lateral spot; terga 3 and 4 similar to 2, but with preapical stripe only slightly broadened at sides; tergum 5 with only very narrow preapical stripe on lateral one-third; sterna 2–5 with irregular lateral blotches.

Head about 1.2 times as broad as long, inner eye margins slightly divergent below. Clypeus rugosopunctate. Paraocular and supraclypeal areas and frons rugosopunctate to subcontiguously punctate, interspaces moderately shiny; vertex similar but punctures subcontiguous and slightly larger. Ocellocular and interocellar

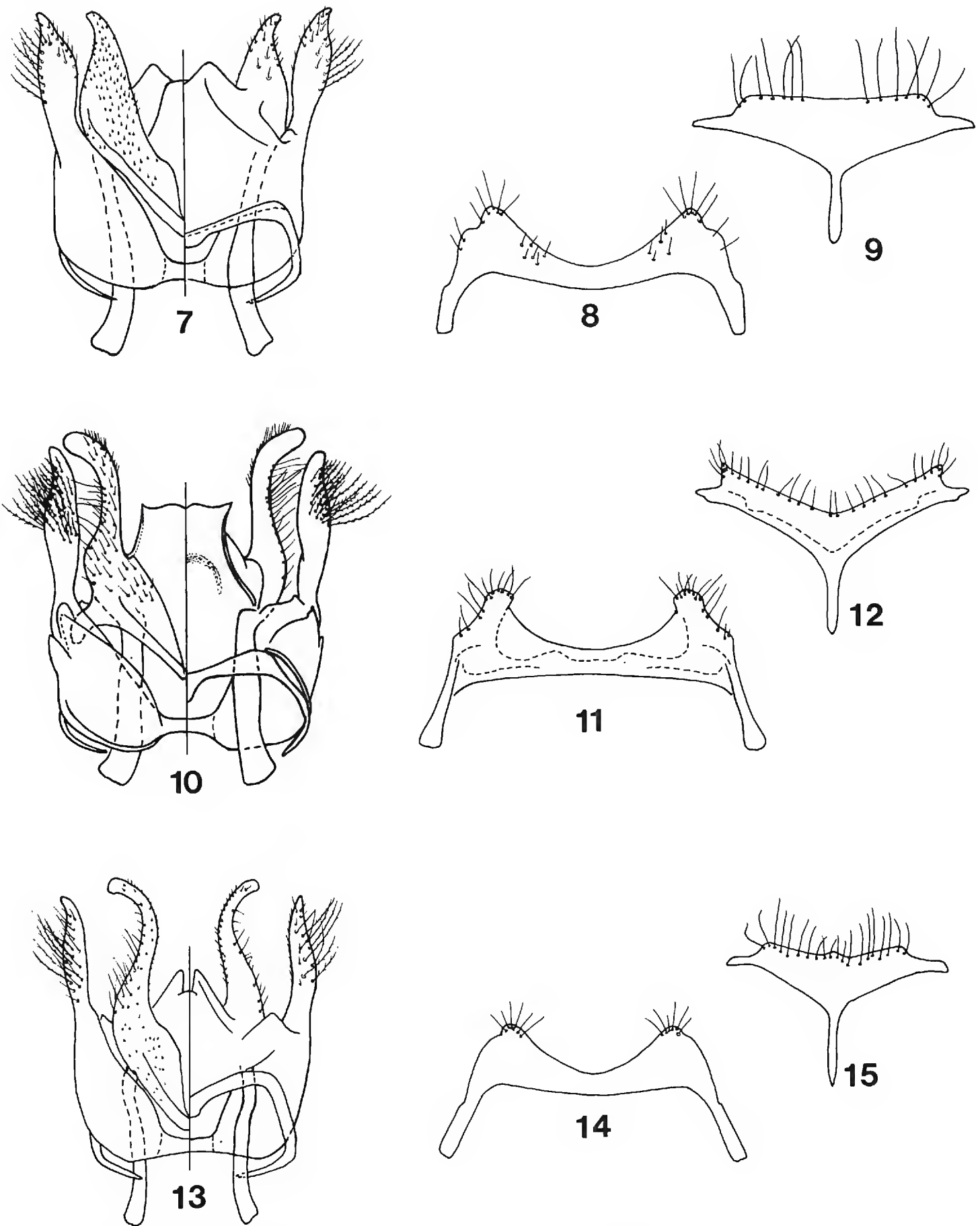


Fig. 7-15. Male genitalia and metasomal sterna 7-8 of : 7-9, *Aztecanthidium cuauhtemocum*; 10-12, *A. tenochtitlanicum*; 13-15, *A. xochipilium*.

distances about equal; ocelloccipital distance about 1.6 times interocellar distance. Greatest width of gena slightly less than width of eye. Labrum slightly depressed along midline. Apical tooth of mandible long, acute; second and third teeth obtuse; inner tooth short, acute.

Mesoscutal interspaces moderately shiny between subcontiguous, moderate

punctures. Propodeum dull, interspaces distinctly roughened, with broad median impunctate area. Dorsal face of scutellum with disc weakly depressed in middle, more broadly so distad, apical margin slightly concave between weak sublateral tubercles. Punctures of mesepisternum very coarse (about 0.08 mm), contiguous to subcontiguous; punctures of metepisternum moderate to coarse, mostly contiguous, but with some irregular interspaces up to a puncture diameter; interspaces of meso- and metepisterna shiny; side of propodeum roughened and slightly shiny between fine, subcontiguous punctures.

Profemur more than three times as long as broad or thick; meso- and metafemora less than three times as long as broad or thick. Pro- and mesobasitarsi each shorter than combined lengths of following segments; metabasitarsus longer than following segments combined.

Punctures of metasomal terga fine to moderate, subcontiguous to dense across middle, becoming almost uniformly subcontiguous at sides, interspaces moderately shiny. Tergum 4 with low, obtuse preapical tubercle at side in dorsal view; tergum 5 with conspicuous lateral spine; tergum 6 with a pair of spines on each side, inner spine longer and stouter; apical margin of tergum 6 slightly produced and subtruncate across middle one-third; tergum 7 bilobed, emargination broader than a semicircle, lobes narrow and subtruncate at apex. Sterna shiny, segments 3–5 slightly raised and impunctate along midline; apical margins straight, except 6 strongly convex medially; sterna 7 and 8 and genitalia as illustrated (Figs. 10–12).

Vestiture whitish, generally sparse and inconspicuous, longer and dense on gular area, side of mesosoma (especially on propodeum), and on side and apical margins of metasomal sterna.

Female.—Measurements (mm): head width 4.51–4.93; head length 3.72–4.09; wing length 10.6–11.5; total length 15.2–17.0.

Agrees generally with description of male except as follows. Inner eye margins strongly divergent below, lower interocular distance (at level of base of clypeus) 1.20–1.26 times minimum interocular distance. Clypeal profile convex toward base, concave before preapical declivity and summit of declivity slightly protuberant (Fig. 3); summit of declivity marked by more or less definite median tubercle and pair of smaller submedian tubercles (latter sometimes absent); disc of clypeus roughened and coarsely rugosopunctate in middle, becoming finely and subcontiguously punctate toward sides, usually without traces of median impunctate line. Ocellocular distance about 1.2 times interocellar distance; ocelloccipital distance 2.0–2.2 times interocellar distance. Gena, in profile, about as wide as eye. Mandible with four approximately equidistant teeth, second and third obtuse; setae of ventral brush sparse, none as much as one-half as long as mandible length. Flagellar segments about as broad as long.

Metasomal terga 4 and 5 without lateral spines or teeth; tergum 6 with short, obtuse spine on each side of broadly convex apical margin; terga 5 and 6 without short, stout, brown setae; sterna densely punctate and with long, yellowish white scopal hairs.

Color about as described for male, but clypeus with transverse yellow band across basal one-half or less, paraocular area black, metasomal tergum 2 with lateral mark only, tergum 5 wholly black, and sterna without lateral spots.

Type material.—Holotype male: Chamela, Jalisco, MÉXICO, 10 June 1983 (S. H. Bullock, 1953), in LACM. Paratypes, all from same locality: 18 ♂♂, 14 ♀♀, various

dates from 9 June to 3 December, various years (S. H. Bullock, C. D. Michener, F. D. Parker, and T. L. Griswold); paratypes in CHAM, LACM, UKAN, and UTSU.

Etymology.—The specific name is derived from that of the former Aztec empire, Tenochtitlán.

Discussion.—In addition to the type material cited above, I have seen 3 ♂♂, 4 ♀♀ from 17 km W Tehuantepec, Oaxaca, MÉXICO, 8 September 1965 (D. H. Janzen; UKAN), on *Caesalpinia sclerocarpa*. The only additional floral data are on Chamela specimens of both sexes collected by Michener at flowers of *Longchocarpus* sp.

The specimens examined are generally uniform in their morphological features. One male is unusually small, total length 11 mm, with a head width of 3.72 mm. Variation among the males otherwise consists of minor fluctuations in the extent of the yellow markings; many specimens lack tegular spots and lateral stripes on the mesoscutum, and most males are without a median preapical band on metasomal tergum 2. A few specimens possess small yellow maculations on the axillae.

The available females exhibit even less variety. The anterior and lateral mesoscutal maculations are more commonly united than in the males. The axilla is immaculate in all specimens and metasomal tergum 2 is consistently without a median preapical band. In many females the submedian tubercles at the summit of the clypeal declivity are reduced or absent; the median tubercle is consistently present.

This species is morphologically most similar to *A. xochipillium*, with which the female shares the emarginate labrum, clypeal shape, and quadridentate mandible. Males of these two species are similar in that both possess a lateral spine or tubercle on tergum 4 and the emargination of tergum 7 is wider than deep. These features separate both from *A. cuauhtemocum*.

The most conspicuous difference between *A. tenochtitlanicum* and *A. xochipillium* is color. The former is conspicuously black and yellow and the latter is red with obscure yellowish marks. The genitalia and associated sterna of *A. tenochtitlanicum* (Figs. 10–12) and *A. xochipillium* (Figs. 13–15) are distinctive for each species, but more similar to each other than either is the *A. cuauhtemocum* (Figs. 7–9).

Aztecantidium xochipillium Michener and Ordway

Figures 5–6, 13–15

Aztecantidium xochipillium Michener and Ordway, 1964: 72–73; ♂ ♀.

The type locality of *A. xochipillium* is 17 mi N Chilpancingo, 2550 feet elevation, Guerrero; the holotype and allotype were collected by Ordway and Roberts on 13 August 1962. The primary type and most paratypes are in UKAN. In addition to a paratype pair, and the specimens from Ahuacatlan, Nayarit, recorded by Michener and Ordway, I have seen the following specimens.

MÉXICO, Jalisco: 1 ♀, 3 ♂♂, Guadalajara, no date (Crawford; LACM). Michoacán: 1 ♀, Cojumatlán, 9 August 1964 (R. E. Ryckman, D. Spencer, C. P. Christianson; LACM). Nayarit: 2 ♂♂, 8 mi NW Ixtlán del Río, 10 September 1970 (E. M. Fisher; LACM).

Like *A. cuauhtemocum*, both sexes are largely reddish bees with obscure yellowish markings on the head and body. In both sexes the scutellum is distinctly bilobed and the lobes extend over the metanotum. Males of *A. xochipillium* have a distinct preapical spine or tooth laterad on metasomal tergum 4. The female clypeus is only

moderately protuberant, lacks a biarcuate carina, and the apex of the labrum is emarginate. In these characters the female is similar to that of *A. tenochtitlanicum*, but the clypeal profile is evenly convex and is without a definite preapical tubercle (Fig. 15).

ACKNOWLEDGMENTS

For the opportunity to examine material in their care I am indebted to S. H. Bullock (CHAM), T. L. Griswold (UTSU), and C. D. Michener (UKAN).

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Host Records and Nest Entry by *Dolichostelis*, a Kleptoparasitic Anthidiine Bee (Hymenoptera: Megachilidae)

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Abstract.—Host-parasite associations were recorded for three species of *Dolichostelis*, a kleptoparasitic anthidiine genus. *D. louisae* (Cockerell) was reared from nests of the megachild bees, *Chalicodoma angelarum* (Cockerell) and *C. campanulae* (Robertson). *D. costaricensis* Friese was reared from cells made by *C. otonita* Cresson. *D. rudbeckiarum* (Cockerell) was observed parasitizing nests of *C. subexelis* (Cockerell). These host records are the first confirmations for any of these parasites. Cocoons of *Dolichostelis* are described and illustrated, sex ratios are calculated, and observations on nest entry by *D. rudbeckiarum* are described and illustrated.

The biologies and taxonomic relations of the parasitic bees in the tribe Anthidiini are relatively unknown. Many undescribed species exist (Parker, unpublished data), and only a few parasites have been associated with their host bees. Anthidine bees are found in all zoogeographic regions and some genera are globally distributed; four genera (*Stelis*, *Odontostelis*, *Dolichostelis*, and *Heterostelis*) occur in North and Central America (Hurd et al., 1979; Parker and Bohart, 1979). Hosts of the parasitic American genera are megachilids such as *Osmia*, *Proteriades*, *Hoplitis*, *Ashmeadiella*, *Anthidium*, and *Megachile* (Hurd et al., 1979, unpublished records). *Odontostelis* parasitizes *Euglossa*, a Neotropical apid (Bennett, 1966).

Dolichostelis is a newly proposed genus from North and Central America. Previously, no host associations were confirmed for any of the six species included (Parker and Bohart, 1979) although Krombein (1967) reared one (*D. louisae* (Cockerell)) from a nest of an unidentified resin-using bee. In this paper, host associations for *Dolichostelis* resulted from three separate studies. First, wooden block traps were placed at several locations near Auburn, Alabama, for a collaborative study of trap-nesting aculeates in cooperation with J. Cane. The design of the traps and methods of rearing the specimens resembled those described by Parker (1985). In the Alabama study, the traps were opened and their contents individually isolated and reared. Adults were weighed after emergence, killed, mounted, and identified. The Costa Rican study was done in cooperation with G. Frankie and S. Vinson, who placed traps for us in the field, employing the same design used in Alabama. In addition, Frankie and Vinson deployed many units of individual stick traps (pine) that had been taped together into bundles bearing several holes sizes/unit (borings of approximately 4.5, 6, 7.5, 10, and 11 mm in diameter). Nests from the stick traps were not opened initially, but they were

individually isolated and all emerging insects were killed and labeled. Adult weights and placement of cells within the nest were not recorded. Observations on *D. rudbeckiarum* were recorded by the senior author from nesting materials placed in his yard in Logan, Utah.

Dolichostelis louisae (Cockerell)

Nests of four species of *Chalicodoma* (*Chelostomoides*) were recovered from traps placed near Auburn, Alabama, during 1985. Twelve specimens of *D. louisae* (Cockerell) emerged from nests of two species of *Chalicodoma*. An eight-celled nest of *C. angularum* (Cockerell) had six cocoons of *D. louisae* in the outer-most cells. In one of six recovered nests of *C. campanulae* (Robertson), a single cell was parasitized by this same bee. Three additional nests of *Chalicodoma* were parasitized by *D. louisae*, but since no hosts emerged, specific associations could not be confirmed. The single nest obtained by Krombein (1976) also contained only *Dolichostelis*, but he believed, correctly, that the host bee was a species of *Chalicodoma*.

Cocoons of *D. louisae* bear a nipple dorsally, a feature that characterizes Anthidiini cocoons. Cocoons of *D. louisae* differed from typical *Stelis* cocoons (Fig. 1) by their barrel-shape and lesser amount of silk. The short fecal pellets formed by *D. louisae* larvae differed from the typical ribbon-like strands made by many *Stelis* larvae. Fecal pellets of *D. louisae* were woven into the outermost layer of the cocoon. Such pellets are not incorporated in cocoon formation by *Stelis* larvae. *D. louisae* cocoons were made from three layers of coarse, white silk strands. Inside the first layer, which bore an anterior nipple, a second layer had a conical and hollow nipple; the second layer was made from an amber-colored substance. The third layer was similar in texture and color to the first layer and it covered all the inner surfaces except beneath the nipple. Cocoons averaged 8 mm long and 5 mm wide.

The observed sex ratio was 1.4 females to 1 male and the calculated sex ratio (Torchio and Tepedino, 1980) was 1.06 males to 1 female. Females were only slightly heavier (22.5 mg, SD 7.1 mm, range 14.5–32.7 mg, $n=7$) than males (21.2 mg, SD 4.2 mg, range 15.2–26.4 mg, $n=5$). Average adult weights of the parasites and their two hosts were compared; average weight of the parasites was 60.7% of *C. angularum* and 73.3% of *C. campanulae*. All pollen and nectar provisions were consumed in parasitized cells. Thus, differences in weights between host and parasite were attributed to differences in relative proportions of fecal and silken materials produced by their respective larvae. Similar differences in allotments of resources have been recorded for a related parasitic bee, *Stelis depressa* Timberlake, and such behavior may be important in survival of these parasites (Parker, 1984).

Dolichostelis costaricensis Friese

Sixteen nests of *Chalicodoma otonita* Cresson were obtained from the stick traps placed at Lomas Barbudal Biological Reserve, Guanacaste, in Costa Rica. Stick traps were placed in shaded forest locations during the extended season, from December to May. A male of *C. otonita* and a male of *D. costaricensis* emerged from one of these isolated nests. When the nest was examined, the first cell made by the host contained an empty cocoon of *Dolichostelis*. Apparently, the male emerged from the second cell. In a three-celled nest of *C. otonita*, two empty cocoons of *D. costaricensis* were found in the same host cell and the cell above contained an empty parasite cocoon. Another two-celled *Chalicodoma* nest produced two *Dolichostelis*

adults. Five more *Dolichostelis* emerged from traps with no host emergence, but these nests were probably made by *C. otonita*. One dead female of this parasite was found in a wooden block trap, but no cells of *C. otonita* were successfully parasitized.

The observed sex ratio was 1:1; since adults were not weighed, calculated sex ratios could not be estimated. Cocoons of *D. costaricensis* were similar in formation, size, and color to those of *D. louisae*.

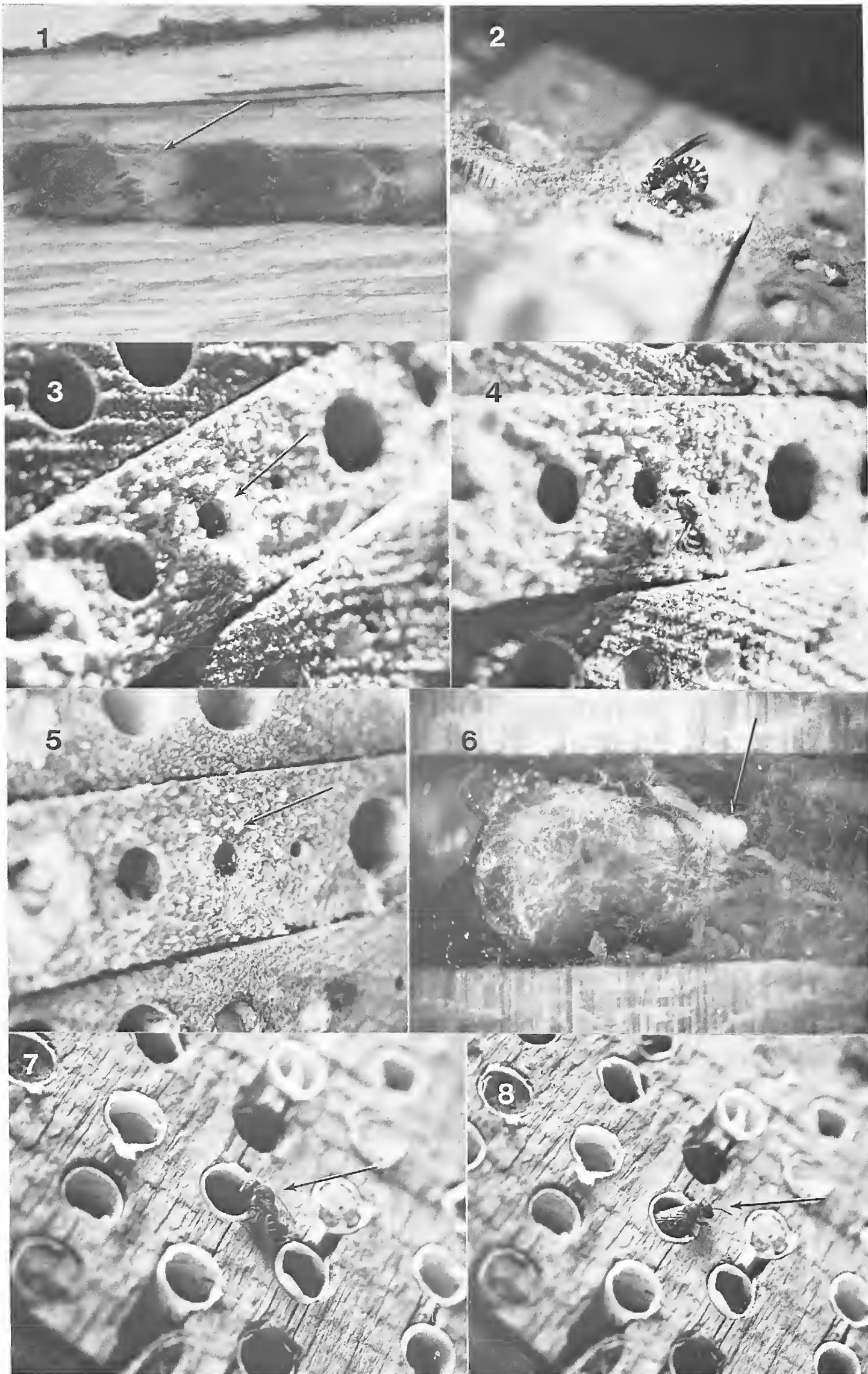
Dolichostelis rudbeckiarum (Cockerell)

For the past several years, a population of *Chalicodoma subexilis* (Cockerell) has nested in several sizes (4, 6, 8 mm in diameter) of borings in pine wood placed on window sills and in the garage of the senior author's home. In 1986, D. Broemling, a graduate student at Utah State University, observed a female of *D. rudbeckiarum* chewing at an entrance plug of a *C. subexilis* nest; it was captured and identified. During the next several weeks in August, other females were noted and the following observations recorded.

Often during the day, females of *Dolichostelis* were seen as they inspected nests of *Chalicodoma*. These small bees were unusually rapid fliers for bees, and darted among the layers of stacked borings. They darted rapidly back and forth horizontally before the faces of the borings from 5–10 cm. The females landed only to inspect resin nests of *Chalicodoma*. They never inspected active nests of other aculeates that used the same sites such as *Megachile*, *Osmia*, *Eumegachile*, *Euodynerus*, *Isodontia*, and *Trypoxylon*, none of which use resin in nest construction. During nest inspection, *Dolichostelis* females either entered opened nests or briefly examined the entrance plug.

At 8:00 P.M. (MDT, 8 August 1986), a female was observed chewing on a resin entrance plug, and F. Parker recorded and photographed its activities. The parasite worked at the entrance plug for several hours, removing tiny pieces of resin which it then stuck on the wood surrounding the boring. As the parasite removed small pieces, it worked most of the resin into an extended lip (Fig. 2). After about two hours, the parasite bent the lip down with the weight of its body while chewing at the top of the plug. During the entire process, the parasite deposited glistening droplets from the tip of its abdomen onto the surface of the resin plug. After each deposition, it then turned around and chewed the area where the droplet was deposited. Apparently, this substance, acting as a solvent, enabled the parasite to soften and mold the resin. Also, this liquid may aid in preventing resin from sticking to the mouthparts, since the parasite frequently groomed and cleaned its head. After sunset, a small lamp was placed near the glass to illuminate the nest surface. The parasite seemed undisturbed by the light since it continued to work. After the

Fig. 1. Portion of a nest of *Chalicodoma angelarum* (Cockerell) made in a trap block and with two cells containing cocoons of *Dolichostelis louisae* (Cockerell). Fig. 2. Female of *Dolichostelis rudbeckiarum* (Cockerell) opening sealed entrance of a nest of *Chalicodoma subexilis*. About 9:00 P.M. (MDT). Fig. 3. Same nest at 8:00 A.M. the following day and with the female parasitic bee resting just inside the entrance. Fig. 4. Same nest being closed by the parasite. Fig. 5. Same nest after parasite had finished closing the entrance. Note the small pellets of resin adjacent to the plugged opening; such pellets indicate nest parasitization by *Dolichostelis*. Fig. 6. Cocoon of *Dolichostelis rudbeckiarum*. Fig. 7. Female of *Chalicodoma subexilis* inspecting a previously capped nest. Fig. 8. Female of *Chalicodoma subexilis* depositing droplets from its abdomen around rim of nest plug.



parasite finally gained entrance to the nest, it proceeded to remove more resin from within the nest. Later, it removed what appeared to be a small amount of host provision. The female continued its back-and-forth entry into the boring until after 12:00 A.M., when observations were discontinued.

The next morning, at 8:00 A.M., the nest was checked and the female was resting just inside the entrance (Fig. 3). As soon as sunlight struck the nest, about 9:00 A.M., the parasite resumed its activities. Soon, it commenced refilling the entrance with the small pieces of resin it had previously stuck adjacent to the opening (Fig. 4). By hanging vertically from above the hole, the parasite grasped the resin lip protruding from the hole and pulled it up and into place as if it had been hinged at the base. Then, the nest plug was smoothed across with more resin (Fig. 5). The parasite finished working at 9:55 A.M. and flew away. The nest was left on the ledge to be opened in the laboratory on Monday, but before removal, the original owner returned to the nest, opened the entrance, and began removing pollen and nectar. Sometime later, it again plugged the nest, but this time using masticated leaf pulp mixed with resin for the final closure. Upon opening in the laboratory, the nest contained a single cell with a large egg lying across the pool of nectar and pollen; this egg hatched into a *Chalicodoma* larva. Twenty other *Chalicodoma* nests were opened, including several with evidence of parasite entry, but only one contained parasite cocoons.

Cocoons of *D. rudbeckiarum* (Fig. 6) resembled *Stelis* cocoons; both had a small nipple. The amber-colored inner layer of *D. rudbeckiarum* cocoons was less dense and the overwintering prepupal larvae were visible. The barrel-shaped cocoons averaged 8 mm long and 5 mm wide.

During the course of these observations, many females of *Chalicodoma* were seen landing at nests they had previously capped. The females would inspect the cap (Fig. 7), turn around, and deposit droplets of liquid from the tip of the abdomen onto the inner rim of the nest cap (Fig. 8). Females of *Dolichostelis* were not observed inspecting such nests.

These limited observations suggest that unique behavioral traits may exist in these parasites and their host. Such behavior has not been reported previously although Bennett (1966) observed that a related parasite, *Odontostelis*, that invaded nests of *Euglossa*, drove the nest owner away, opened cells of its host, removed and killed eggs or early larval instars of *Euglossa*, deposited its own egg on the provision, and resealed the cells. It appears that *Chalicodoma* females can detect parasitized nests and neutralize parasitized cells. It was not uncommon to observe females of the host bee examining, opening, and removing pollen and nectar (along with the parasite egg?) from a previously finished nest and then recapping it. One such female remained in the entrance of a nest for two days before the nest was finally recapped.

Nest usurping among host females probably does not explain this kind of nesting behavior (since females were not marked) because there were few nesting females and a surplus of available nesting sites.

During the past 15 years of collecting and observing bee nests in the vicinity of Logan, nests of *C. subexilis* have been commonly found in units provided for the alfalfa leafcutting bee, *Megachile rotundata* (F.). Not a single nest contained a cell parasitized by the *Dolichostelis*, nor have any specimens of this parasite been observed or net-collected this far north. It appears that this parasite may have extended its range and/or its available hosts recently.

ACKNOWLEDGMENTS

We are dedicating this manuscript to E. Gorton Linsley, who has contributed many papers on the biology and taxonomy of bees, including the discovery of several new species of *Stelis*.

We would like to thank D. Veirs, R. Griswold, and V. Rhea (USDA Bee Lab, Logan, Utah) for making the trap blocks, recording the biological information, and curating the specimens.

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A Revision of the Dufoureine Genus *Micralictoides* Timberlake (Hymenoptera: Halictidae)

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Abstract.—The southwestern North American genus, *Micralictoides*, is reviewed, a key to species presented, five new species described (*M. chaenactidis*, *M. dinoceps*, *M. grossus*, *M. linsleyi*, and *M. quadriceps*), and new records provided for the three previously included species.

Timberlake (1939) established *Micralictoides* as a subgenus of *Dufourea* for two species, *D. altadenae* (Michener) and *D. ruficaudus* (Michener), described under *Halictoides* (Michener 1937). Bohart (1942) later gave *Micralictoides* generic status and described a third species, *M. mojavensis*. Michener (1965), in a generic review of the New World Dufoureinae, briefly characterized *Micralictoides* and provided a key separating it from the other six New World genera.

Genus *Micralictoides* Timberlake

Micralictoides Timberlake 1939: 397 (as subgenus). Type: *Halictoides ruficaudus* Michener.

Generic Diagnosis.—Size small, body length 3.5 to 6 mm; abdomen of male broad as in female; punctures of head and mesonotum shallow; tergal punctures fine and shallow; body without metallic reflections; legs with tarsi (and usually tibiae) paler than femora; clypeal margin of female truncate or nearly so between tubercles; labrum very short, nearly truncate; maxillary palpus of female nearly as long as flagellum; flagellum of male with segments not or scarcely longer than broad, without modified hairs; male without modified legs; forewing with two submarginal cells, first submarginal twice as long as wide, marginal cell from apex of stigma to apex of cell no longer than distance from apex of cell to wing tip; propodeum with weak, irregular striae becoming obsolescent laterally and along posterior margin; sternum VI of male without distinct grooves, carinae, or strong protuberances, but sometimes gently swollen toward apex; sternum VII with pair of slender, depressed, apical lobes, each with terminal, incurved appendage; sternum VIII medially with broad articulating lobe, apically with slender median lobe about one-third total segment length; genital capsule swollen basally, with simple, strap-like gonostylus, distinct from gonobase, with short, strongly incurved sagitta, and knob-like, polished volsella.

Micralictoides can be distinguished from other dufoureine genera by a combination of the two submarginal cells in the forewing and the hind basitarsus which is distinctly paler than the hind femur. The configuration of metasomal sterna VII and VIII in the male is unique in the subfamily. Superficially, *Micralictoides* resembles some of the smaller species of *Dufourea* such as the *D. leachi* Timberlake

group. Both have relatively simple antennae, legs, and visible sterna in the male, and both have a swollen basal portion of the genital capsule and a shortened volsella.

Systematics.—The eight known species of *Micralictoides* can be separated into three groups based on the structure of the metasomal sterna (especially VII) and the genitalia of the males. The *altadenae* group includes four species: *M. altadenae* (Michener) with a broad face and short mouthparts, *M. chaenactidis* n. sp. and *M. linsleyi* n. sp. with face and mouthparts moderate in length, and *M. quadriceps* n. sp. with a long face and long mouthparts. The *grossus* group, which contains only *M. grossus* n. sp., may be related to *M. quadriceps* of the *altadenae* group on the basis of a somewhat similar development of sternum VI. The *ruficaudus* group includes *M. ruficaudus* (Michener), *M. mojavenensis* Bohart, and *M. dinoceps* n. sp. The relationship between these three species is most apparent in the configuration of male sternum VII. This group probably developed from the *altadenae* group; in fact, the female of *M. mojavenensis* is difficult to distinguish from that of *M. chaenactidis*.

Distribution.—*Micralictoides* is restricted to the southwestern United States where it is known only from California, Nevada, and Arizona. All eight species are found in California and only one of them, *M. chaenactidis*, ranges much beyond its borders (into north-central Nevada and west-central Arizona). In California, the various species are distributed as follows: *M. chaenactidis* in the central and southern coastal ranges and the southern deserts, *M. mojavenensis* in the Mojave Desert and Los Angeles Basin, *M. dinoceps* in the San Bernardino Mountains, *M. ruficaudus* and *M. altadenae* from the central and southern coastal ranges, *M. quadriceps* and *M. grossus* in the central Sierra Nevada foothills, and *M. linsleyi* on the eastern side of the northern Sierras.

Biology.—The nesting habits of *Micralictoides* are unknown. Collection records indicate that members of the genus are remarkably oligolectic. Apparent pollen sources for *Micralictoides* are: *Allium* (*M. dinoceps*), *Chaenactis* (*M. chaenactidis*), *Eriophyllum* (*M. altadenae*), *Gilia* (*M. grossus*), *Eschscholtzia* (*M. ruficaudus*), and *Navarretia* (*M. quadriceps*). Pollen preference in *M. mojavenensis* is unclear. Floral records for females include *Gilia*, *Salvia*, *Eschscholtzia*, *Phacelia*, *Layia*, *Baeria*, and *Malacothrix*. There are no floral associations for *M. linsleyi*.

Since species of *Micralictoides* are strikingly oligolectic, we deemed it appropriate to dedicate this paper to Dr. E. G. Linsley, whose important contributions to bee systematics and biology include special studies on problems of oligolecty, and to name one of the included new species after him.

KEY TO MALES OF *MICRALICTOIDES*

1. Head distinctly longer than wide *quadriceps* n. sp.
 Head at least slightly wider than long 2
2. Abdomen largely red or reddish-brown *ruficaudus* (Michener)
 Abdomen dark brown to black, segments sometimes paler apically 3
3. Sternum VI in profile with low but distinct bulge near middle, surface nearly obscured by moderately long, dense pubescence (Fig. 18), lateral arm of sternum VII short, stout basally, hammer-shaped apically (Fig. 16) .. *grossus* n. sp.
 Sternum VI nearly straight in profile, with short, sparse pubescence not at all obscuring surface (Fig. 19), lateral arm of sternum VII long, slender basally, clubbed apically (Figs. 10–12, 14, 15) 4

4. Sternum VIII with lateral arm (preceding apical "foot") with abrupt expansion near middle (Figs. 14, 15) 5
 Sternum VII with lateral arm not distinctly expanded preceding apical "foot" (Figs. 10, 11, 12) 6
5. Head width at most 1.2 times length; lateral arm of sternum VII beyond expansion slender then widened apically (Fig. 15) *mojavensis* Bohart
 Head width 1.3 times length; lateral arm of sternum VII beyond expansion uniformly wide (Fig. 14) *dinoceps* n. sp.
6. Sternum VIII with median apical projection short, slender, tapering toward apex throughout (Fig. 2); sternum VII with basal flaps nearly touching broadly triangular apical "foot" (Fig. 10) *linsleyi* n. sp.
 Sternum VIII with median apical projection long, parallel sided or slightly narrowed sub-basally (Figs. 3, 4); sternum VII with basal flaps remote from oval apical "foot" (Figs. 11, 12) 7
7. Prementum shorter than eye; propodeal enclosure with well-defined but slightly irregular striae even when viewed from directly above or from slightly in front *altadenae* (Michener)
 Prementum longer than eye; propodeal enclosure appearing rugose or with striae highly irregular and difficult to trace separately, even when viewed from directly above or from slightly in front *chaenactidis* n. sp.

KEY TO FEMALES OF *MICRALICTOIDES*

1. Head distinctly longer than wide (Fig. 38) *quadriceps* n. sp.
 Head at least slightly broader than long (Figs. 33–37, 39, 40) 2
2. Tergum II with punctures of mid-line area mostly less than one puncture width apart (except on apical impunctate border), if punctures fine and indistinct, interpunctural areas shagreened 3
 Tergum II with punctures of mid-line area mostly more than one puncture width apart (except sometimes on basal half) and with interpunctural areas shiny . 5
3. Head more than nine tenths as long as wide (Fig. 40); distance between antennal scrobes less than median clypeal length; anterior wing (measured from apex of tegula) at least 3.5 mm long *grossus* n. sp.
 Head less than nine tenths as long as wide; distance between antennal scrobes greater than median clypeal width; anterior wing not more than 3.4 mm long 4
4. Prementum and stipes shorter than eye; head not more than 0.82 times as long as wide (Fig. 39) *altadenae* (Michener)
 Prementum and stipes longer than eye; head at least 0.85 times as long as wide (Fig. 35) *chaenactidis* n. sp.
5. Frons with surface between punctures strongly shagreened *linsleyi* n. sp.
 Frons with surface between punctures polished 6
6. Abdomen red; stipes and prementum shiny, not shagreened *ruficaudus* (Michener)
 Abdomen black; stipes and prementum shagreened 7
7. Maxillary palpus elongate, as long or longer than stipes (Fig. 26) ... *mojavensis* Bohart
 Maxillary palpus not elongate, shorter than stipes (Fig. 27) *dinoceps* n. sp.

Micralictoides chaenactidis, NEW SPECIES

(Figs. 4, 12, 30, 35)

Holotype male.—Length about 4.5 mm, forewing length 2.9 mm; body moderately shining, black except mid and fore tarsi, tip of hind tibia, abdomen dark brown; tegula, hind tarsi, sternum VI light brown; pubescence white, sparse, rather short, not concealing integument.

Head. Head slightly broader than length from vertex to clypeal margin (9:8); clypeus about half as long as breadth of apical truncation, its surface with rather numerous, coarse punctures; lower margin of median ocellus lower than upper eye margin; distance from median ocellus to antennal scrobe more than twice that between scrobes; mandible moderately long but not slender, apical tooth less than one-third length of mandible and slightly darker than middle third; punctures of frons close and broad except sparser between and close to ocelli; antennal scape nearly half as broad apically as long, with scattered large punctures; flagellomeres I and II distinctly, III slightly broader than long, IV to X ranging from about as long as broad to about one-fifth longer than broad; length of prementum, maxillary palpus each greater than eye length.

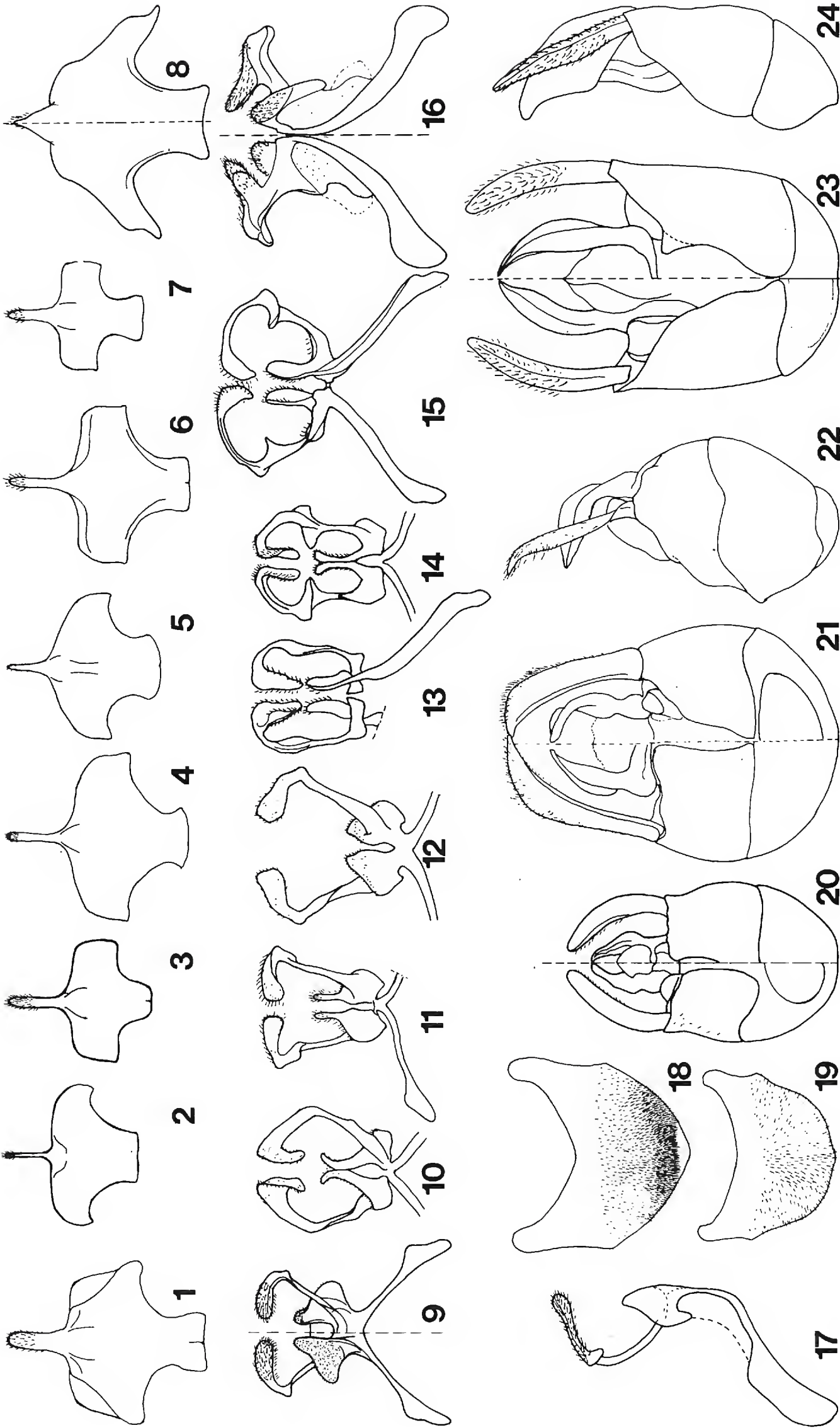
Thorax. Punctures of central half of scutum averaging about one puncture width apart, interpunctural areas not roughened; scutellum more irregularly punctate but average distance between punctures as on scutum; propodeal enclosure strongly, rather closely, somewhat irregularly striate throughout.

Abdomen. Impunctate margins of terga translucent, not much lighter than remainder of segments; punctures of first tergum about half as large, nearly as close as those on scutellum, those on succeeding terga successively smaller but not minute; sternum VI practically straight in profile, uniformly sparsely haired; sternum VII as in Fig. 12; sternum VIII as in Fig. 4.

Female.—Differs from male in having the face much more polished, punctation of frons sparse (usually separated by two or more puncture widths) and with an additional scattering of much smaller punctures. Scutum and scutellum rather polished, with fine punctures generally more than one puncture width apart submedially. Abdominal terga more finely punctate, generally more polished. Hind tibia nearly as light as hind basitarsus, dorsal scopal hairs longer than apical width of tibia. Elevated portion of clypeus slightly rounded apically, marginal truncation about twice as broad as long, head and mouthparts proportioned as in Figs. 30, 35.

Type Material.—Holotype male: ARIZONA, Yavapai Co., 30 miles (48.3 km) NW Wickenburg 16-IV-1965, *Chaenactis*, G. E. Bohart, P. F. Torchio, N. Youssef. Paratypes: Thirty-nine females and four males, same data as holotype; Pima County: 3 females, Marana, 26-IV-1973, *Chaenactis douglasii*, G. E. Bohart; 3 males, 9 females, Silver Bell Bajada, J. L. Neff; Pinal County: 1 male, Mammoth, 29-III-68, *Phacelia*, Torchio & Youssef. Holotype deposited at U.S. National Museum, paratypes at BBSL and LACM.

Additional Material.—CALIFORNIA. Los Angeles County: 1 male, Aliso Canyon, 3-V-1934, C. D. Michener; 1 female, Little Rock, Mojave Desert, 20-V-1937, E. P. VanDuzee; 1 female, Lovejoy Butte, 11-V-1944, *Acamptopappus*, P. H. Timberlake; 1 female, Mint Canyon, 3-V-1936, E. G. Linsley; 2 males, Newhall, 20-IV-1940, R. M. Bohart; 1 female, Palmdale, 2 miles (3.2 km) E, 17-V-1937, *Astragulus*, E. P. VanDuzee; 1 male, Piute Butte, Mojave Desert, 12-V-1944, A. L. Melander; 6 males, 15 females, Piute Butte, S of,



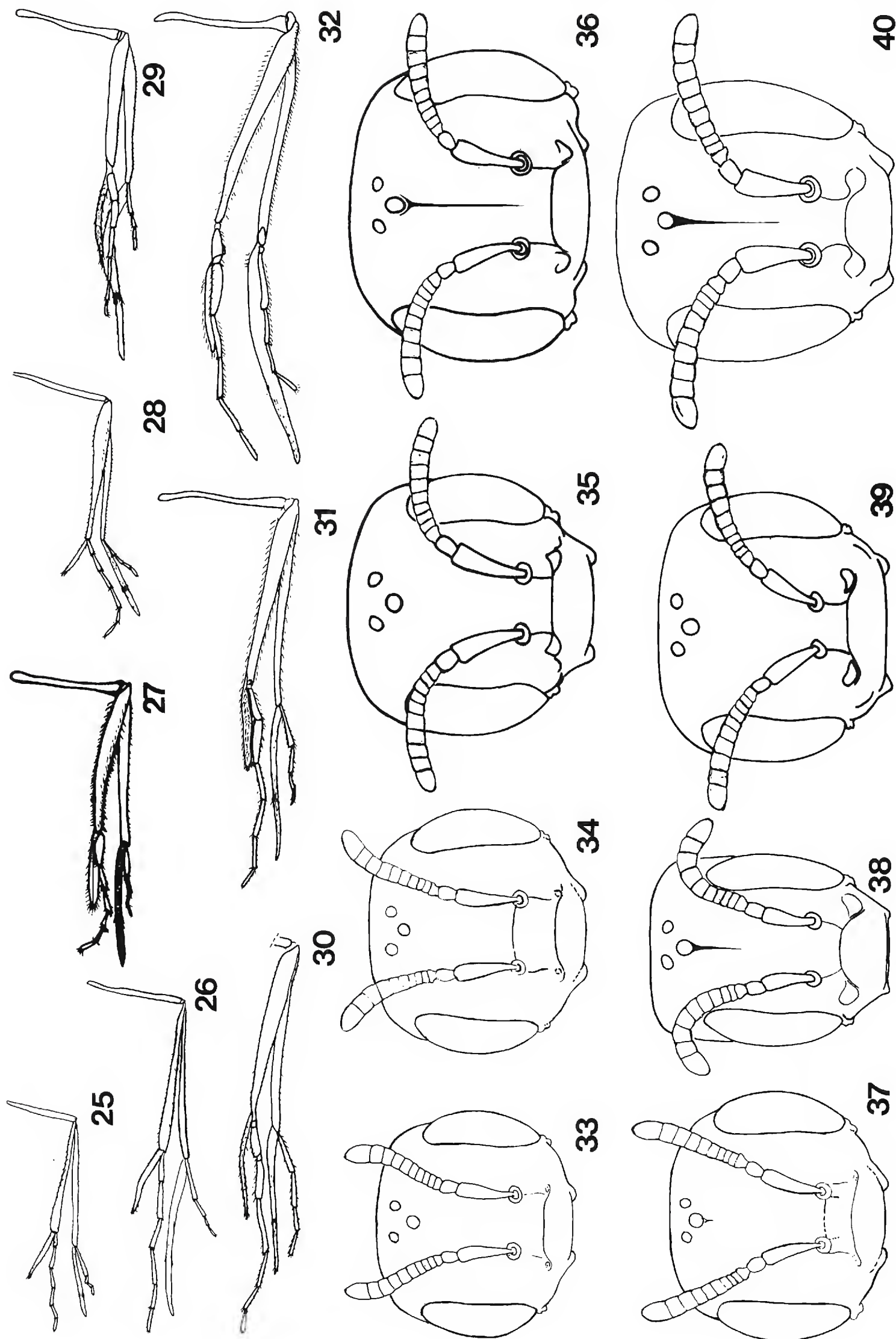
12-V-1944, *Chaenactis brachypappa*, P. H. Timberlake; 1 male, 1 female, Tapia Park, 18-IV-1953; 3 males, Three Points, 2-V-1968, D. Veirs. Riverside County: 8 males, 3 females, Joshua Tree Natl. Mon., 20-V-1970, *Chaenactis*, P. F. & D. M. Torchio. San Benito County: 1 male, 1 female, Pinnacles Natl. Mon. vicinity, 5-V-1979, *Chaenactis glabriuscula*, A. R. Moldenke; 1 female, Pinnacles, 3 miles (4.8 km) NE, 27-IV-1962, J. K. Drew; 1 female, same except *Chaenactis glabriuscula*, R. W. Thorp. San Bernardino County: 2 males, Morongo Valley, 21-IV-1957, R. R. Snelling & M. D. Stage; 3 females, same except *Malacothrix*; 1 male, Wildwood Cyn., 3 miles (4.8 km) E Yucaipa, 29-V-1977, T. Griswold. San Luis Obispo County: 1 male, Black Mt., 6 air miles (9.7 km) NE Pozo, 3300'-3600' (1006m-1097m), 1-V-1962, *Eriophyllum confertiflorum*, C. A. Toschi; 2 males, Black Mt., same except J. Powell; 2 males, 2 females, Creston, 10 miles (16.1 km) SE, 25-IV-1968, J. Powell; 1 male, Creston, 10 miles (16.1 km) SE, 25-IV-1968, D. Veirs; 2 males, same except *Malacothrix*, J. Doyen; 1 male, Creston, 2.5 miles (4.0 km) S, 4-V-1962, C. A. Toschi; 4 males, La Panza Camp, 12 miles (19.3 km) NE Pozo, 29-IV-1962, *Eriophyllum confertiflorum*, P. H. Timberlake; 2 males, same except P. D. Hurd; 27 females, Santa Margarita, 6 miles (9.7 km) NE, 5-V-1962, *Chaenactis glabriuscula*, P. H. Timberlake; 5 males, 1 female, Shandon, 7 miles (11.3 km) SW, 24-IV-1960, J. W. MacSwain. Ventura County: 1 male, Chuchupate Ranger Station, base Frazier Mt., 10-V-1959, *Baeria chrysostoma*, P. H. Timberlake; 1 male, same except 8-V-1959, P. D. Hurd; 1 female, Hungry Valley, 5 miles (8.0 km) S Gorman, 4-V-1959, *Chaenactis glabriuscula*, J. Powell; 1 male, same except 6-V-1959, J. R. Powers; 26 females, same except P. H. Timberlake; 8 males, 29 females, same except 9-V-1959, P. H. Timberlake; 20 males, 51 females, Quatal Canyon, NW corner Ventura Co., 9-V-1959, *Chaenactis glabriuscula*, P. H. Timberlake; 1 male, same except P. D. Hurd; 1 male, same except *Eriophyllum confertiflorum*, C. W. O'Brien; 1 female, same except J. Powell; 1 female, same except no floral data, J. R. Powers; 1 female, same except G. I. Stage. NEVADA. Lander County: 3 males, 2 females, Battle Mountain, 12-VI-1962, *Chaenactis*, G. E. Bohart; 1 female, same except on Cruciferae. Specimens in the collections of BBSL, CAS, CIS, LACM, and UCR.

Distribution.—This is the widest ranging of the *Micralictoides* species, ranging from the desert regions of Nevada and Arizona across the Sonoran and southern Mojave Deserts of California and into drier parts of the coastal ranges of California.

Discussion.—*M. chaenactidis* is probably closer to *M. altadenae* than to other species on the basis of its almost identical male sterna and genitalia. It differs principally in having longer mouthparts and face, and sparser punctation on the female frons. The female of *M. chaenactidis* is also similar to that of *M. mojavensis*, but the basal zone of the propodeum is more strongly sculptured and the dorsal scopal hairs of the hind tibia are longer than the apical width of the tibia. The male differs from *M. mojavensis* most obviously in sternum VII (Fig. 12), but it also has a more strongly punctate clypeus and more roughened frons.



Figs. 1-24. Males. Figs. 1-8: Metasomal sternum VIII. Fig. 1, *M. quadriceps*; Fig. 2, *M. linsleyi*; Fig. 3, *M. altadenae*; Fig. 4, *M. chaenactidis*; Fig. 5, *M. ruficaudus*; Fig. 6, *M. dinoceps*; Fig. 7, *M. mojavensis*; Fig. 8, *M. grossus*. Figs. 9-16: Metasomal sternum VII. Fig. 9, *M. quadriceps*; Fig. 10, *M. linsleyi*; Fig. 11, *M. altadenae*; Fig. 12, *M. chaenactidis*; Fig. 13, *M. ruficaudus*; Fig. 14, *M. dinoceps*; Fig. 15, *M. mojavensis*; Fig. 16, *M. grossus*. Fig. 17: Metasomal sternum VII, lateral view, *M. quadriceps*. Figs. 18-19: Metasomal sternum VI. Fig. 18, *M. grossus*; Fig. 19, *M. ruficaudus*. Figs. 20-24: Genital capsule. Fig. 20, *M. quadriceps*; Figs. 21, 22, *M. grossus*; Figs. 23, 24, *M. dinoceps*. (Illustrations not drawn to scale.)



Specimens from California localities differ from the type series in having the integument less intensely black, the frons of the female more uniformly and usually a little more densely punctured, and the abdominal terga slightly more coarsely and closely punctate.

***Micralictoides altadenae* (MICHENER)**

(Figs. 3, 11, 29, 39)

Halictoides altadenae Michener 1937: 395 (Holotype female: SMEK).

Dufourea (Micralictoides) altadenae; Timberlake 1939: 397.

Micralictoides altadenae; Bohart 1942: 123.

Male.—Length about 4.5 mm, forewing length 3 mm; very similar to *M. chaenactidis*, but differs in having a wider head (8:7) and shorter mouthparts. It also has denser pubescence on the foreparts of the face (partially obscuring the clypeus), somewhat paler integument of the abdomen (dark brown instead of largely glossy black), and partially brownish (instead of entirely whitish) pubescence on terga IV and V. The mid and hind basitarsi are somewhat paler in contrast to the tibiae and the abdominal pubescence is generally more abundant. Sterna VI, VII (Fig. 11), VIII (Fig. 3) and the genital capsule are similar to those of *M. chaenactidis*.

Female.—Much like *M. chaenactidis* but differs in having a wider face and shorter mouthparts (Fig. 29, 39). Punctures of the frons are generally larger and closer together (from less than one to slightly over one puncture width apart) and those of the scutum are denser and more irregular in size (averaging about one puncture width apart). The integument is somewhat paler (mostly dark brown on the abdomen instead of mostly black) and the hind tibia is almost the same color as the basitarsus instead of distinctly darker brown.

Distribution.—Known only from two widely separated localities in cismontane California, the type series from Altadena, Los Angeles County, California and a new record from Yolo County. (The record from Aliso Canyon, Los Angeles County, is an error and actually represents *M. chaenactidis*.)

New Records.—CALIFORNIA. Yolo County: 2 males, 4 females, 30-V-1956, R. M. Bohart.

Discussion.—This species is very close to *M. chaenactidis* (for differences, see discussion under the latter). The female resembles *M. mojavenensis* as well, but has shorter mouthparts (Fig. 29) and browner abdominal pubescence. The face is proportionately broader than that of *M. mojavenensis* (compare Fig. 39 and Fig. 34) but the contrast is less pronounced than in comparison with *M. chaenactidis*. The male is easily distinguished from *M. mojavenensis* on the basis of sternum VII.

Figs. 25–40. Females. Mouthparts in lateral view. Fig. 25, *M. linsleyi*; Fig. 26, *M. mojavenensis*; Fig. 27, *M. dinoceps*; Fig. 28, *M. ruficaudus*; Fig. 29, *M. altadenae*; Fig. 30, *M. chaenactidis*; Fig. 31, *M. quadriceps*; Fig. 32, *M. grossus*. Figs. 33–40: Head in frontal view. Fig. 33, *M. linsleyi*; Fig. 34, *M. mojavenensis*; Fig. 35, *M. chaenactidis*; Fig. 36, *M. dinoceps*; Fig. 37, *M. ruficaudus*; Fig. 38, *M. quadriceps*; Fig. 39, *M. altadenae*; Fig. 40, *M. grossus*. (Illustrations not drawn to scale.)

***Micralictoides linsleyi*, New Species**
(Figs. 2, 10, 25, 33)

Holotype male.—Length about 3.5 mm, forewing length 2.5 mm; body black except antenna, tegula, tarsi brown; abdomen slightly reddish. Pubescence white, sparse, rather short, not concealing integument.

Head. Head length less than width (0.80); clypeus one-half as long as width of truncation, its surface with dense, coarse punctures; lower margin of midocellus well below upper eye margin; distance from median ocellus to antennal scrobe approximately twice that between antennal scrobes; mandible moderately long but not slender, apical tooth less than one-third length of mandible, slightly darker than middle part; punctures of frons close and broad; antennal scape one-third as broad apically as long, with scattered large punctures; flagellomeres I–III distinctly broader than long, IV–X ranging from as long as broad to one and one-half times as long as broad; prementum and stipes slightly shagreened, length of prementum slightly greater than eye length, maxillary palpus approximately equal to eye length.

Thorax. Punctures of disk of scutum and scutellum more than a puncture width apart; interspaces shiny; propodeal enclosure with fine, close, irregular carinae not reaching posterior margin.

Abdomen. Impunctate margins of terga translucent, not much lighter than remainder of segments; punctures of terga as large as those on scutum and scutellum but much sparser; sternum VI practically straight in profile, with a few long hairs medially; sternum VII as in Fig. 10, sternum VIII as in Fig. 2.

Female.—Head proportions and mouthparts as in Figs. 25, 33; elevated preapical margin of clypeus nearly straight; vertex in frontal view well elevated behind eye; scutum and scutellum rather polished, punctures finer and much closer than in male; hind tibia with dorsal scopal hairs not as long as apical width of tibia. Abdominal punctation as in male.

Type Material.—Holotype male: NEVADA, Washoe Co., 4 miles (6.4 km) N Sparks, 18–VI–1959, G. I. Stage. Paratypes: 7 females, same data as holotype; 1 female same except 3.4 miles (5.5 km) N of Sparks. Holotype deposited at CAS, paratypes at BBSL, LACM, and UCB.

Additional Material.—CALIFORNIA. Lassen County: 1 male, Litchfield, 10.6 miles (17.1 km) N, 19–VI–1959; 1 male, Ravendale, 10 miles (16.1 km) S, 5–VI–1964, R. C. Dickson; 1 male, Termo, 9–VI–1960, G. I. Stage.

Distribution.—Eastern side of the northern Sierra Nevada Mountains.

Discussion.—Females of *M. linsleyi* are similar to those of *M. ruficaudus*. Differences include frons roughened between punctures, vertex elevated above eyes, and preapical margin of clypeus less arcuate.

The males are distinct from those of *M. ruficaudus* in having the abdominal reddish coloration nearly confined to the apical tergal margins. From other *Micralictoides* males, they can be distinguished by the contrastingly reddish brown color of the apical tergal margins and by the configuration of sterna VII and VIII.

***Micralictoides quadriceps*, NEW SPECIES**
(Figs. 1, 9, 17, 20, 31, 38)

Holotype male.—Length about 4 mm, forewing length 2.6 mm; body dull black, with close, broad, rather shallow punctures and short, pale, sparse pubescence.

Head. Face from vertex to clypeal margin subquadrate, broadened apically, head slightly longer than broad (7:6.5); lower margin of median ocellus above upper eye margin; distance from median ocellus to antennal scrobe about three times that between scrobes or between lateral ocelli; mandibles unusually long, slender, with middle one-third yellowish; punctures of frons separated by much less than one puncture width except a little sparser near ocelli and medially on clypeus; clypeal integument only slightly obscured by pubescence; antennal scape shining between punctures and three times as long as broad; flagellomeres I and III to XI longer than broad; mouthparts (including palpi) over twice as long as mesonotum, metanotum, dorsal face of propodeum combined.

Thorax. Scutal punctures moderately strong, uniform, averaging less than one puncture width apart; median impressed line well developed on scutum and scutellum; scutal width (between tegulae) less than length of scutum and scutellum combined (4:5); hind basitarsus, tip of hind femur, yellowish brown, other basitarsi, all femoro-tibial areas brown; dorsal propodeal enclosure with moderately regular striae laterally, weak, irregular ones medially.

Abdomen. Transparent marginal zones of terga conspicuously lighter than remainder; discs of terga with fine, rather shallow punctures from one to two or more puncture widths apart; sternum VI with shallow median impression and rather abrupt bend in dorsal direction at apical one-fifth, the sternum not obscured in ventral view by rather abundant preapical zone of pubescence; sternum VII as in Figs. 9, 17; sternum VIII as in Fig. 1.

Female.—Similar to male, but head longer, more parallel sided (Fig. 38), labrum longer, rounded apically; mouthparts as in Fig. 31; clypeus with seven or eight large, well separated punctures on flattened portion; hind basitarsus, tibia, tip of femur orange-yellow; discs of terga more closely punctured and minutely roughened.

Type Material.—Holotype male: CALIFORNIA, Amador County, Daffodil Hill, 3–VI–1963, R. M. Bohart. Paratypes: 48 males, 3 females, same as holotype; 34 males, 1 female, same except F. D. Parker; 55 males, 2 females, same except M. E. Irwin; 8 males, 4 females, Volcano, Amador County, California, 4–VI–1961, *Navarretia*, R. M. Bohart. Holotype deposited at UCD; paratypes at BBSL and UCD.

Additional Material.—1 female, Dunlap, Fresno County, California, 25–VI–1963, R. R. Snelling; 1 female, Bear Valley, Placer County, California, 4–VII–1956, R. R. Snelling. Specimens at LACM.

Distribution.—Known only from the western foothills of the Sierra Nevada Mountains.

Discussion.—Variation is slight in this species. Some specimens are smaller than those described above and some of the males have the face nearly as parallel-sided as the females.

The elongated, nearly parallel-sided face is unique in the genus. The male genitalia and sterna closely resemble those of *M. chaenactidis* and *M. altadenae*. On the other hand, the reflexed tip of sternum VI bears some resemblance to that of *M. grossus*.

***Micralictoides grossus*, NEW SPECIES**

(Figs. 8, 16, 18, 21, 22, 32, 40)

Holotype male.—Length about 6 mm, forewing length 4 mm; body dull black, closely punctured on head but only moderately so elsewhere, the punctures deeper

than usual for the genus; pubescence pale brownish, moderately profuse, partially obscuring lower parts of face, side of mesepisternum, tip of abdomen.

Head. Head slightly broader than long (9:8.5); lower margin of median ocellus slightly below upper eye margin; distance from median ocellus to antennal scrobe less than three times that between scrobes (6:2.5) and about twice that between lateral ocelli; punctures of face, including clypeus, less than one puncture width apart except close to ocelli, in subantennal area; scape dull, rough, less than twice as long as broad; flagellomeres mostly broader than long; mandible moderately long, black basally, reddish apically, the apical tooth less than one-third as long as mandible; tongue with total length slightly less than twice that of mesonotum, metanotum, dorsal enclosure of propodeum combined (17:9).

Thorax. Punctures of scutum averaging about one puncture width apart, not unusually broad or shallow, those of scutellum sparser sublaterally; median, impressed line of scutum visible on scutellum only as dense row of punctures; width of scutum between tegulae as great as length of scutum and scutellum combined; basitarsi, apical portion of posterior tibia yellowish; middle two-thirds of posterior tibia as dark as femur; dorsal propodeal enclosure appearing finely granular with superimposed, weak, irregular striae.

Abdomen. Dorsally longer than broad (14:10); apical impunctate margins of terga transparent, rather inconspicuous; discs of terga with moderately fine punctures, mostly ranging from one to two puncture widths apart; sternum VI conspicuously bulging in profile, the bulge densely covered with reddish-brown pubescence (Fig. 18); sternum VII as in Fig. 16; sternum VIII as in Fig. 8.

Female.—As in male but larger (length 6 mm) with pubescence shorter, generally sparser, punctation closer, stronger on scutum, clypeus with only a few large punctures on anteromedian flattened area, propodeum more finely sculptured, tergal discs less polished, a little more closely punctate, hind tibia about same color of brown as hind basitarsus, somewhat paler than hind femur. Head proportions as in Fig. 40; mouthparts as in Fig. 32.

Type Material.—Holotype male: CALIFORNIA, Tuolumne Co., Tuolumne City, 3–VI-1953, *Gilia capitata*, B. L. Rozen. Paratypes: CALIFORNIA. Tuolumne County: 1 female, same data as holotype; 2 males, 18 females, same except J. G. Rozen; 1 female, same except 22–VI-1953, J. G. Rozen; 3 males, same except 27–V-1953; 2 males, same except 29–V-1953; 1 male, Buck Meadows-Mather site, #50982, A. R. Moldenke; 1 female, Early Intake Power House, 3 miles (4.8 km) S, Stanislaus Natl. For., 1–VI-1977, #119159, P. Lincoln; 1 female, same except 2–VI-1977, *Gilia capitata*, P. Lincoln; 1 female, same except 4–VI-1977. Madera County: 1 female, North Fork, 10–V-1936, F. T. Scott. Sierra County: 1 male, Yuba River, 9 miles (14.5 km) W Goodyears Bar, 29–V-1965, C. D. MacNeill. Holotype deposited at CAS, paratypes at UCB, LACM, and BBSL.

Distribution.—Known only from the western foothills of the Sierra Nevada Mountains.

Discussion.—Size is somewhat variable in this species, the smallest male being about 4.5 mm and the smallest female 5 mm in length. Some of the males have the propodeal striae completely irregular.

This species is easily distinguished by its large size, strong, deep punctures, and dull first tergum. The male is very distinctive in sterna VI, VII and VIII and the genital capsule as illustrated. It is not closely related to any other species, although

the male shows a possible relationship to *M. quadriceps* in the bulging and pubescent profile of sternum VI.

***Micralictoides ruficaudus* (MICHENER)**

(Figs. 5, 13, 19, 28, 37)

Halictoides ruficaudus Michener 1937: 397 (Holotype female: SMEK).

Dufourea (Micralictoides) ruficauda; Timberlake 1939: 397.

Micralictoides ruficaudus; Bohart 1942: 121.

Male.—Length about 4.5 mm, forewing length 3 mm; body black except metasomal terga I–III, and frequently IV, mostly orange (dark areas basally on I and laterally on II) and legs varying from dark brown on coxae and femora to lighter brown (but only slightly) on tarsi. Punctures of head and thorax mostly closer than one puncture width apart except about one puncture width apart on middle of scutum and sides of mesepisternum and sparse and fine subgenally; pubescence off-white, rather sparse, only slightly obscuring lower parts of face, sides of mesepisternum; that of abdominal apex yellowish.

Head. Head slightly broader than long (7:6.5); lower margin of median ocellus in line with upper eye margin; distance from median ocellus to antennal scrobe a little over twice that between scrobes or between lateral ocelli; clypeus at least half as long as breadth of truncate apical margin, surface strongly, rather closely, punctate; mandibles rather short, the apical third orange to red; antennal scape nearly half as broad as long, strongly roughened; flagellomeres II and III about twice as broad as long, much shorter than either I or IV, both of which (and all succeeding segments except the last) are broader than long; mouthparts (including palpi) about 1½ times as long as mesonotum, metanotum, and dorsal enclosure of propodeum combined; terminal maxillary palpal segment longer than either of preceding segments.

Thorax. Punctures rather broad and shallow, those of median portion of scutum about one puncture width apart, those of lower portions of mesepisternum broad but very shallow, leaving its surface rather polished; tarsi only slightly paler than femora, central portion of tibiae; propodeal enclosure strongly, rather irregularly striate throughout; total propodeal length considerably greater than that of metanotum and scutellum combined.

Abdomen. Tergal discs polished but punctures rather coarse (about as large as scutal), shallow, and mostly a little more than one diameter apart; sterna completely orange in some specimens, but parts or all of sterna III–VI dark brown in others; sternum VI approximately straight in profile, with moderately dense, dark pubescence medially (Fig. 19); sternum VII (Fig. 13) similar to that of *M. mojavensis*; sternum VIII (Fig. 5) and genital capsule similar to those of *M. altadenae*.

Female.—Differs from male in having face more shining but only slightly more sparsely punctate (generally less than one diameter apart) except clypeus which has punctures two or more diameters apart; head unusually convex and with inner eye margins nearly parallel (Fig. 37); mouthparts as in Fig. 28; low portions of mesepisternum with punctures somewhat finer and scutum with punctures coarse and slightly less than one diameter apart, even medially; tarsi about unicolorous with tibiae, scarcely paler than femora; metasomal terga I to III generally orange except for large dark spot laterally on II; terga IV and V becoming darker (especially on

some specimens); tergal punctures coarse, ranging from less than one to about two diameters apart.

Distribution.—Found in the coastal ranges of California from San Diego to Marin Counties. This spring species appears to be oligolectic on *Eschscholtzia californica*.

New Records.—CALIFORNIA. Alameda County: 1 male, 8 females, Oakland, Skyline Drive, 12-V-1953, E. Gilbert. Kern County: 1 male, Kern River Pres., 1.5 miles (2.4 km) W Weldon, 21-IV-1983, J. D. Pinto & R. K. Velten. Los Angeles County: 1 female, Altadena, 2-V-1936, *Eschscholtzia californica*, C. D. Michener. Marin County: 1 female, Mill Valley, 12-V-1950, F. X. Williams; 1 female, Novato, 6-V-1962, D. C. Rentz. Monterey County: 2 males, Hastings Reserve, near Jamesburg, 3-V-1958, J. Powell; 9 males, 8 females, Hollister, 22 miles (35.4 km) S, 3-V-1982, *Eschscholtzia californica*, P. F. Torchio; 2 females, Jolon, 14 miles (22.5 km) W, 2-IV-1959, C. W. O'Brien. Riverside County: 2 males, Corona, 12 miles (19.3 km) S, I-15 & Indian Truck Trail, 14-IV-1985, *Cryptantha intermedia*, R. R. Snelling; 2 males, Riverside, 10-IV-1935, *Eschscholtzia californica*, P. H. Timberlake; 1 male, same except 12-IV-1935; 1 male, same except *Cryptantha intermedia*; 1 female, same except 12-IV-1933, *Eschscholtzia californica*, S. C. Dorman; 1 female, same except 15-IV-1929, P. H. Timberlake; 1 male, same except 15-IV-1932, *Cryptantha intermedia*; 1 male, same except 15-IV-1933, H. L. McKenzie; 1 female, same except 15-V-1934, *Cryptantha intermedia*, P. H. Timberlake; 1 female, same except 2-IV-1929, *Eschscholtzia californica*; 1 female, same except 24-IV-1928; 1 female, same except 29-III-1933, *Amsinckia douglasiana*, H. L. McKenzie; 1 male, same except 5-IV-1933, *Cryptantha intermedia*, P. H. Timberlake; 1 male, same except 9-V-1935. San Bernardino County: 1 female, Devore, 21-IV-1974, J. C. & E. M. Hall. San Luis Obispo County: 3 females, Black Mt., 6 air miles (9.7 km) NE Pozo, 3300–3600' (1006–1097m), 1-V-1962, J. K. Drew.

Discussion.—This is a very distinctive species, apparently related to *M. mojavensis* on the basis of sternum VII in the male, but with many unusual features including the largely orange abdomen, the short male flagellum, and the coarse abdominal punctation. Except that the abdomen varies in the amount of black beyond tergum III, there is no evidence of geographical variation. This red abdomen is distinctive among *Micralictoides* except for some females of *M. linsleyi* which also exhibit orange coloration on the basal terga but differ from *M. ruficaudus* in having roughened interpunctural areas on the frons.

***Micralictoides mojavensis* BOHART**

(Figs. 7, 15, 26, 34)

Micralictoides mojavensis Bohart 1942: 120 (Holotype male: CAS).

Male.—Length about 4.5 mm, forewing length 3 mm, head width slightly greater than length (1.1 or 1.2); similar in most respects to *M. chaenactidis*, but differs in having the clypeus and supra-clypeal area more polished, the clypeus more nearly impunctate (except basolaterally) and the punctures of the supra-clypeal area mostly separated by three or four times their diameters. The facial pubescence is somewhat sparser, not at all concealing the clypeus and supraclypeal area. The mouthparts are about as long as those of *M. chaenactidis* and distinctly longer than those of *M. altadena*. The propodeum has the sculptured area of the enclosure more restricted

than that of *M. chaenactidis* and has a broad, nearly smooth zone laterally within the enclosural boundaries. Sternum VI resembles that of *M. chaenactidis*, but sternum VII is strikingly different (Fig. 15). Sternum VIII is similar to that of *M. chaenactidis*, but its apical process is a little broader (Fig. 7).

Female.—Very similar to *M. altadenae* and to the widespread California form of *M. chaenactidis*. Head (Fig. 34) length to breadth ratio varies from 0.88 to 0.99. Mouthparts (Fig. 26) long as in *M. chaenactidis*. Length of dorsal scopal hair on hind tibia slightly less than apical width of tibia. Tergum II with punctation of disk sparse, especially in middle.

Distribution.—Mojave Desert and Los Angeles Basin. All collection records are from mid-April to late May. Males were collected on *Gilia multicaulis* and *Platystemon californicus*.

New Records.—CALIFORNIA. Inyo County: 1 female, Darwin, 12-V-1969, J. Doyen; 2 females, same except P. Wells. Riverside County: 2 males, 1 female, Gavilan, 4-IV-1952, *Salvia columbariae*, P. H. Timberlake; 1 female, same except 22-IV-1952, *Eschscholtzia californica*; 1 female, same except 10-IV-1956; 1 female, same except 16-IV-1956, *Gilia multicaulis*. San Bernardino County: 3 females, Adelanto, 20 miles (32.2 km) N, 18-IV-1962, *Malacothrix glabrata*, P. H. Timberlake; 1 male, Atolia, 1-V-1952, R. M. Bohart; 3 males, 5 females, Mid Hills, 9 miles (14.5 km) SSE Cima, 26-V-1975, T. Griswold; 1 male, Mid Hills, Sec. 12 T12N R14E, 5620' (1713m), 19-V-1980, T. Griswold; 1 male, Sacaton Spr., New York Mts., 4100' (1250m), 10-V-1978, T. Griswold; 1 female, Twentynine Palms, 4 miles (6.4 km) S, 14-IV-1935, *Malacothrix californica*, P. H. Timberlake; 1 female, Victorville, 12 miles (19.3 km) W, 14-IV-1963, *Phacelia fremontii*, M. Dickson.

Discussion.—This species is difficult to distinguish from *M. chaenactidis* in its externally visible characteristics even though sternum VII of the male resembles that of *M. ruficaudus* more than it does that of *M. chaenactidis*. The female appears to be separable from *M. chaenactidis* only by the more sparse punctation of tergum II and the shorter scopal hair. Since the distribution of these two species overlaps, it is possible that our association of the sexes in *M. mojavensis* (based primarily on similarity in headshape) is not entirely correct. Longer series from single localities will probably clarify this matter in the future. The punctation and coloration of *M. mojavensis*, in general, appears to be intermediate between those of the Coast Range and more interior forms of *M. chaenactidis*. Like *M. chaenactidis*, the species differs from *altadenae* in both sexes by its narrower face (but only slightly so), longer clypeus, and longer mouthparts.

Four females from Red Rock Canyon, Kern County, California are a composite of characteristics of *M. mojavensis* and *M. dinoceps*. The head shape and propodeal sculpturing are as in *M. dinoceps*, while the scutal punctation and length of the maxillary palpi are as in *M. mojavensis*. It is possible that these females represent intermediate conditions in a polymorphic species and, consequently, that *M. dinoceps* is not a valid species. However, the available material of both *M. mojavensis* and *M. dinoceps* is quite homogeneous with respect to these two characters. It, therefore, seems possible that the Red Rock Canyon females represent a third species. Resolution of this problem must await discovery of the corresponding male.

Micralictoides dinoceps, NEW SPECIES

(Figs. 6, 14, 23, 24, 27, 36)

Holotype male.—Length about 4.5 mm, forewing length 3 mm; body black except tegula, tarsi, sterna brown. Pubescence white, sparse, rather short, not concealing integument.

Head. Head distinctly broader than long (1.3); clypeus less than one-third as long as breadth of truncation, its surface with sparse, coarse punctures; lower margin of median ocellus lower than upper eye margin; distance from median ocellus to antellal scrobe less than twice that between antennal scrobes; mandible moderately long but not slender, apical tooth less than one-third length of mandible, slightly darker than middle third; punctures of frons close and broad; antennal scape one-third as broad apically as long, with scattered large punctures; flagellomeres I–III distinctly broader than long, IV–X ranging from as long as broad to one and one-half times as long as broad; prementum and stipes shagreened, length of prementum slightly greater than eye length, maxillary palpus shorter than eye length.

Thorax. Punctures of scutum and scutellum less than a puncture width apart, interspaces not shagreened; propodeal enclosure with strong, rather close, regular longitudinal carinae throughout.

Abdomen. Impunctate margins of terga translucent, not much lighter than remainder of segments; punctures of terga smaller and much sparser than those on scutum and scutellum; sternum VI practically straight in profile, uniformly sparsely haired; sternum VII as in Fig. 14, sternum VIII as in Fig. 6, genital capsule as in Figs. 23, 24.

Female.—Differs from male in having the face more polished, punctation of frons slightly more sparse; head proportioned as in Fig. 36; mouthparts as in Fig. 27; elevated portion of clypeus nearly straight apically, width of marginal truncation more than twice length; scutum and scutellum rather polished, with fine punctures less than a puncture width apart; abdominal terga with punctures as coarse, but much more sparse; hind tibia nearly as light as hind basitarsus, dorsal scopal hair no longer than apical width of tibia.

Type Material.—Holotype male. CALIFORNIA, San Bernardino Co., Arrastre Flat, 7,450 ft (2,271m), 26–VI–1979, *Allium fimbriatum*, M. H. O'Brien. Paratypes: California, San Bernardino County: 7 males and 16 females, same data as holotype; 1 female, Mill Creek, 7400' (2,256m), 29–VI–1942, R. M. Bohart. Los Angeles County: 1 male, Valyermo, 4 miles (6.4 km) SE, 13–IV–1960, R. R. Snelling. Holotype deposited at LACM; paratypes at LACM, BBSL, and UCD.

Distribution.—Apparently restricted to the San Bernardino Mountains of southern California.

Discussion.—Males of *M. dinoceps* are close to those of *M. mojavensis* and both can be distinguished from other *Micralictoides* by the abrupt expansion near the middle of the lateral arm of sternum VII. *M. dinoceps* can be separated from *M. mojavensis* by the wider head and differences in sternum VII. In *M. dinoceps*, the lateral arms of sternum VII are in a tight arc so that together, they form an area longer than wide; in *M. mojavensis*, these arms are in loose curves so that they form an area wider than long. The lateral arm of *M. dinoceps* is of uniform thickness

beyond the medial expansion whereas in *M. mojavenensis*, it is narrow then apically expanded.

Females of *M. dinoceps* are easily confused with those of *M. altadenae*, *M. chaenactidis* and *M. mojavenensis*. From these, they differ by the shortened maxillary palpi, the fine and more dense scutal punctation, and in the sculpturing of the basal zone of the propodeum. They further differ from *M. mojavenensis* by the broader head, and from *M. altadenae* and *M. chaenactidis* by the shorter scopal hairs and the sparser punctation of tergum II.

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**A new species of *Andrena* (*Onagrandrena*) from Utah's
San Rafael Desert (Hymenoptera: Andrenidae)**

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Abstract.—A series of a large, distinctive, undescribed species of black *Andrena* belonging to the subgenus *Onagrandrena* was collected by Dr. Frank Parker, USDA Bee Biology and Systematics Laboratory, Logan, Utah during a survey of aculeate Hymenoptera from Utah's San Rafael Desert. It is related to a complex of species described by E. G. Linsley and J. W. MacSwain for their ecological studies of bees and Onagraceae of the Great Basin (Linsley, et al. 1963b). I describe the species at this time to include it in this volume dedicated to E. Gorton Linsley and to make the name available for a forthcoming review of the subgenus. The format and abbreviations used in the description follow those used by LaBerge (1967), with the exception that UCD is now RMB (R. M. Bohart Museum of Entomology).

***Andrena* (*Onagrandrena*) *linsleyana* Thorp, NEW SPECIES**

Female.—*Measurements and Ratios.*—N=20; length, 14–15.5 mm; width, 4.8–5 mm; wing length, $M=8.7 \pm 0.06$ mm; FL/FW, $M=1 \pm 0.129$; FOVL/FOVW, $M=2.8 \pm 0.007$.

Integumental Color.—Black except as follows: mandible tips mahogany; antennal flagellomeres 3–10 brownish beneath; tegulae posteriorly mahogany; wing membrane infuscated, veins light yellowish brown; legs and basal areas of metasomal sternites mahogany.

Structure.—Antennal scape equal to flagellomeres 1 to 3; flagellomere 1 slightly shorter than 2 plus 3 combined (1:1.25); flagellomeres 2, 3 and 4 each as wide as long and equal to each other in length. Eyes 3 times as long as wide, inner margins essentially parallel. Malar space short, linear. Mandibles somewhat elongate, when closed outer mandible extends to end of labrum with subapical dorsal tooth surpassing midlabrum by two fifths length, without tooth or angle on basal inferior margin. Galea with outer margin angled outward from apex in straight line, then bending rearward to insertion of palpus; surface moderately dull, shagreened. Maxillary palpus nearly twice as long as galea; segmental ratio about (1.2:2.0:1.5:2.0:1.7:1.7). Labial palpus with first segment curved, somewhat flattened; segmental ratio about (2.0:1.2:1.0:1.5). Labral process short, tumid, converging and shallowly emarginate apically with two, very short, blunt teeth, longer than apical width, without basal depression (Fig. 2); labrum apical to process without transverse sulcus, with median longitudinal crista, with coarse, longitudinally elongate, nearly contiguous punctures. Clypeus convex; punctures coarse, separated by less than one diameter centrally, finer and nearly contiguous laterally and dorsally; surface shiny, with narrow median longitudinal impunctate line. Supraclypeal area dull, punctures nearly contiguous and finer than on clypeus.

Face above antennal fossae with coarse, contiguous punctures between fine longitudinal rugulae. Facial fovea long, extending below level of antennal bases and 2.8 times maximum width, width at top twice width at bottom and separated from lateral ocellus by 0.4 ocellar diameter, area between fovea and ocellus finely striate-punctate. Lateral ocelli 2.4 diameters from inner margins of compound eyes and about one diameter from the top of the vertex. Vertex above lateral ocellus dull, densely, moderately coarsely punctate. Genal area in profile broader than eye (about as 8:5), punctures finer than on clypeus, sparse, separated by 1–2 diameters centrally, closer, and separated by less than one diameter peripherally, surface dull, shagreened, shiniest centrally.

Pronotum with rounded humeral angle and without dorsoventral ridge, dull, finely, moderately sparsely punctate, shagreened posteriorly, shiny anteriorly. Mesoscutum dull with coarse, close punctures separated by less than one diameter, interspaces shagreened. Scutellum dull, punctures coarse, close (<1 diameter) becoming contiguous posteriorly. Metanotum dull, punctures coarse and contiguous. Propodeum with dorsal enclosure moderately rugose, irregular, without longitudinal rugae (Fig. 1); dorsolaterally and posteriorly dull, with coarse, close and vertically long-ovate punctures, laterally sparsely punctate in center of corbicular area. Fore wing with base of vein M ending about 2 vein widths anterior to cu-v.

Metasomal tergum 1 shiny with anterior face impunctate, rounded to dorsal sparsely punctate disk. Terga 2–4 shiny, finely, sparsely, punctate with punctures separated by 1–2 diameters, impunctate margin shiny, about one-fifth length of apical impressed area. Pygidial plate V-shaped with apex truncate, margins curved upwards, with distinct, raised internal triangular area grading apically and basolaterally toward margins, mediolaterally sharply declivous with fine striae extending onto depressed submarginal, impunctate, dull, shagreened area, surface of raised internal area finely, irregularly striate. Sterna 2–5 with basal areas sparsely, moderately finely punctate, separated by 3–4 diameters on sternum 2, becoming closer on succeeding sterna to 1–2 diameters on sternum 5, narrow apical areas impunctate, shiny, moderately transparent.

Vestiture.—Black. Propodeal corbiculum incomplete, dorsal hairs moderately long, straight, similar to other hairs above, with many internal hairs and only a ventral tuft of hairs anteriorly; trochanteral flocculus complete with moderately long curved hairs; tibial scopal hairs sparse, long (nearly twice tibial width), simple. Tergal hairs erect, long on tergum 1 (7 times as long as on tergum 2).

Male.—Measurements and Ratios:— $N=20$; length, 9.5–14.5 mm; width, 3–4.5 mm; wing length, $M=7.4 \pm 0.37$; FL/FW, $M=1.12 \pm 0.001$; FS1/FS2, $M=1.25 \pm 0.003$.

Integumental Color.—Black with exceptions as in female.

Structure.—Antennal scape equal to first two and one fourth flagellomeres; flagellomere 1 longer than 2 (as 1.3:1.0), equal to 3; segment 2 as wide as long; segment 3 slightly longer than wide (as 1.3:1.0). Mandibles moderately long, when closed, outer mandible extends slightly beyond end of labrum. Malar space and galea as in female. Maxillary palpus as in female, but segmental ratio (1.0:1.5:1.3:1.7:1.3:1.7). Labial palpus as in female, but ratio about (1.5:1.0:1.0:1.3). Labral process wider than long (as 2.5:1.5), deeply emarginate with two teeth (Fig. 4); labrum apical to process convex, finely, sparsely punctate, shiny, without crista. Clypeus with sculpture as in female, except median impunctate

line more difficult to detect, especially above; shiny centrally. Supraclypeal area and face above antennal fossae as in female. Lateral ocelli separated from inner margin of compound eye by 3 diameters and from vertex by one diameter. Vertex sculptured as in female. Genal area in profile broader than eye (as about 7.5:5), sculpture as in female.

Pronotum with rounded humeral angle and without dorsoventral ridge, surface sculpture as in female. Mesoscutum and scutellum sculptured as in female. Propodeum sculptured as in female (Fig. 3). Fore wing with base of vein M as in female.

Metasomal terga 1–5 sculptured as in female. Tergum 7 with pseudopygidial area concealed by long hairs at lateral margin, V-shaped and broadly truncate apically. Sterna 2–5 punctate as in female. Sternum 6 with apical margin turned down slightly, without emargination. Sternum 7 emarginate apically. Sternum 8 with terminal shaft equal in length to that of broad base and with apex slightly emarginate. Penis valves moderately broadened medially, tips narrow, not exceeding tips of gonostyli; dorsal lobe of gonocoxite relatively narrow, acute apically shorter than base of gonocoxite (as 3:5); gonostyli enlarged nearly axe-shaped apically with concave outer face, longer than distance to apex of dorsal lobe of gonocoxite (as 3.5:1.5) (Figs. 5–6).

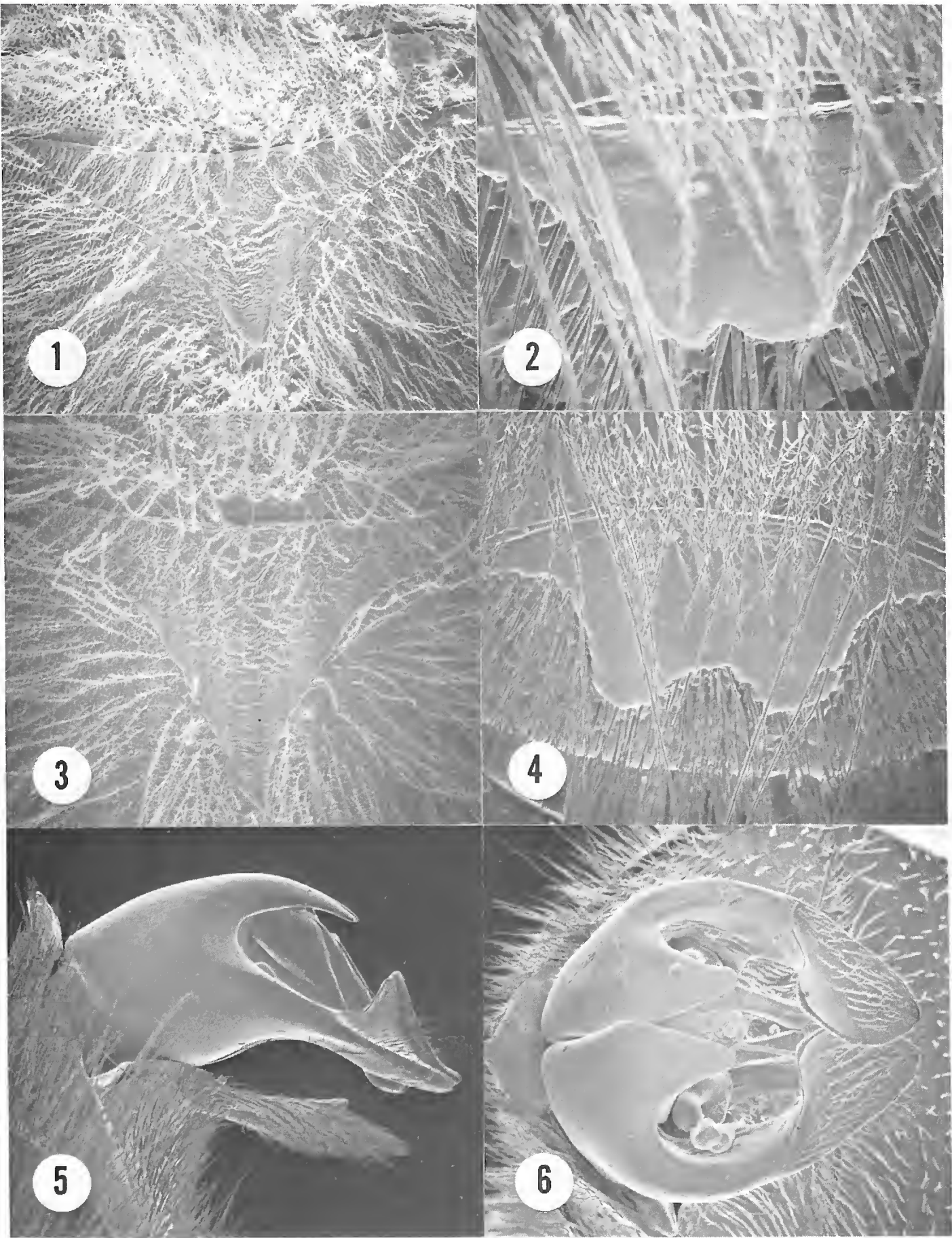
Vestiture.—Black.

Type Material.—The holotype female (USNM) and allotype (USNM), 8 female and 57 male paratypes (USU; CAS; CIS; RMB) were collected at Bullfrog Campground, Kane County, Utah, 21 April 1983 by F. D. and J. H. Parker. The type locality is near the end of the road at Lake Powell about 120 km south of Hanksville, Wayne County (confirmed by F. D. Parker, personal communication). An additional 11 female paratypes (USU) were collected as follows: UTAH: Emery Co.: 5,100', 4 air mi. N. Gilson Butte, 29 May 1981, F. D. Parker, 1 female on *Oenothera* and 6 females on Compositae; 4,900', Wildhorse Creek, N of Goblin Valley, 3 June 1982, F. D. Parker, T. L. Griswold, 4 females on *Oenothera*.

Variation.—Males vary considerably in size with their lengths ranging from 9.5–14.5 mm ($M = 12 \pm 1.263$) while females vary only slightly with lengths ranging from 14–15.5 mm ($M = 14.9 \pm 0.326$). The median longitudinal impunctate line of the clypeus of some males is reduced to the lower portion only.

Systematics.—*Andrena linsleyana* belongs to the species complex that includes: *A. (O.) chylismae-nevadae-thorpi-stagei* all described by Linsley and MacSwain. Its females can be separated from others of this complex by their larger size, the less pronounced and more irregularly rugose propodeal enclosure, the presence of a median longitudinal impunctate line on the clypeus, the shorter and more emarginate labral process. Males of *A. linsleyana* can be separated from those of *A. chylismae*, the only species of this complex for which males have been described, by their larger size, the less pronounced and more irregularly rugose propodeal enclosure, and the presence of a median longitudinal impunctate line on the clypeus. Males of both have all black pubescence. This is a unique characteristic among *Onagrandroidrena* of the Intermountain Region and will likely be true for other members of this species group as the males become known.

Flower and Collociton Records.—According to Dr. F. D. Parker (personal communication) the specific floral records for the above are: *Oenothera pallida* Lindley and *Hymenopappus filifolius* Hook. and the bees were foraging as late as 11 A.M. I examined the specimens for pollen. All the bees collected on *Oenothera* bore small amounts of *Oenothera* pollen in their scopae. All the females collected on



Figures 1–6. *Andrena linsleyana*, paratypes. 1. Propodeal enclosure of female. 2. Labral process of female. 3. Propodeal enclosure of male. 4. Labral process of male. 5, 6. Male genital capsule lateral and apical views.

Hymenopappus had moderate amounts of pollen from Compositae on their faces below their antennae, but none in their scopae indicating that this was a nectar source. Its flight season is from late April into June. The specimens from Bullfrog Campground on 21 April 1981 are all very fresh. The collections made at the other

two sites in late May and early June show wear of the mandibles, hairs of the clypeus and labrum and of the wing tips. The presence of pollen in the scopae of the females and the lack of males in the latter collections also suggests that these were made near the end of the season for the bees.

Discussion.—Based on the flower records and pollen analyses, females of *A. linsleyana* presumably collect residual pollen in the morning from the evening opening *O. pallida* when the nectar supply in the deep hypanthium is low and forage for nectar on flowers of compositae. This is similar to the behavior of females of *A. (O.) linsleyi* Timberlake which forage in the morning for residual pollen from the nocturnal *O. deltoides* Torrey & Fremont and for nectar on *Geraea canescens* Torrey & Gray in the Colorado Desert of California (Linsley, et al. 1963a). Females from Bullfrog Campground were collected at a nest site and males were found sleeping in shallow burrows under rocks (F. D. Parker, personal communication).

The Canyon Lands subdivision of the Colorado Plateau Province which contains the San Rafael Desert of Utah has the greatest number of endemic plant species of any part of the Intermountain Region (Cronquist, et al. 1972). The San Rafael Desert has produced several endemic bee species (F. D. Parker, personal communication) as well, so it is not surprising that *A. linsleyana* with the largest females of any *Onagrandroidrena* represents another endemic species.

Etymology.—I take great pleasure in naming this species in honor of Dr. E. Gorton Linsley who has contributed greatly to the understanding of the systematics and ecology of this subgenus of *Andrena* and who had a great influence on my career as my major professor and mentor during my graduate years at Berkeley.

ACKNOWLEDGMENTS

I thank Dr. Frank Parker for bringing this species to my attention and for providing additional biological information. I thank Drs. Parker and W. E. LaBerge for reviewing the manuscript. I thank Mrs. Mary Ann Tenorio, Entomology, California Academy of Sciences, for assistance with the scanning electron microscope photos.

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Proceedings of the Pacific Coast Entomological Society, 1986

FOUR HUNDRED AND FORTY-FOURTH MEETING

The 444th meeting was held Friday, 21 February 1986, at 8:15 P.M., in the Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Mr. Larry G. Bezark presiding.

The minutes of the meeting held 13 December 1985 were read and accepted. Nine persons were proposed and elected as new members: Mr. Richard L. Bottorff and Mr. Tim A. Christiansen as student members; Mr. Richard P. and Mrs. Louise H. Fall as regular family members; and Mr. Robert D. Haines, Dr. Patricia G. Lincoln, Mr. Terry D. Miller, Dr. Frank J. Radovsky, and Dr. Jose A. Ramos as regular members.

Mr. Bezark announced the topics for some of the forthcoming meetings. Several guests were introduced. Dr. Kirby A. Brown showed slides of bronze medallions casted in 1911 by the Paris mint in honor of the famous entomologist Jean-Henri Fabre.

The featured speaker, Dr. Jarmila Kukalova-Peck, Department of Geology, Carleton University, Ottawa, presented a lecture entitled "Paleozoic Insects, the Origin of Wings and the Evolution of Insect Flight." She showed slides of these monstrous and bizarre-looking insects from the Carboniferous and Permian Periods, a majority of which have highly modified beaks for penetrating and sucking the strobili of primitive plants. She discussed the old paranotal theory which proposes evolution of flight by gradual modifications of the paranotal lobes from rigid gliding structures to foldable, then flapping structures, and finally to wings that can power flight. Combining knowledge from paleontology, embryology, and comparative anatomy, she presented her own "exite-ting" theory which proposes wing evolution from basipodite exites that migrated from the ventral to the dorso-lateral position. The presence of musculature in the articulations of the wings supports her theory that any prewing structures were already flexible before true wings evolved. Nearly all of the very early insects also had segmented abdominal legs. Her research also led her to conclude that the Arthropoda is a monophyletic group.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 102 persons was present, of which 51 signed as members and 29 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-FIFTH MEETING

The 445th meeting was held Friday, 21 March 1986, at 8:15 P.M., in Mulford Hall, University of California, Berkeley, with President Mr. Larry G. Bezark presiding.

The minutes of the meeting held 21 February 1986 were read and accepted. Five persons were proposed and elected as new members: Mr. Marc L. Utheim as a student member; and Dr. Edward I. Coher, Prof. Hua Lizhong, Dr. Daniel Udovic, and Dr. Floyd G. Werner as regular members.

Mr. Bezark mentioned a few papers that appeared in some recent journals and the recent publication of the 1986 volume of *Annual Review of Entomology*. Dr. Edward L. Smith presented his recent findings on a proposed new classification of the hexapodan groups.

The featured speaker, Dr. David H. Kistner, Chico State University, presented a lecture entitled "Wallace, Wallace's Lines, and the Wallace Expedition." He gave a brief biographical sketch of Alfred Russell Wallace and discussed the Wallace's Lines, which separate the Oriental from the Australian Zoogeographical Regions. He suggested that the fauna of Sulawesi (or Celebes) might have been influenced by plate tectonics since the island is a composite of land masses from each of these regions. In 1985, the Royal Entomological Society of London celebrated its 150th anniversary by sponsoring the year-long Wallace Expedition, which is the largest expedition in the last 50 years, involving 102 scientists, including Dr. Kistner and his wife, Alzada. She discussed the logistics of the expedition, in which volunteers from the British military helped by carrying supplies and setting up camp, etc. for the scientists. Dr. Kistner discussed his research on the termitophilic staphylinids taken from termite nests in the Oriental part of the island.

The social hour was held in Wellman Hall following adjournment of the meeting.

A total of 63 persons was present, of which 34 signed as members and 14 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-SIXTH MEETING

The 446th meeting was held Friday, 18 April 1986, at 8:15 P.M., in Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Mr. Larry G. Bezark presiding.

The minutes of the meeting held 21 March 1986 were read and accepted. Two persons were proposed and elected as new regular members: Dr. Jeffrey C. Burne and Dr. Robert V. Dowell.

The featured speaker, Dr. Kirby W. Brown, entomologist with the San Joaquin County Department of Agriculture, Stockton, presented a lecture entitled "Paper Beetles or Adventures in Literature." He showed slides of some old entomological books, some of which had very decorative title pages, and discussed the evolution of colored illustrations from copper to steel engravings with hand-painted colors to chromolithographs to photographs. He also discussed the importance of literature to taxonomists. He summarized the history of entomological literature from the perspective of expeditions, taxonomic monographs, faunistic studies, and book catalogs. He emphasized that books produced today cannot duplicate the efforts that went into the older ones because of higher production costs. However, the older books are being destroyed for their colored plates, which are often removed, framed, and sold separately to command higher prices than if the books were to be sold intact. Their scientific value is therefore much reduced.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 36 persons was present, of which 23 signed as members and 11 as guest.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-SEVENTH MEETING

The 447th meeting was held Friday, 17 October 1986, at 8:15 P.M., in Morrison Auditorium, California Academy of Sciences, Golden Gate Park, San Francisco, with President Mr. Larry G. Bezark presiding.

The minutes of the meeting held 18 April 1986 were read and accepted. Twelve persons were proposed and elected as new members: Mr. Timothy G. Myles, Mr. Felipe N. Soto Adames, and Mr. William P. Weaver Jr. as student members for 1986, and Mr. Gregory S. Forbes, Mr. Elgin E. Huckstep, Mr. Timothy A. Kellogg, Mr. Stephen A. Manweiler, Mr. Ronald G. Robertson, Dr. Geoffrey G. E. Scudder, and Dr. William D. Shepard as regular members for 1986, and Mr. Craig Sondergaard and Dr. Gregory R. Walker as regular members for 1987.

Mr. Bezark announced two forthcoming entomological conferences and presented slides of his summer collecting trip to the Rockies. Dr. Edward L. Smith presented slides of the Eagle Lake Biological Field Station, operated by California State University, Chico, that is being threatened with closure due to lack of funding, and make an appeal for letters of support from the audience.

The featured speaker, Dr. Harry Greene, professor of zoology at the University of California, Berkeley, presented a lecture entitled "Behavioral Ecology of Tropical Predators." He showed slides of predatory vertebrates and invertebrates of the Finca La Selva station in Costa Rica and discussed why there is an increase in the diversity of vertebrates when one compares the polar areas to the tropics. He also suggested that larger vertebrate predators in the tropics should not be eliminated because they can check the smaller predators which are able to more significantly affect avian populations.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 71 persons was present, of which 44 signed as members and 20 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-EIGHTH MEETING

The 448th meeting was held as a joint meeting with the Northern California Spider Society on Friday, 21 November 1986, at 8:15 P.M., in Mulford Hall, University of California, Berkeley, with President Mr. Larry G. Bezark presiding.

The minutes of the meeting held 17 October 1986 were read and accepted. Two persons were proposed and elected as new student members for 1987: Mr. Dennis W. Gray and Mr. Larry J. Orsak.

Mr. Bezark appointed members of the auditing committee, consisting of Mr. H. Vannoy Davis (as chair), Dr. Paul H. Arnaud Jr., and Mrs. Helen K. Court, and the nominating committee, consisting of Dr. Clifford Y. Kitayama (as chair), Dr. Barry M. Wilk, and Dr. Robbin W. Thorp. He reminded the audience of the forthcoming Entomological Society of American meeting in Reno in December. He demonstrated a way to conserve space when pinning specimens into schmitt boxes. Dr. J. Gordon Edwards showed slides of his recent trip to New Zealand. Mr. Bezark then introduced Dr. Jack B. Fraser,

president of the Northern California Spider Society, who invited members of the audience to join the spider society and offered their tee shirts for sale.

Dr. Fraser introduced the featured speaker, Ms. Teresa Meikle-Griswold, Natal Museum, Pietermaritzburg, South Africa, who presented a slide lecture entitled "The Natural History of Two Species of Group-living Eresid Spiders in Southern Africa." She discussed the natural history of *Magunia dunicola* (Pocock) and *Stegodyphus mimosarum* Pavesi, commonly called community spiders. These spiders form group living cooperatives. She showed that the eresid colonies are very complex biological communities, with predators, parasitoids, and kleptoparasites living among the eresids. The Zulus utilize these spiders in the control of flies that live around cattle pens.

The social hour was held in Wellman Hall following adjournment of the meeting.

A total of 55 persons was present, of which 28 signed as members and 22 as guests.—V. F. Lee, Secretary.

FOUR HUNDRED AND FORTY-NINTH MEETING

The 449th meeting was held on Friday, 12 December 1986, at 8:20 P.M., in Morrison Auditorium, California Academy of Sciences, San Francisco, with President Mr. Larry G. Bezark presiding.

The minutes of the meeting held 21 November 1986 were read and accepted. Three persons were proposed and elected as new regular members: for 1986, Dr. Allen M. Young, and for 1987, Mr. E. Penryn Flemyng and Dr. Paul K. Lago.

Mr. Bezark introduced his parents, Bud and Betty. Dr. Stanley C. Williams introduced Dr. Donald K. Fletcher. Mr. Bezark announced that he recently returned from the Entomological Society of American meetings where he saw Christmas cards with depictions of insects, a new book with keys to braconids, and a new book on Pacific Island names. He then called for committee reports. Dr. Paul H. Arnaud Jr., chair of the historical committee, reported that there was considerable use of the Albert Koebele notes. Mr. Daniel F. Gross, chair of the membership committee, reported that the 1986 membership rolls consisted of 433 members, including 306 regular members, 60 student members, 44 sponsoring members and sponsoring family members. The year saw an addition of 38 new members, 27 regular and 11 student members. He then read the names of the members who continue to support the journal by being sponsoring members for 1986: Phillip A. Adams, Robert P. Allen, Richard K. Allen, William F. Barr, Richard M. Bohart, Paula and Robert Buickerood, Donald J. Burdick, Leopoldo E. Caltagirone, Arthur L. Chan, Kenneth W. Cooper, J. Gordon and Alice Edwards, George R. Ferguson, William E. and Stephenie S. Ferguson, Wayne C. Field Jr., Eric M. Fisher, John G. Franclemont, E. Eric Grissell, John E. Hafernink Jr., Kenneth S. Hagen, Alice S. Hunter, Johannes L. Joos, Benjamin Keh, Dennis M. Kubly, Robert J. Lyon, Robert L. Mangan, David G. Marqua, Gordon A. Marsh, Woodrow W. Middlekauff, Robert B. Miller, Calvert E. Norland, Harry W. Oswald, Richard L. Penrose, Jacqueline L. Robertson, Leslie S. Saul, Evert I. Schlinger, David B. Scott, Harvey I. Scudder, Terry N. Seenno, Frank E. Skinner, Edward L. Smith, Roy R. Snelling, Marius S. and Joanne S. Wasbauer, and David B. Weissman. Dr. Arnaud read notes from Mr. H. Vannoy Davis, chair of the auditing committee, stating that the financial books of the Society were in good order. He also read a report from Dr. Wojciech J. Pulawski, Treasurer, on the fund balances of the Society as of 30 September 1986, and thanked Mrs. L. Gail Freihofer and Mr. Davis for their help in maintaining the books. He mentioned that page charges for Dr. Hua Lizhong's paper on new Chinese cerambycids, published in vol. 62 of *The Pan-Pacific Entomologist*, was supported by a grant from the Charles P. Alexander Publication Fund. Mr. Bezark raffled a book, *California Insects* by Powell and Hogue, to a member of the audience.

Dr. Clifford Y. Kitayama, chair of the nominating committee, proposed the 1987 slate of candidates for officers: Dr. Stanley C. Williams, as president, Dr. Wojciech J. Pulawski, as treasurer, Mr. Vincent F. Lee, as secretary, and Mr. Alan I. Kaplan, as president-elect. The members of the Society then voted in the slate as officers for the new year. Mr. Bezark handed the gavel over to the president, Dr. Williams, who then presided over the remainder of the meeting.

Mr. Lee announced that, by the action of the publication committee, the Society has changed the printer for the journal: A-R Editions of Madison, Wisconsin will replace Allen Press, starting in 1987. Dr. Ronald E. Stecker mentioned that a former entomology student of San Jose State University, Mr. Robert Anderson, died tragically in an auto accident a few months ago. Dr. Williams announced with regret that the Society will not participate in the annual meeting of the American Association for the Advancement of Science-Pacific Division in San Diego in June 1987. However, he suggested that the Society put on an all-day seminar and meeting in place of it at the end of the year.

Dr. Edward L. Smith announced two new books: *Spider: Webs, Behavior, and Evolution*, edited by W. A. Shear, and E. N. Kjellesvig-Waering's posthumous monograph on the fossil scorpions of the world, published in *Palaeontologica Americana*. He also showed drawings of Carboniferous thysanurans, japygids, and monurans, and a rediscovered Protodonata, which was previously misidentified as belonging to another insect order, executed by Dr. Jarmila Kukalova-Peck. Mr. Benjamin Keh showed a book on insect studies in China, written in Esperanto. Mr. Dean W. Jamieson mentioned that insect and arachnid specimens from Iran collected by Mr. Bruce Sanford will be on display at the social hour. Mr. Larry J. Orsak showed slides of possible spider mimics by tephritids and possibly by otitids, possible spider images on wings of geometrids in Wau, New Guinea, and noctuid caterpillars which resemble teratological flowers in Arizona.

Dr. Williams introduced the featured speaker, Mr. Larry G. Bezark, Biological Control Services, California Department of Food Agriculture, Sacramento, who presented the presidential address entitled "Biological Control of Water Hyacinth in California." He discussed the introduction and spread of this aquatic weed, the world's most prolific plant, and the attempts to control it in California with two species of weevils (*Neochetina bruchi* Hustache and *N. eichorniae* Warner) and one species of pyralid moth (*Sameodes albiguttalis* (Warren)). He talked about the life cycles of the host and the biological control agents. The insects are now well established in California and are keeping the weed in check.

The social hour was held in the entomology conference room following adjournment of the meeting.

A total of 42 persons was present, of which 30 signed as members and 12 as guests.—V. F. Lee, Secretary.

PACIFIC COAST ENTOMOLOGICAL SOCIETY
STATEMENT OF INCOME, EXPENDITURES AND
CHANGES IN FUND BALANCES

Year Ended September 30, 1986 and 1985

| | <u>1986</u> | <u>1985</u> |
|---|-----------------|-----------------|
| Income | | |
| Dues and subscriptions | \$11,450 | \$ 9,714 |
| Reprints and miscellaneous | 12,179 | 20,504 |
| Sales of Memoirs | 74 | 47 |
| Interest | 5,013 | 5,708 |
| Dividends | 485 | 463 |
| Increase in value of capital stock: American Telephone & Telegraph Com- pany and Pacific Telesis Group | <u>2,477</u> | <u>402</u> |
| | <u>\$31,678</u> | <u>\$36,838</u> |
| Expenditures | | |
| Publication costs—Pan-Pacific Entomologist | \$18,343 | \$25,165 |
| Reprints, postage and miscellaneous | 1,087 | 514 |
| IBM Personal Computer | | <u>2,400</u> |
| | <u>\$19,430</u> | <u>\$28,079</u> |
| Increase (Decrease) in fund balances | \$12,248 | \$ 8,759 |
| Fund balances October 1, 1985 and 1984 | <u>87,230</u> | <u>78,471</u> |
| Fund balances September 30, 1986 and 1985 | <u>\$99,478</u> | <u>\$87,230</u> |

STATEMENT OF ASSETS

September 30, 1986 and 1985

| | <u>1986</u> | <u>1985</u> |
|---|-----------------|-----------------|
| Cash in bank | | |
| Commercial account | \$ 9,258 | \$ 3,941 |
| Savings accounts & Certificates of Deposit | | |
| General Fund | 18,863 | 17,832 |
| Charles P. Alexander Fund | 36,264 | 34,282 |
| Fall Memoir Fund | <u>26,359</u> | <u>24,918</u> |
| Total cash in bank | <u>\$90,744</u> | <u>\$80,973</u> |
| Investment in 80 shares of American Telephone & Telegraph Co. common stock and 132 shares of Pacific Telesis Group at market value. | <u>\$ 8,734</u> | <u>\$ 6,257</u> |
| | <u>\$99,478</u> | <u>\$87,230</u> |

See accompanying notes to the financial statements on following page.

PACIFIC COAST ENTOMOLOGICAL SOCIETY
NOTES TO THE FINANCIAL STATEMENTS

Year Ended September 30, 1986

Summary of Significant Accounting Policies

Accounting Method: Income and expenses are recorded by using the cash basis of accounting. *Capital Expenditures:* Annual capital expenditures of \$5,000 or less are charged to expense. *Marketable Securities:* American Telephone & Telegraph Co. and Pacific Telesis Group common stock are 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. *Undeposited Receipts*—\$525. *Accounts Receivable*—\$3,322. *Accounts Payable*—\$7,042.

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

Corrigenda

We regret that figures 1–9 in C. Dennis Hyne's article, "New Species of the Genus *Stringomyia* from the South Pacific and Southeast Asia (Diptera, Tipulidae)," Vol. 63/1 (January 1987), were omitted. The omitted figures appear below.



Figures 1–9. 1. *Stringomyia bidentata* n. sp. 2. *S. bidens* n. sp. 3. *S. digitostylus* n. sp. 4. *S. rostrastylus* n. sp. 5. *S. vietnamensis* n. sp. 6. *S. labuanae* n. sp. 7. *S. ysabellae* n. sp. 8. *S. dilinhi* n. sp. 9. *S. idioformosa* n. sp. (b = basistyle, t = ninth tergite, s = ninth sternite, od = outer dististyle, id = inner dististyle, il = inner lobe of inner dististyle, ol = outer lobe of inner dististyle, p = phallosome).

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**The Male Mating Strategy of the Bee *Nomia nevadensis*
(Hymenoptera: Halictidae):
Leg Structure and Mate Guarding**

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Abstract.—Males of the bee *Nomia nevadensis bakeri* Cockerell congregate in large numbers within the previous generation's nesting area and mate with emerging virgin females. Competition among males, much of which occurs below ground before the female emerges, and the fact that females are receptive to only one male upon emergence (confirmed experimentally) favors males that: a) search for evidence (possibly odor) that a female is about to emerge at a specific location; b) rendezvous with a female before she emerges from the ground; and c) upon finding a female, use behavioral and morphological means to prevent takeover by other males. Evidence is presented that males use flattened expansions of their hind tibia to grip females firmly. The activities of males in the emergence area makes them conspicuous targets for predation by robberflies (Asilidae).

Females of many species of solitary ground-nesting bees and wasps nest in dense aggregations. Thus, adult virgin females emerging the following generation may provide mate-searching males with a clumped source of receptive females. If these females mate only once, or several times over long periods in their lives, there is a selective advantage to traits that aid males to find mates as close as possible to the time at which the females become receptive (Thornhill and Alcock, 1983). It may even be beneficial for males to attempt to reach a female before she emerges from the ground (e.g., Alcock *et al.*, 1976; O'Neill and Evans, 1983; Schöne and Tengö, 1981). However, in many situations, the high density of conspecific males makes it difficult, even for those finding females early, to complete copulation without interference from competitors. A variety of mechanisms have evolved to minimize such interference including removing females from the vicinity of competitors or guarding the female in a manner that prevents takeovers. In some insects, guarding ability is enhanced by the presence of morphological structures that help the male secure a hold upon the female (Thornhill and Alcock, 1983).

This paper reports on a study of the mating strategy of males of the bee *Nomia nevadensis bakeri* Cockerell. Females of this and other species of *Nomia* construct multicellular nests in extremely dense aggregations (Cross and Bohart, 1960; Kerfoot, 1964; Johansen *et al.*, 1978), such that large numbers of males and females emerge the following year within a restricted area. We studied a dense natural aggregation of *N. nevadensis bakeri* in the summers of 1984 and 1985. Here we present information on the mating strategy of males, the behavioral and

morphological adaptations that may help them avoid interference from competing males, and the predation risk undertaken by mate-searching males. We also conducted experiments to determine whether females are receptive to more than one male upon emergence.

MATERIALS AND METHODS

Nomia nevadensis bakeri was studied on five days between 28 July and 11 August, 1984 and on five days between 24 July and 2 August, 1985. The study site was located beside a dirt road approximately 9 km northeast of Roggen, Weld County, Colorado, U.S.A. The soil in the emergence area was sandy, with a surface crust about 0.5 to 1.0 cm thick. The area from which female bees emerged measured approximately 2×10 m in 1984 and 2×5 m in 1985, and contained sparse vegetation, primarily sunflowers (*Helianthus sp.*) and scurfpea (*Psoralea lanceolata* Pursh).

This aggregation was observed for a total of 24.3 hours over the ten days of study. Focal observations were made on interactions of males with females and conspecific males at emergence holes. Occurrences of all observed matings and predations upon males were recorded and mating pairs were collected and preserved in order to determine the size of mating males and emerging females. An estimate of the body size distribution of males in the population was made from three sweep net samples taken in the emergence area on two days in 1984. Head widths of both males and females were determined to the nearest 0.1 mm with a VWR Scientific Products micrometer accurate to 0.05 mm. In 1985, 53 males were marked on the thorax with dots of enamel paint to facilitate later identification.

We preserved mating pairs in natural positions so that they could be returned to the laboratory to examine the posturing and positioning of the males' legs. In the field, pairs were immersed and stored in liquid nitrogen (boiling point: -195.8°C); they were examined under a dissecting microscope immediately upon removal from the liquid. This technique was possible because, once a male grasped a female, we could usually transfer them to the liquid nitrogen without causing them to separate. Liquid nitrogen is commonly used for rapid freezing of biological specimens (Dawes, 1979).

We conducted an experiment to determine if females were receptive to the mating attempts of more than one male upon emergence. For each manipulation, we recorded whether the female mated with the male to which she was presented. In one experimental group (29 females), each was allowed to complete copulation with the male that had found her upon emergence. Following this, each female was presented to a second male. To determine if manipulating females in this way affected their receptivity, each of 15 females in a control group was separated, prior to copulation, from the male that was mounted upon her as she emerged; each was then presented to a second male. As a second experimental group, 12 of the females from the control group were presented to a third male after the second interaction was complete. The protocol for this experiment is outlined in Table 1.

RESULTS

Searching and Mating Behavior. Males were active in the emergence area from about 900 to 1300 hours when soil surface temperatures ranged between about 25° and 45°C . At the peak of activity, hundreds of males swarmed over the emergence

Table 1. Experimental protocol and results of mating experiments. Females used in #3 were those used originally in #2.

| Protocol | Female Response to Manipulation | |
|---|---------------------------------|------------------|
| | Female Refused to Mate | Female Copulated |
| 1) Copulation completed; female then paired with another male. | 29 | 0 |
| 2) First copulation interrupted before coupling; female then paired with second male. | 0 | 15 |
| 3) Mated female from #2 paired with third male. | 12 | 0 |

area within 10 cm of the surface. Each male flew in an irregular pattern, occasionally landing to investigate holes, 0.5 to 1.0 cm in diameter, in the surface of the sand. The lack of a tumulus or depression around these holes indicates that they were emergence holes, rather than active nest entrances (Kerfoot, 1964). No nesting females were seen in the area during the course of the study. After landing near a hole, a male usually stood facing the entrance or entered it to remain underground for from several seconds to over a minute. As many as four males were observed within in a single hole at a given time with others standing near the entrance, facing the hole, when a female was about to emerge.

Initial pairing of males and females always occurred below the surface within the tunnels before the female had emerged from the ground. Each female emerged from a hole with a male mounted upon her, although they had not coupled genitalia at this time. During the study, we saw males digging at the surface only three times. Apparently, waiting males entered holes after the female broke through to the surface. However, this is an inference, since we never observed the exact moment when the emergence hole was opened. Usually within 60 seconds of emerging with the female, if other males were not in contact with the pair, the mounted male moved back along the female's body, probed with his genitalia, and coupled. After coupling genitalia, the male's abdomen began to pulsate rhythmically and he often released the female from his leg grasp. During this entire period, a receptive female remained quiescent and did not attempt to break free from the male. This copulatory phase lasted from 4 to 43 seconds (mean = 19.2; SD = 8.8; N = 42). The male then broke genitalic contact and left or, more often (90% of 42 cases), moved forward on the female's body to his original position and remained for 2 to 72 seconds (mean = 22.2; SD = 16.8; N = 38). Following this post-copulatory phase, the male broke contact and the female immediately flew away from the emergence area. Males often reentered the swarm following copulation. On one day in 1985, six males that mated were marked after they had copulated. Five of these males were resighted in the swarm within 5 to 29 minutes. Males were also observed within the emergence area up to seven days after they were marked.

All mating pairs were collected within several cm of an emergence hole. Males were never observed flying and carrying a female away from the emergence area. A total of 271 mating pairs were seen during the course of the study. Most of the matings ($N = 246$; mean = 18.1/hour of observation) were observed in the first year of the study. During the second year, activity was much lower probably due to heavy rains before and during the seasonal period of activity, and only 25 matings were observed (mean = 2.3/hour of observation).

Emerging females released a strong, "sweet" odor. If a female (mated or unmated) was held in a pair of forceps or within the end of an insect net 5 to 10 cm above the surface of the ground within several minutes of her emergence, males always approached upwind in a rapid zig-zag flight and landed upon her, often causing a struggle among males for the female. This procedure never failed to attract males to recently emerged females (alive or dead; $N = 66$) or to males that had recently been in contact with a live female. The entire sequence of copulation could be initiated in this way if the female was a virgin (see next section).

On five occasions we observed males investigating (i.e. walking in tight circles and antennating the soil surface) localized areas (several cm^2), but not in the vicinity of a hole. All five times we scraped away the surface soil, once to a depth of 5 cm, and discovered a female who was releasing the strong scent. Apparently, males, possibly by orienting to the "sweet" odor, can detect females that have not yet reached the surface. By doing so, they could wait for the females at the exact point of emergence. The presence of the surface crust may act to delay the female just below the surface and increase the chance that she will be discovered by a male.

Female Receptivity in the Emergence Area. We were able to demonstrate that females will mate with only one male between the time that they emerge and the time they leave the emergence area. Females that had already copulated always refused to mate with other males (Table 1, #1 & #3), although the latter made vigorous mating attempts. On the other hand, females that were separated before copulation from the first male mounted upon them were always receptive (Table 1, #2). The latter data indicate that our technique was not responsible for non-receptivity of the females used in the above experiments.

When a female was not receptive to mating attempts she had means of preventing copulation, even though the male often had a secure hold upon her. The form of these interactions, which sometimes lasted longer than 5 minutes, was distinctly different from those that resulted in successful copulation. To refuse a mating attempt, a female curled her abdomen forward until her genitalic region nearly touched her head. This prevented the male from making genitalic contact. She also attempted to pry herself loose from the male by pushing backwards and upwards at him with her hind legs and by beating her wings if they were free. Typically, she walked forward during these attempts. None of these behaviors were seen in interactions that resulted in successful copulation. Eventually, unreceptive females were able to break free and leave the emergence area without further interference from males. Outside of our experiments, we observed one instance of a female refusing to mate with a male in the emergence area.

Interactions among Males. There is potential for competition among males both below and above ground. We have noted that a number of males may enter an emergence hole. By peering into the emergence holes, we often observed what were apparently intense struggles for females, though we were unable to record the

duration of such interactions or determine whether they involved interference or scramble competition.

Above ground, after the female emerged with a male mounted upon her back, one to four males were frequently in contact with the pair during the pre-copulatory phase, struggling to gain access to the female. The males were mounted either dorsally on the first male's back or ventrally beneath the female. Generally, the posture and behavior, particularly of the dorsally mounted males, was similar to that of a male mounted upon a female. Some of these interactions may simply have been mistaken attempts by males to mount females. The pervasive odor of the female could have been responsible for a failure of males to discriminate between the sexes. We also observed twelve cases of isolated "homosexual" pairs (i.e. males mounted upon other males). Odor has been implicated as the trigger for inappropriate sexual mounts in other insect species in both natural (Tomkins *et al.*, 1980; Tengö, 1979) and experimental (Shimron and Hefetz, 1985) situations.

We detected no size-biased mating success among males. Males sampled from copulating pairs (mean head width = 3.01 mm; S.D. = 0.07; N = 89) were not significantly different in size from males in sweep net samples taken in the emergence area (mean = 3.01 mm; S.D. = 0.08; N = 252; t-test, $t_{339} = 0$). On the other hand, females taken in the emergence area (mean = 3.19; S.D. = 0.09; N = 66) were not only significantly larger than copulating males on average (t-test, $t_{153} = 14.2$; $p < 0.001$), but in each mating pair were either larger than (95%) or equal to (5%) the male in size (N = 43). There were no females present among the 252 bees taken in the sweep samples, giving further confirmation that they do not remain in the emergence area after mating (although they must return later to nest).

Morphological Modifications for Mate Guarding. The structure and exact placement of the hind legs may combine to prevent the mounted male from being supplanted by others during the pre-copulatory phase. The male's head was just behind that of the female's, with his front and middle legs usually held over her wings, preventing them from moving. His hind legs were wrapped around her abdomen just posterior to her petiole, usually between the first and second gastral segments. Above ground at least, males were never supplanted by others, when positioned in this manner. In addition, when an unreceptive female was presented to a male, it was difficult for her to break free, although the male could not induce her to mate. In hundreds of observed interactions, a pair was disrupted during the post-copulatory phase only twice, and during the pre-copulatory phase only once. In the latter case, the male did not have his legs properly situated under the female's abdomen; she mated with the usurping male.

By immersing pairs that were in the pre-copulatory position into a Dewar flask containing liquid nitrogen, we were able to return five pairs from the field intact, for closer examination. Only the right side of each pair was examined, since manipulation caused the pair to separate slightly.

A structure on the males' hindlegs that may help them grasp a female was evident: the tibia is expanded distally to form a pair of flattened triangular flanges (Fig. 1) that lie flat against the female's abdomen, pointing anteriorly, when a male has his legs wrapped around a female. The positioning of the flanges on the males' tibiae suggests that they locked onto the female by sliding the larger one beneath the posterior edge of a sclerite beneath her abdomen (Fig. 2). On one female the larger flange was almost completely inserted beneath the ventral posterior edge of gastral tergum I

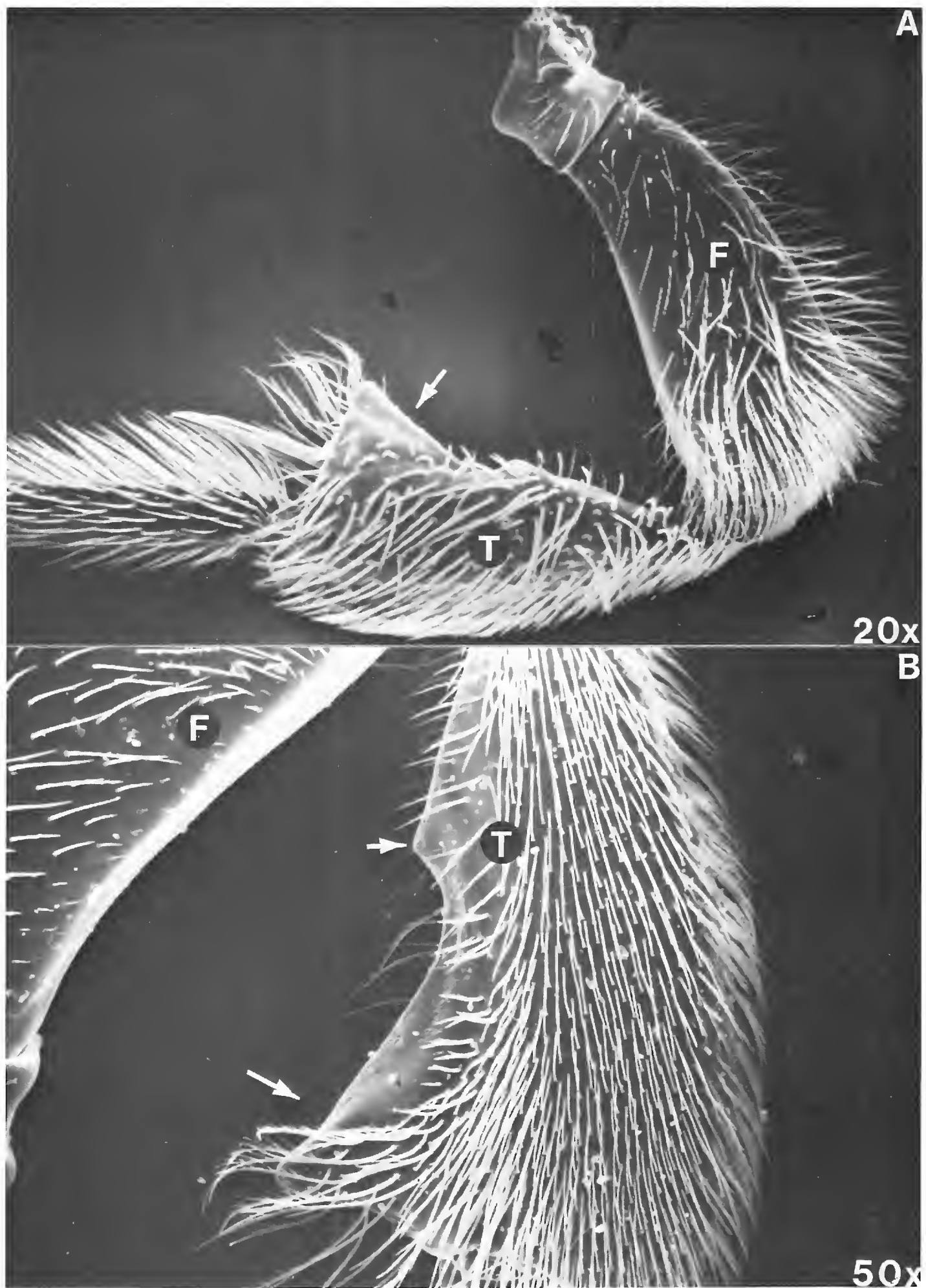


Figure 1. A) Scanning electron micrograph of the left hindleg of male of *N. nevadensis bakeri*, (20X; side of tibia shown is that which lies against the female when the male is mounted in the pre-copulatory posture); B) Close-up view (50X) of right hind tibia (opposite aspect from A) of male showing expansions (arrows); F = femur; T = tibia.

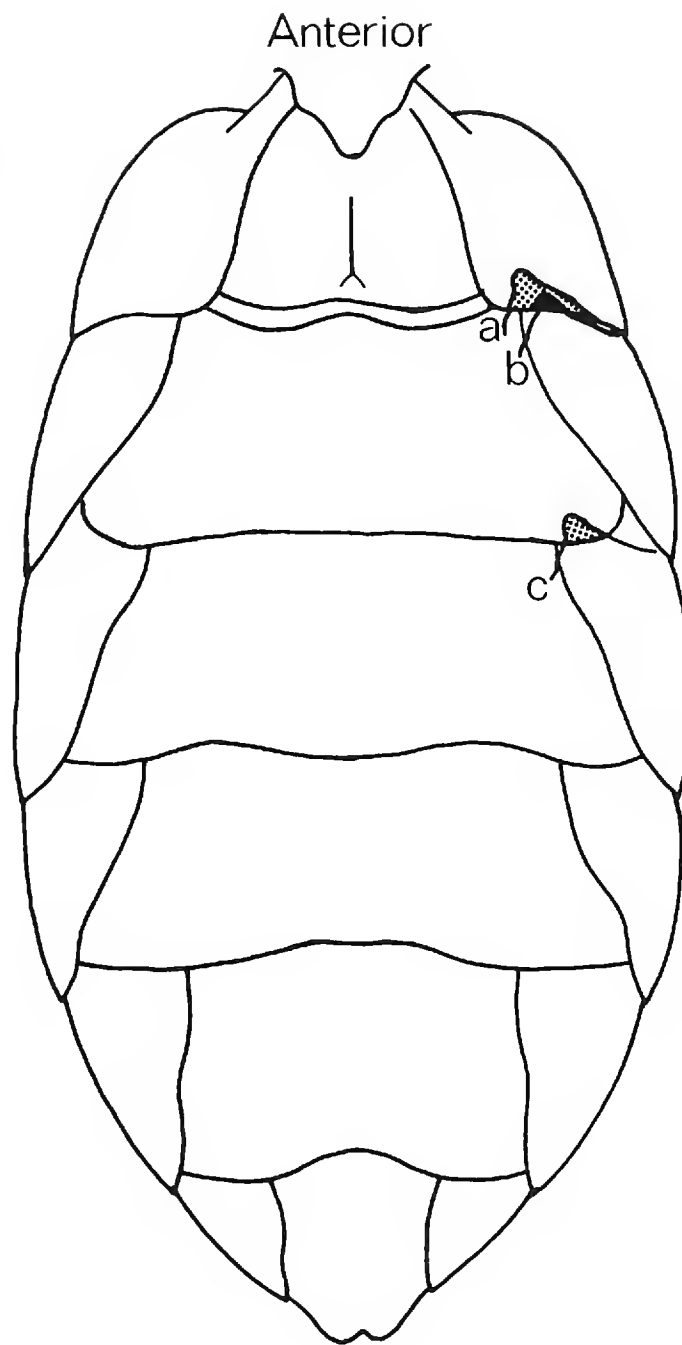


Figure 2. Schematic representation of the venter of the abdomen of a female *N. nevadensis bakeri*, showing where the large flange of the male hind tibia was positioned on five pairs examined. One each found in position (a) and (c) (stippled area denotes portion inserted under female's sclerite); three found in position (b) (black area denotes portion inserted).

where the latter curls beneath the abdomen (Fig. 2,a). The tip of the flange was so inserted when examined on three others (Fig. 2,b), although it may have pulled out slightly in the process of the examination. On the fifth female, approximately half of the flange was inserted beneath the posterior edge of sternum II (Fig. 2,c). The tarsal segments of the males' legs were lying back along the medial line of the female's venter.

Predation upon Males. Males were sometimes preyed upon by robberflies of the species *Diogmites angustipennis* Loew. These flies, which reach up to 22 mm in length (Lavigne and Holland, 1969), were apparently attracted by the conspicuous movements of male bees flying about the emergence area. Twenty-three successful

predations were observed, the majority (21) of which occurred on the one day in which the flies were most abundant.

DISCUSSION

Females of *Nomia nevadensis bakeri* in this population were receptive upon emergence, mated with only one male while in the emergence area, were apparently detectable prior to emergence, possibly because of the odor they emit, and emerged within an area containing many conspecific males. It is also probable that some degree of protandry occurs in this population, as it does in other species of *Nomia* (Kerfoot, 1964; Cross and Bohart, 1960; Johansen *et al.*, 1978). The combination of these factors creates a competitive situation favoring males that reach and mate with an *emerging* female before conspecific males do. To accomplish this, males in this population: 1) search for evidence of females about to emerge, 2) attempt to rendezvous with females before they emerge from the ground, and 3) upon finding a female, use behavioral and morphological means to prevent other males from usurping their position. Males were rarely seen digging where a female was about to emerge. This contrasts with other species of Hymenoptera with similar mating systems (e.g., Alcock *et al.*, 1976; O'Neill and Evans, 1983; Schöne and Tengö, 1981), where males invest much time and energy digging for pre-emergent females.

Male insects competing for females within a crowded emergence area use a variety of means to prevent interference from conspecific males (Thornhill and Alcock, 1983). Males of some species of bees and wasps avoid takeover by competitors by carrying the female away in flight from the emergence area before mating with her (Alcock *et al.*, 1976; O'Neill and Evans, 1983). However, it would have been difficult for males of *N. nevadensis* in this population to do this, since they were never larger than the female and would probably have had difficulty carrying her in flight. The male is usually larger than the female in insects in which the male carries the female during courtship or mating (O'Neill, 1985). In contrast to other species of Hymenoptera in which larger size has been shown to aid males in their attempts to obtain matings (e.g., Alcock *et al.*, 1976; O'Neill, 1983a,b; O'Neill and Evans, 1983; Severinghaus *et al.*, 1981), no such effect was detected in our analysis. Males of *N. nevadensis* show much less range in size than species of digger wasps (O'Neill, 1985) and bees (Alcock, *et al.*, 1976) for which a size advantage among competing conspecifics has been shown, although the reason for this is unclear. We can speculate on one factor selecting *against* large size in this species: males that are too large may be unable to maneuver for position on a female within an emergence hole. However, this hypothesis would be difficult to test.

Rather than leave the emergence area with the female, males of *N. nevadensis* remained. Those males grasping females with the aid of modified leg structures were highly successful at maintaining contact with a female and completing copulation. It could also be hypothesized that these leg structures function to subdue the female so that mating can take place, much as male scorpionflies use their notal organ to force copulation upon females (Thornhill, 1980). However, this seems unlikely for several reasons. First, virgin females were generally quiescent during mating attempts, so need not have been subdued. Second, as demonstrated in the mating experiments, previously mated females were capable of refusing to copulate and could break free from the males. Therefore, it seems more likely that the behavior and leg structure of

males have evolved as traits that prevent interference from conspecific males, thus assuring sole access to a receptive female.

Males of a variety of insect species utilize leg modifications to maintain a grip upon females during courtship and mating. Males of other species of the subgenus to which *N. nevadensis* belongs (*Epinomia*) also have flattened expansions of their hind tibia (Cross, 1958). Males of some species of the subgenus *Acunomia* possess even larger expansions of the hind tibia that are not flattened like they are in *N. nevadensis* and are sometimes larger than the main part of the tibia itself (Ribble, 1965); this indicates that these tibial modifications may be utilized in a slightly different manner than they are in *N. nevadensis*, if indeed they are used at all during courtship and mating in these other species. The hind femora are also enlarged in some species of *Nomia*. We have not been able to find reference to the potential use of these leg structures in other species of *Nomia*. Males of the melittid bee *Meganomia binghami* Cockerell use enlargements of the hindlegs to assist in maintaining a grip upon females in the presence of up to ten conspecific males (Rozen, 1977; Stage, 1971). Male bees of some species of the genus *Agapostemon* (Halictidae) have similar modifications of the hindlegs, although their function is unknown (Roberts, 1969, 1972). The unmodified structure of the legs of males of most species of bees contrasts markedly with that of males of *Nomia*, *Agapostemon*, and *Meganomia* and with females of most non-parasitic species (Stephen *et al.*, 1969). Given the morphological specialization associated with foraging evident in the hind legs of female bees (e.g., Roberts and Vallespir, 1978), leg structure in bees appears to have maintained a high degree of evolutionary plasticity.

Some species of beetles (Crowson, 1981) and flies (Spieth, 1952) also have leg structures that provide a firm grasp upon mates. For example, in the fly *Sepsis cynipsea* (L.), the front legs of a male are structured so that they act as a clamp around the female's wing bases. In this species, mating occurs at cattle droppings where up to 500 males may be present (Parker, 1972). Males of a variety of insects possess modifications of wings, genitalia, jaws, and antennae that are used to grip females (Thornhill and Alcock, 1983; Rothschild and Hinton, 1968).

Along with our observations on *Nomia*, the comparative information suggests that sexual selection has promoted the independent evolution of a variety of morphological structures that enhance the mating success of individual males through an ability to grasp females securely in the presence of competitors. The ability to manipulate interactions among male and female *Nomia* and, potentially, the leg structure of males, may provide a good system for experimental and comparative studies of the function and efficiency of mate guarding. Our brief study also leaves open questions concerning the below ground competition for females, the function of the male's remaining with the female for a short time after insemination, and cues used by males to locate pre-emergent females.

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**Phenology of Douglas-Fir Tussock Moth, *Orgyia pseudotsugata*, Egg
Eclosion and Mortality in a Thinned and Unthinned Stand
(Lepidoptera: Lymantriidae)**

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Abstract.—Heat-unit accumulation and egg eclosion were monitored in unthinned and thinned white fir stands in southern Oregon. Degree-day accumulation and egg eclosion on the unthinned site were 7 to 10 days behind development in the thinned site. Parasitism and predation were higher on egg masses in the thinned stand.

The ability to predict phenological development of insect-host systems has important applications for pest management as well as for research on population biology. Studies on phenology of the Douglas-fir tussock moth, *Orgyia pseudotsugata* (McDunnough), in California and Oregon (Wickman 1976a, 1976b, 1981) show egg eclosion is synchronous with host budburst. During population sampling for early instars, we observed a spread in developmental stages from 1st to 3rd instars on some sites. Phenological data suggest that egg eclosion on a given site is related to the amount of solar radiation reaching an egg mass; eclosion usually occurs first in the exposed tops of large trees and last in shaded areas under full forest canopy (Wickman 1976b).

In the past, we compared tussock moth egg masses only from exposed trees but at different elevations (Wickman 1976a, 1976b, 1981). Egg eclosion was assumed to be early on exposed trees, and later in shaded habitats. In this study, our object was to compare tussock moth eclosion and egg mortality in two different environments at the same elevation—a thinned (exposed) and an adjacent unthinned (shaded) stand.

The study was limited by available sites, egg masses, and instrumentation. These preliminary data are reported to encourage more definitive studies on the effects of silvicultural prescriptions on insect phenology and mortality.

METHODS

The study site was near Mare's Egg Spring, 10 km southwest of Fort Klamath, in south-central Oregon. The site, with an eastern exposure, is at 1350 m elevation and on a level bench about 100 m above the upper Klamath basin. The site was partly on a population-study plot used for phenological monitoring of tussock moth from 1976–80 (Wickman 1981).

One exposed and one shaded habitat were compared. The exposed habitat was in a thinned stand of second-growth white fir (*Abies concolor* (Gordon and Glend.) Lindley ex Hildebr.) with widely spaced saplings and pole-sized trees and a few overstory ponderosa pine (*Pinus ponderosa* Douglas ex Lawson). The shaded habitat, about 100 m to the east, was a dense, unthinned, second-growth white fir stand of pole-sized trees with a closed canopy.

Temperature was recorded in the thinned stand by a 31-day battery-powered, weather-sheltered hygrothermograph from November 1976 to November 1977. From these records, Fahrenheit degree-day ($^{\circ}\text{D}$) accumulations were calculated for the exposed environment. The heat-unit threshold for development selected was 5.6°C (42°F) (Wickman 1976a). When budburst began on May 31 in the area, a weather-sheltered, 7-day hygrothermograph was installed in the unthinned stand; monitoring continued until July 5. The $^{\circ}\text{D}$ accumulations for the two stands were compared from June 1 to July 5.

Because natural populations of Douglas-fir tussock moth in the area were low and egg masses difficult to find, we used egg masses reared in the laboratory from larvae collected locally in June 1976. The egg-mass stock, which was also used for other population studies (Torgersen and Ryan 1981), showed normal fecundity and development. The egg masses ranged from 100 to 250 eggs ($\bar{x} = 150$).

To acclimate the egg masses, they were randomly divided into two batches, placed in fine-mesh nylon bags, and hung in both stands on February 9. On April 5, egg masses were individually wired to branches (Torgersen and Mason 1979). One egg mass was wired at about 2 m from the ground at the four cardinal directions on four trees, for a total of 16 egg masses in each stand. In the thinned stand, the masses were wired to the underside of live, lower crown foliage. Because not much foliage was present at 2 m in the unthinned stand, the masses were placed on small, foliated adventitious branches on the main trunk at that height. Egg masses occur naturally in such locations, as well as on large foliated branches. A 30- \times 60-cm fine-mesh nylon bag was placed over each stocked branch to prevent predation, although the mesh did not keep out parasites. Bags were left in place until June 6. Masses were checked every 2 days from June 6–12, and then daily through July 5. Each morning, egg eclosion was recorded and new larvae counted and removed. On July 5, the egg masses were removed for further rearing in the laboratory at 20°C . Each egg mass was dissected when eclosion was complete and parasites ceased to emerge. Emerging adult parasites were counted daily, and egg numbers were recorded. Unbroken eggs from which neither tussock moth larvae nor parasites emerged were recorded as “unknown mortality” (Torgersen and Mason 1979).

RESULTS AND DISCUSSION

A steady divergence of $^{\circ}\text{D}$ accumulation is evident between the thinned and unthinned stands (Fig. 1). On June 20 when eclosion began in the thinned stand, $^{\circ}\text{D}$ reached 432 (from June 1), and 282 $^{\circ}\text{D}$ had accumulated in the unthinned stand—a difference of 150 $^{\circ}\text{D}$. By July 5, thermal development on the two sites had diverged by 285 $^{\circ}\text{D}$. These $^{\circ}\text{D}$ differences between thinned and unthinned stands at the same elevation were greater than those found between two exposed sites with a 100 m difference in elevation (Wickman 1981). Hopkins' (1918) “bioclimatic law” states that natural development is delayed 4 days for each 400 ft (122 m) rise in elevation at a given latitude. Thus, local variation in $^{\circ}\text{D}$ development resulting from thinning may surpass elevational differences of as much as 100 m.

The mean $^{\circ}\text{D}$ accumulation in the unthinned stand from June 1 to 20 was 14 $^{\circ}\text{D}/\text{day}$. Therefore, $^{\circ}\text{D}$ accumulation in the thinned stand was about 11 days ahead of the unthinned stand. Egg masses in the unthinned stand were exposed to predation for nearly 2 weeks longer than eggs in the thinned stand.

Egg eclosion differed on the two sites (Fig. 1), consistent with the previous finding

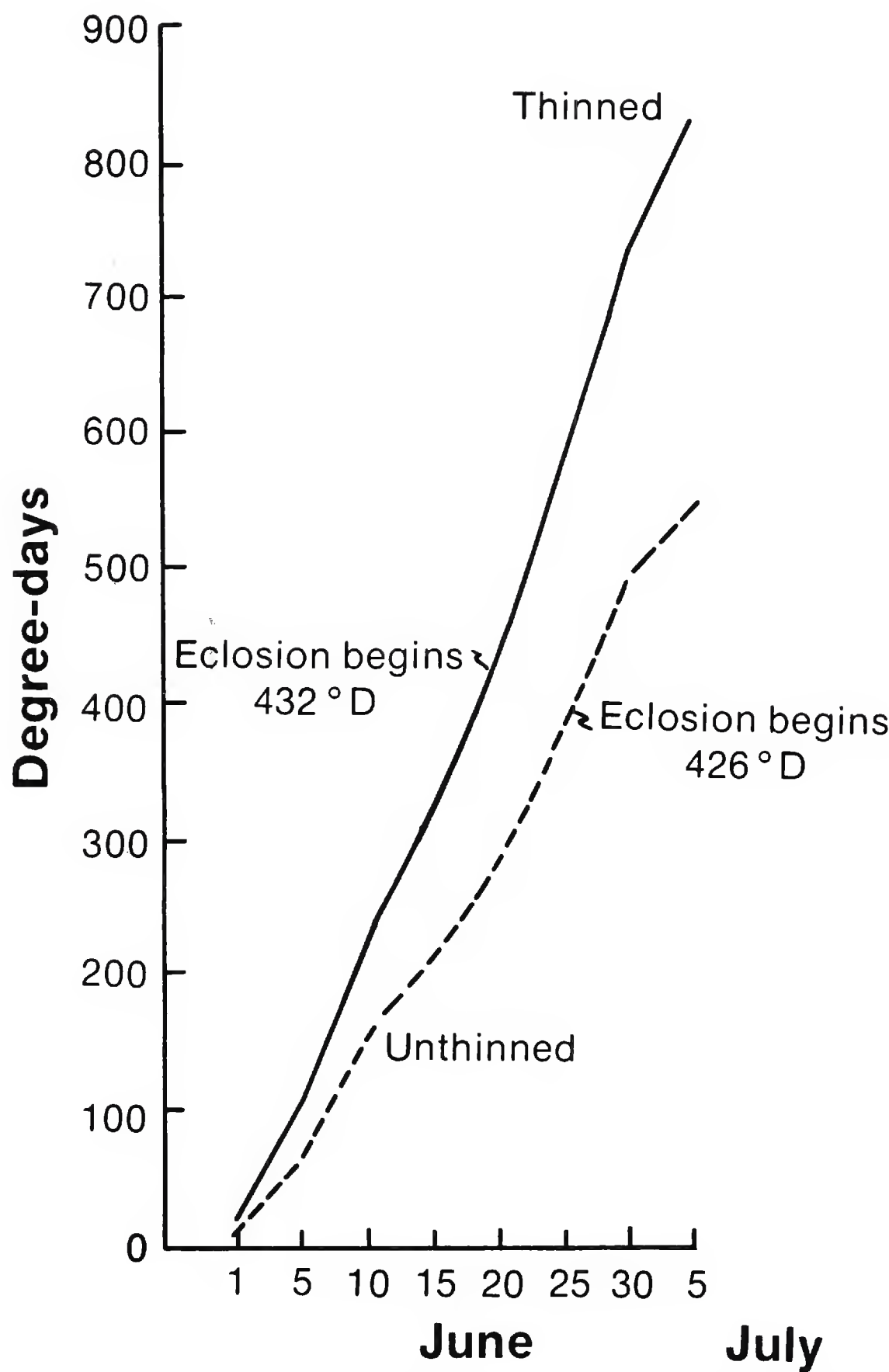


Figure 1. Accumulated degree-days in thinned and unthinned stands in south-central Oregon, 1977.

that hatch of tussock moth eggs is influenced by exposure to solar radiation (Wickman 1976a). Egg eclosion began on June 20 in the thinned stand and was 99 percent complete on July 5. Eclosion did not begin in the unthinned stand until June 27 and was only 61 percent complete on July 5. Eclosion from eggs in the unthinned stand continued for 10 days in the laboratory.

The mesh bags around the egg masses did not prevent heavy attack by the egg parasite *Telenomus californicus* Ashmead in the early spring. In another study,

Table 1. Douglas-fir tussock moth egg eclosion, *Telenomus californicus* emergence, and unknown mortality in a thinned and unthinned stand, south-central Oregon, 1977.

| | Eggs per mass | Douglas-fir tussock moth eclosion | <i>Telenomus californicus</i> emergence | Unknown mortality | Parasitism | Unknown mortality |
|-----------|---------------------|---|--|----------------------|------------|----------------------|
| | Number | | | Percent | | |
| Thinned | | | | | | |
| Total | | 298 | 943 | 392 | | |
| \bar{x} | 101.9 | | | | 61.9 | 15.9 |
| S.D. | 47.83 | | | | 22.06 | 22.16 |
| Unthinned | | | | | | |
| Total | | 781 | 1072 | 362 | | |
| \bar{x} | 138.4 | | | | 48.9 | 17.8 |
| S.D. | 52.75 | | | | 14.75 | 17.44 |

females of this tiny parasite were first observed on egg masses at nearby Mare’s Egg Spring plots on April 1, and parasite oviposition was essentially completed by April 20 (Torgersen and Ryan 1981).

In our study, egg masses were also heavily parasitized, averaging 61.9 percent in the thinned stand and 48.9 percent in the unthinned stand (Table 1). Parasites began to emerge from egg masses in the unthinned stand 6 °D later, lagging behind the thinned stand; emergence ceased on the same day in both stands, however (Fig. 2). Emergence of *T. californicus* can be roughly predicted from heat-unit accumulation. In the combined field and laboratory rearing, emergence was completed at 1,635 °D, accumulated from April 1 to July 24. This included 468 °D accumulated in the laboratory—26 °D daily for 18 days.

Higher parasitism in the thinned stand (Table 1) suggests either that the parasites do more searching in exposed tree crowns than in closed canopies or that some other environmental condition draws them there.

The egg masses were exposed to predators from June 6 to July 5. Torgersen and Mason (1979, 1985) found that birds and ants can partially destroy or completely remove egg masses, and about half the eggs can be lost from predation by birds alone. They also found significantly greater egg parasitism on xeric than on mesic plots in California, Oregon, and Idaho.

In our study, egg masses appeared to be about the same size when we placed them in the field. On July 5, masses from the thinned stand had one-third fewer eggs than those from the unthinned stand and looked broken and ragged, which is typical of predation.

A t-test showed that the differences in egg survival, after parasitism and apparent predation between thinned and unthinned stands, were significant ($p = < 0.05$). The difference between the two sites in unknown egg mortality was not significant, however. As expected, egg viability was similar ($p = > 0.05$) because the egg masses came from the same natural population.

Thinning increases the exposure of host trees to solar radiation and affects °D accumulation, which speeds tussock moth egg development and eclosion. Thus,

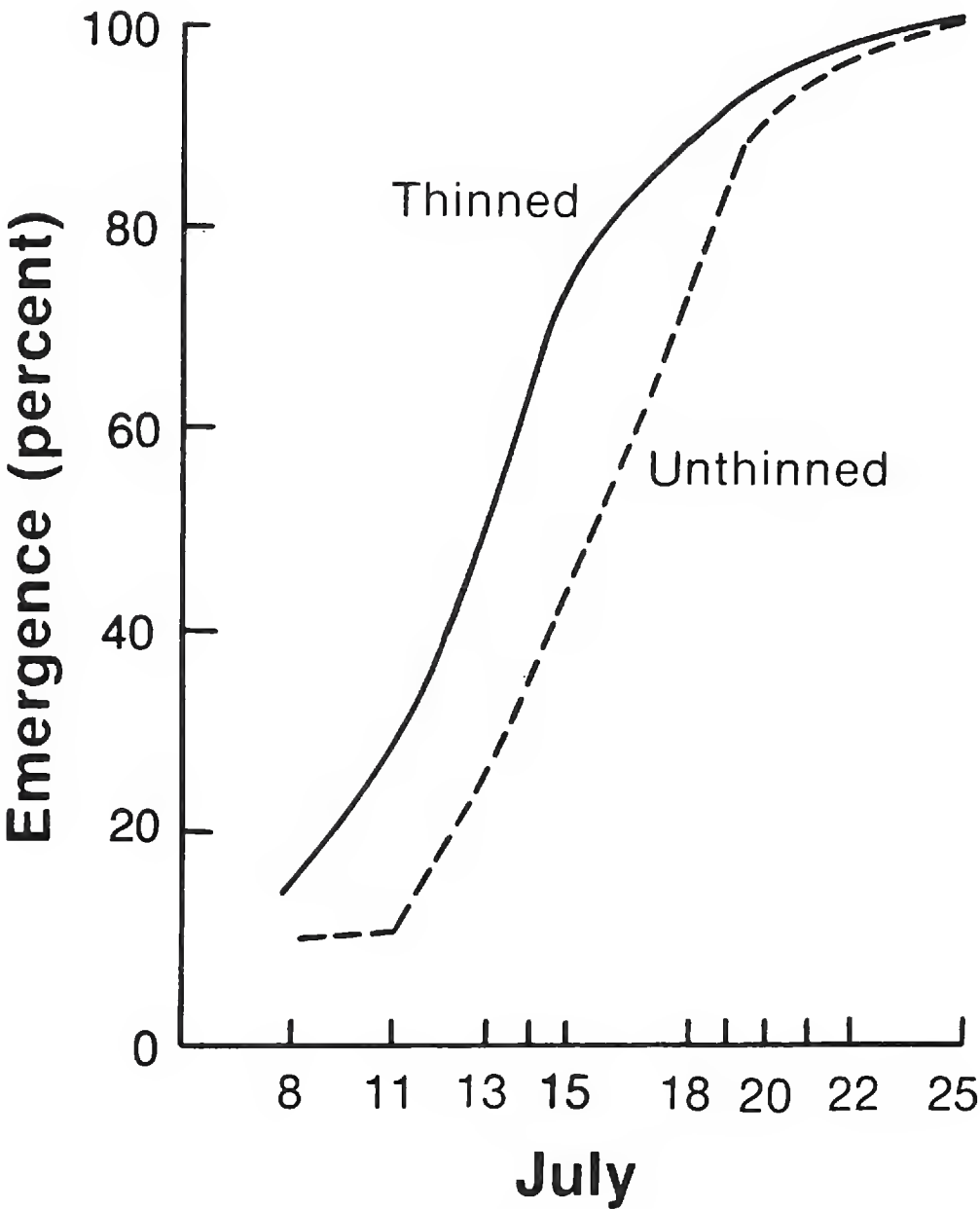


Figure 2. Accumulated percentage emergence of *Telenomus californicus*, from Douglas-fir tussock moth egg masses in thinned and unthinned stands in south-central Oregon, 1977.

some survival advantage could be gained by egg deposition in open stands, where eggs might be exposed to predation for 14 fewer days. Thinning also apparently enhances predation by birds and ants and parasitism by *T. californicus*. These limited data leave unclear whether the advantages of earlier egg eclosion and reduced length of exposure to predation can be offset by greater intensity of predation and higher parasitism. More study is needed to measure precisely the effects of thinning on the population dynamics of the tussock moth and other defoliating insects.

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A Morphometric Analysis of *Mordellistena* Costa in the Southwestern United States (Coleoptera: Mordellidae)

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Abstract.—Beetles of the genus *Mordellistena* Costa in the southwestern United States are submitted to a morphometric analysis in order to obtain more reliable taxonomic characters and to establish the foundations for construction of a phylogeny. Thirty external characters were chosen for measurement in a preliminary statistical analysis of four well-defined species groups. These results were submitted to a discriminant analysis which reduced the number of significant characters to 14. Over 500 specimens were then measured for these characters, and the results then submitted to a cluster analysis. The results of the analysis are discussed as to their taxonomic and classificatory possibilities. Accomplishments of the study include the generation of a list of the species of *Mordellistena* for Arizona, the discovery of several undescribed species, a more confident method of identification, and the foundation of a phylogeny for the genus. Shortcomings of the analysis were the failure to construct species specific groups and inability to group 100%.

Beetles of the genus *Mordellistena* Costa have long been a problem to taxonomists in that they are difficult to identify because the characters used to separate species are indecisive. Despite the extensive work of Liljeblad (1945), the use of leg ridges as the major identification characters has remained unsatisfactory. A morphometric analysis of the genus *Mordellistena* was undertaken in the hope of attaining 1) more reliable characters, 2) an easier and more confident taxonomy, and 3) the basis for a phylogeny.

Since Liljeblad's (1945) monograph on the entire family, little work has been done on New World Mordellidae. Ray (1944, 1946, and 1947) dealt with neotropical species and Khalaf (1970 and 1971) did some studies on wing venation of southeastern species. Recently, much work has been done in Europe and Asia on the Mordellidae, but there has been a complete lack of work on members of the Mordellidae of the southwestern United States. Liljeblad (1945) lists 22 species of *Mordellistena* from the southwest, the majority from California only. Individuals of the genus from the southwest (New Mexico, Arizona, southern California, and western Texas) are even more uniform than the mordellids in general, being relatively slender and largely of a unicolorous brown or black body color. Because of this uniformity and in consideration of the past difficulties with Mordellidae in general, it was thought that a morphometric analysis would prove especially useful in a study of the group. While the immediate goal of the study was the discovery of reliable taxonomic characters and the generation of a list of the species of *Mordellistena* present in Arizona, the long term goal is to use such an analysis for a complete revision of the North American *Mordellistena*.

MATERIALS AND METHODS

The University of Arizona insect collection contains over 1,500 specimens of *Mordellistena* from a variety of localities throughout the Southwest. Along with approximately 200 specimens borrowed from the Arizona State University collection, a large base was present for a morphometric analysis of the Southwestern species.

All of the approximately 1,700 specimens were first tagged with individual identification numbers. Next came the selection of morphologic characters to be measured. This was based primarily on which characters were consistently observable in the genus. This selection resulted in the choice of 30 external morphological characters which are listed in Table 1 and illustrated in Figures 1–4.

Following character selection, four groups of specimens, all identified to species through the use of Liljeblad's key (1945), all very distinct in appearance, and all represented by a large series from a single collection locality were selected. The four selected were: *M. scapularis* (Say), *M. nunenmacheri* Liljeblad, *M. sericans* Fall, and *M. tosta* LeConte. It was on these groups that the preliminary set of 32 characters was tested in order to determine their validity for taxonomic identification.

Measurements for the characters were accomplished using a Lasico Auto-Scaler device attached to the right ocular tube of a Wild M-5 stereomicroscope. Adjustments were made which allowed results to be recorded in millimeters in rapid fashion.

Following measurement of specimens in the four groups for the 30 characters, a discriminant analysis (SAS program) was run on the results. From these data were chosen only those morphological characters which separated all of the specimens back into their four original species groups. Only raw measurements were utilized in the study due to the problems associated with the use of ratios (Blacklith and Reyment, 1971). A series of 80 specimens were measured and 14 of the characters accomplished the desired separation. These 14 characters are listed in Table 2.

Next came the measurement of as many specimens as possible for the 14 characters with subsequent analysis of the results. In doing this, it was assumed that no additional character variation was present. This was necessary in order to establish some starting point for the cluster analysis. Thus the discriminant analysis was utilized in order to select only those characters useful in taxonomic separation. Prior to selection of specimens for measurement, all 1,700 *Mordellistena* were grouped according to locality. From each resulting locality group, a random selection of specimens, up to a maximum of 25, was made. For localities in which there were fewer than 25 examples, all members from that locality were measured. In this way, a total of 650 beetles were selected and then measured. Results of the measurements were then transposed to key-punch computer cards with one card per beetle. The identification number (i.e. label) of each insect and results of measurement of each character on that insect were thus present on cards and ready for analysis. This analysis was accomplished through the use of BMDP Computer Program P2M written by Lazlo Engelman (1979).

The BMDP P2M clustering program is written so that each case (beetle) is read and considered as a single cluster to begin with. By then comparing the results of each case for each variable (morphological character), the process of grouping is initiated with each case placed into ever-enlarging groups until ultimately all cases are united

Table 1.

| <i>Original 30 External Morphological Characters</i> |
|---|
| 1. length of ultimate abdominal sternite (a) |
| 2. length of antenna (b) |
| 3. combined length of 3rd and 4th antennal segments (c) |
| 4. length of 5th antennal segment (d) |
| 5. length of metatrochanter (e) |
| 6. length of metepisternum (f) |
| 7. eye height (g) |
| 8. eye length (g) |
| 9. ocular width (h) |
| 10. length of metafemora (i) |
| 11. length of large metatibial spur (j) |
| 12. length of small metatibial spur (k) |
| 13. height of mandible (l) |
| 14. width of mandible (l) |
| 15. length of metatarsal claw (m) |
| 16. length of head capsule (n) |
| 17. length of total body |
| 18. length of ultimate tergite (o) |
| 19. width of metasternum (p) |
| 20. width of pronotum (q) |
| 21. length of 1st metatibial ridge (r) |
| 22. length of 2nd metatibial ridge (r) |
| 23. length of 3rd metatibial ridge (if present) (r) |
| 24. width of clypeus (s) |
| 25. length of metatarsus (t) |
| 26. length of mesofermora (u) |
| 27. length of mesotibia (v) |
| 28. length of mesotarsus (w) |
| 29. length of ultimate segment of maxillary palp (x) |
| 30. width of ultimate segment of maxillary palp (x) |

in a single cluster. As might be expected, there are limits to the number of cases that can be analyzed in a program of this type, dependent on the number of variables utilized. Indeed, it was found that the needed computer capacity for 650 specimens and 14 characters exceeded the core memory of the University of Arizona CYBER. For this reason, a reduction in the number of cases was necessary. This was done through the elimination of cases from localities with larger groups in that all localities with 25 specimens were reduced to 20 until the total sample set numbered 400. This was the maximum number of cases that the computer was able to handle with 14 variables. In this way, the number of cases was reduced with no sacrifice of samples from localities with few representatives.

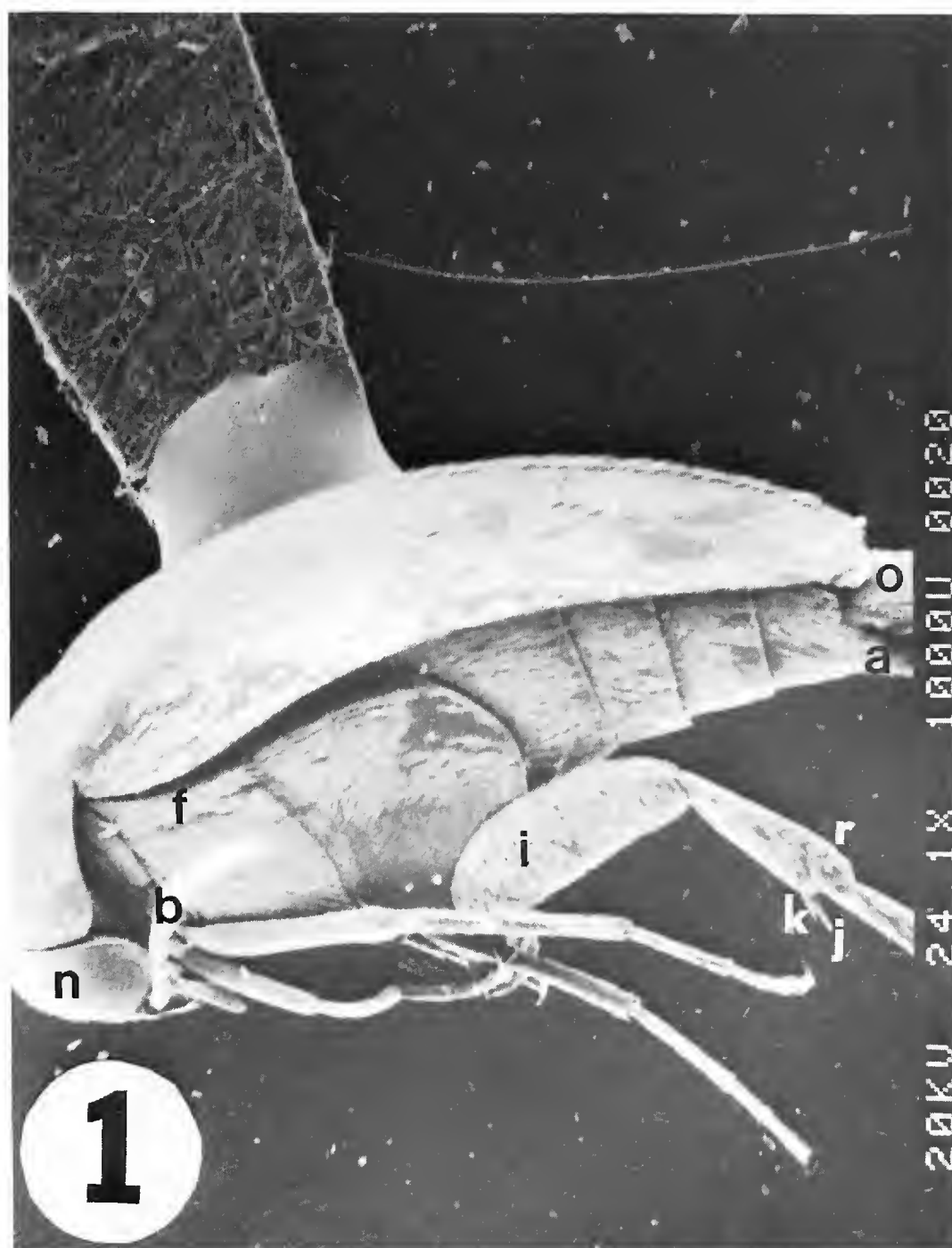


Figure 1. Scanning electron microscope photograph, lateral view of a specimen of the genus *Mordellistena*; see Table 1 for explanation of letters.

The results of the BMDP P2M program were given in several different graphical displays. These included 1) a vertical tree showing the sequence of cluster formation, 2) a table listing the amalgamation distance and the mean for each variable as each new cluster is formed, 3) a shaded distance matrix graphical display, 4) a listing of the data, 5) a matrix of the distances between all cases, and 6) a histogram of the distances. Of these the most useful for determination of relationships were found to be the vertical tree, the matrix of distances, and the shaded distance matrix.

The shaded distance matrix is made by the computer via the overprinting of characters beyond each specimen number (which run along the x-axis) with darker characters, or more overprinting, indicating closer relatives. By following the line out (along the horizontal) from any specimen number, it is possible to observe the extent of relationship of any specimen to any other. Through examination of the

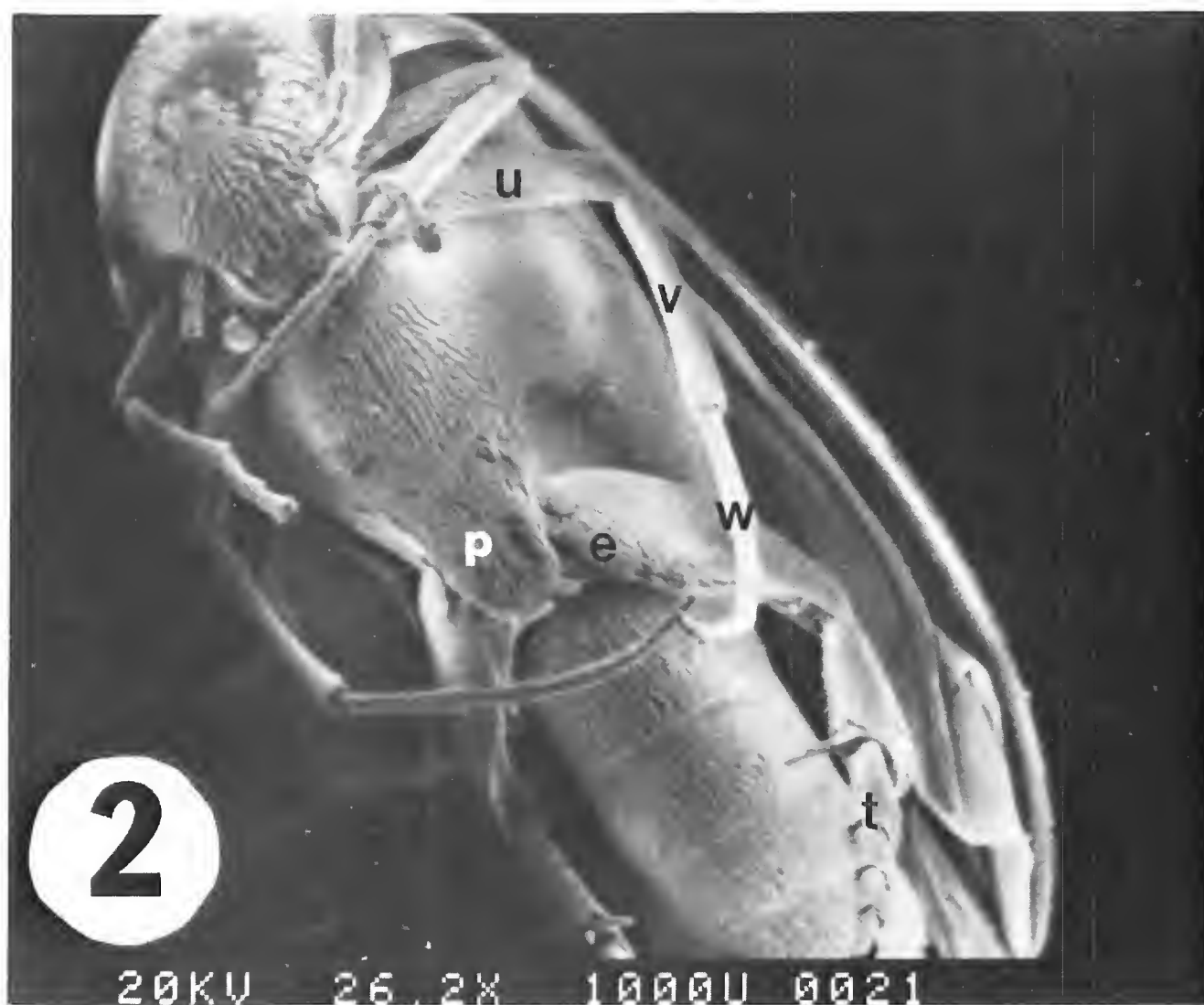


Figure 2. Scanning electron microscope photograph, ventral view; see Table 1 for explanation of letters.

shaded matrix for large, dark triangles, it is an easy matter to observe the location of groups and discern the members of these. Dark triangles of this type may be seen by referring to the sample shaded matrix in Figure 5.

The vertical tree is formed by the computer through the process of step-by-step clustering and reflects precisely this process. The 400 beetles are first arranged across the top of the display and at this point each case represents a separate cluster. Proceeding down the page, then, it is possible to follow a line from any specimen and determine at what point that beetle is grouped with another and when these two are joined with another and so on. Along the y-axis of this tree are listed the amalgamation distances so that it is possible to determine at what mathematical distance any cluster is formed. These amalgamation distances ranged from 0.00 to 10.734 and increased down the display in increments less than or equal to 0.500 with the exception of the final step, which went from 3.522 to 10.374. These numbers reflected the sum of squares of the variables measured. It was at the amalgamation distance of 10.374 that all 400 cases finally came to rest in a single cluster. The diagram was very useful in the rapid discovery of odd specimens that had few relatives. In these examples, odd specimens were seen to join the clustering process near the bottom of the page. A sample vertical tree diagram is illustrated in Figure 6.

Finally, there is the actual distances matrix. In this printout, any specimen may be compared to any other and thus the matrix of distances is simply a 400-by-400 chart

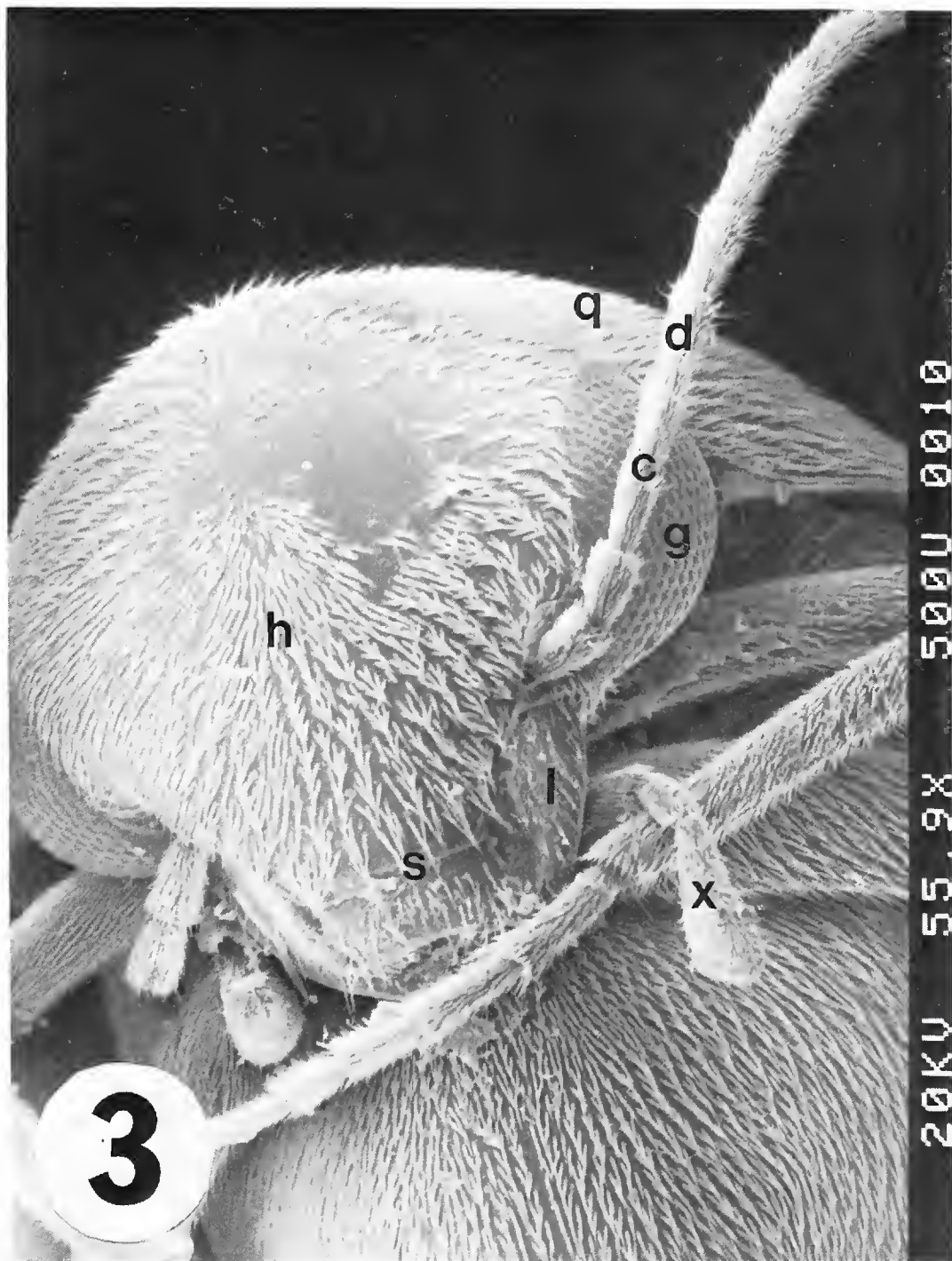


Figure 3. Scanning electron microscope photograph, close-up view of frons; see Table 1 for explanation of letters.

with separation distances ranging from 0.00 (comparison of any case to itself) to distances over 13.00.

All three of the preceding printouts discussed were used to determine what groups had been constructed by the clustering program. Following this all 400 individual specimens were examined and compared with Liljeblad's key and descriptions (1945) to determine what species had been found and overall concurrency with the grouping process of the computer.

RESULTS AND DISCUSSION

The cluster analysis delineated 14 major groups (those with five or more members) comprising a total of 223 specimens, 25 minor groups (those with four or few members) comprising a total of 73 specimens, and 104 specimens not definitely aligned with any of the 39 total groups. All 104 of these non-grouped specimens were

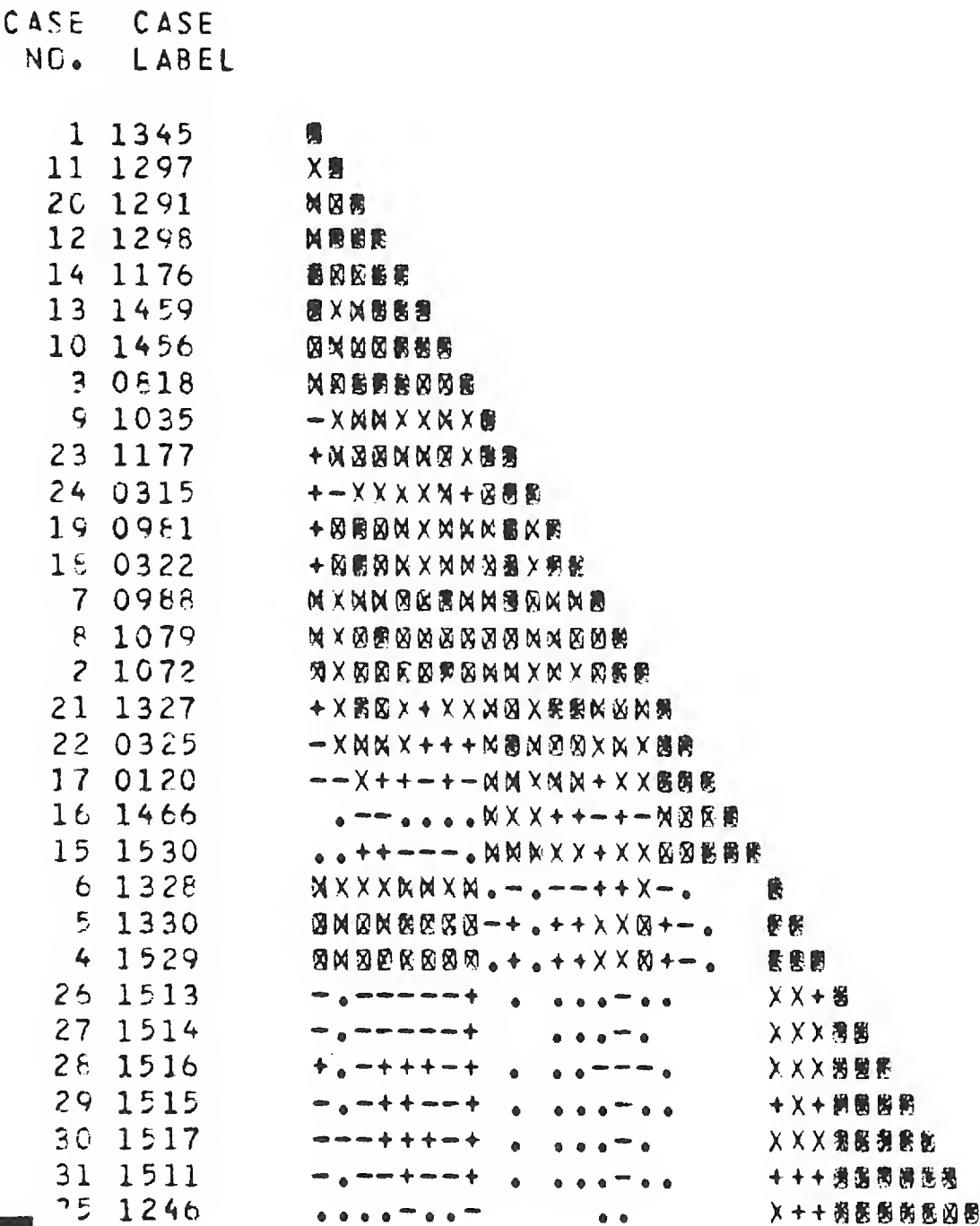
Table 2.

| <i>Final 14 Characters Used in Cluster Analysis</i> | |
|---|--|
| 1. | length of ultimate abdominal sternite |
| 2. | length of metatrochanter |
| 3. | length of metepisternum |
| 4. | eye height |
| 5. | eye length |
| 6. | length of large metatibial spur |
| 7. | length of small metatibial spur |
| 8. | length of metatarsal claw |
| 9. | length of head capsule |
| 10. | length of metafemora |
| 11. | length of mesotibia |
| 12. | length of mesofemora |
| 13. | length of ultimate segment of maxillary palp |
| 14. | ocular width |



Figure 4. Scanning electron microscope photograph, close-up view of metatarsal claw; see Table 1 for explanation of letters.

DISTANCES BETWEEN CASES REPRESENTED IN SHADED FORM.
HEAVY SHADING INDICATES SMALL DISTANCES.



5

Figure 5. Shaded Distance Matrix Sample Diagram.

however easily grouped by hand, based on having at least one close relative among the remaining 399 specimens.

Following visual examination of all 400 beetles, it became evident that while the minor groups were all single species, only two of the major groups were single species, while the other 12 all contained more than one species. However, these were easily separated on the basis of ground color and color patterns. The 25 minor groups all consisted of but a single species, so at least in some cases the 14 characters selected

represented new species. A list of these species is presented in Table 2. It should be noted that Liljeblad had 10 species recorded as occurring in Arizona. The generation of such a species list for Arizona was one of the major goals of this project.

The other goal of this study was the identification of reliable taxonomic characters and the validation of the leg ridges. It was clearly evident that the ridges of the metathoracic legs were unreliable as shown by their failure to separate the four groups of the discriminant analysis. The tibial ridges did seem to demonstrate more constancy in form and number and may yet prove useful as identification characters. The tarsal ridges, however, are far too transient, even varying from one side to the other of a single insect, to be of any use. Liljeblad attempted no conclusions on phylogeny. Rather, he merely grouped species according to ridge pattern. There were several examples where the cluster analysis grouped different species together that were in close proximity in Liljeblad's work. This is an indication that there may indeed be some phylogenetic significance to the ridges.

While ridges proved unreliable, the examination of the members of the groups showed that members of the same group possessed very similarly structured ultimate maxillary palp segments. This was true even in the larger groups made up of several species. Liljeblad suggested the possible importance of this character and this importance was reinforced by the fact that it was shown to be successful in the separation of the four species in the discriminant analysis phase of the study. Especially noticeable was the shape of the ultimate maxillary palp segment in two of the major groups in which the shape exhibited was long, narrow and parallel-sided in contrast to the usual scalene shape found in *Mordellistena*. As the pollen-feeding habits of the adults would appear to indicate an important food-gathering function for these segments, it is possible that the related morphology may be species specific. The use of this small character (usually under .300 mm in length and often somewhat hidden) in a taxonomic scheme is indeed much easier where numerical values are attached rather than general descriptions of the shape.

Perhaps the most noticeable problem encountered was the limitation in the number of cases that the CYBER was able to handle, as previously mentioned. Considering the case-by-case comparison method of the analysis, it is perhaps not too surprising that there is indeed a limit to the number of cases that any computer can handle. The point here is that there are finite and attainable limits restricting a numerical study.

The occurrence of one apparent species in more than one group occurred in two cases in the study and involves specimens which key in Liljeblad to *M. tosta* LeConte and *M. comata* (LeConte). In each case, specimens keying to these species were found in five groups formed by the cluster analysis. There are several possible reasons for this placement. First, there is the possibility that one or both of these species exhibit a wide range of variation in size and characters seemingly not usual for *Mordellistena*. This would mean that the 14 characters which work for the rest of the group are not suitable for these two species and this seems unlikely. A more plausible explanation is separation based on sexual dimorphism. There is a definite wide separation between small specimens keying to *M. tosta* and *M. comata* and larger specimens keying to these two species. In addition, there is a noticeable difference in the morphology of the ultimate maxillary palp segment with it being scalene in the smaller specimens and elongate-securiform in the larger specimens. This difference and these shapes were noted by Liljeblad in the descriptions of both species with the

males having the scalene, and the females the elongate-securiform, morphology. Finally, there is the explanation that several species are represented and cannot be distinguished except by the exacting method of a morphometric analysis. Whatever the answer, all specimens keying to *M. tosta* and *M. comata* warrant further study.

The grouping of several apparent species in a single cluster questions the discriminatory power of the analysis. As previously mentioned, in all instances little or no difficulty was encountered in separating these based on color and color patterns. The addition, or coding, of these characters is evidently a necessary one in a future revision of the entire group.

Finally, there is the inability of the analysis to group 104 specimens. The 104 all had at least one close relative and the majority had several among the rest of the specimens. In addition, all but two specimens fell just outside the limits of a group. The reason for these specimens not fitting into any group may be something as simple as an inaccurate measurement of one or more characters or something more complex involving character aberration. The relative of these specimens as indicated by the analysis should, however, provide rapid clues as to their identity. The ideal procedure, in keeping with the idea behind a study such as this, would be to add more characters until these obstacles are overcome and grouping is accomplished for all 104 specimens. Investigation of such possibilities, which again may simply involve a color coding, is something to be accomplished in an expanded study of the entire group.

SUMMARY

The question of usefulness of a morphometric analysis such as this in forming a phylogeny for *Mordellistena* is now addressed. Two pieces of evidence indicate that indeed this study can form an important part of such a phylogenetic reconstruction. The first is the placement of the two groups with unusually elongate ultimate maxillary palpal segments next to each other in the analytical results. It seems likely that this elongate segment represents some sort of offshoot of a section of the *Mordellistena* and the close clustering indicates phylogenetic significance to the character. The second concerns the character of an elongated upper tibial ridge. In cases where this striking character was present, it was seen in adjacent or solitary groups, again indicating possible phylogenetic significance.

The cluster analysis formed 39 groups of specimens comprising a total of 296 of the 400 specimens submitted for analysis. This is a 74% successful grouping with 102 of the remaining 104 specimens just outside the limits of the 39 groups. Thus the establishment of valid characters for taxonomic use, the 14 delineated plus those of color and color patterns, is seen as having been achieved. For a more detailed explanation of the groups, the reader is referred to Burne (1985). Forty-four species recognizable in Liljeblad, as well as 14 species either unrecognizable or undescribed, were found through the analysis generating the list of *Mordellistena* of Arizona seen in Table 3.

ACKNOWLEDGMENTS

I would like to express gratitude to the following: Dr. Floyd G. Werner for serving as advisor during this research and Carl A. Olson for assistance with photography, both of the University of Arizona, Tucson; and Dr. C. Ferris, Dr. C. C. Burkhardt and Dr. R. Pfadt for critical analysis, all of the University of Wyoming, Laramie.

Table 3. Species List from Study

| | | |
|------------------------------|------------------------|---------------------|
| <i>M. vapida</i> | <i>M. conformis</i> | <i>M. husseyi</i> |
| <i>M. intermixta</i> | <i>M. picipennis</i> | <i>M. unicolor</i> |
| <i>M. tantula</i> | <i>M. Smithi</i> | <i>M. pustulata</i> |
| <i>M. aspersa</i> | <i>M. divisa</i> | <i>M. sp. 1</i> |
| <i>M. sp. prob. testacea</i> | <i>M. texana</i> | <i>M. sp. 2</i> |
| <i>M. paradisa</i> | <i>M. marginalis</i> | <i>M. sp. 3</i> |
| <i>M. pullata</i> | <i>M. calignosa</i> | <i>M. sp. 4</i> |
| <i>M. aethiops</i> | <i>M. palmi</i> | <i>M. sp. 5</i> |
| <i>M. tosta</i> | <i>M. lutea</i> | <i>M. sp. 6</i> |
| <i>M. morula</i> | <i>M. ruficeps</i> | <i>M. sp. 7</i> |
| <i>M. nebulosa</i> | <i>M. rufa</i> | <i>M. sp. 8</i> |
| <i>M. comata</i> | <i>M. aemula</i> | <i>M. sp. 9</i> |
| <i>M. rubrifascia</i> | <i>M. splendens</i> | <i>M. sp. 10</i> |
| <i>M. nigricans</i> | <i>M. blandula</i> | <i>M. sp. 11</i> |
| <i>M. sericans</i> | <i>M. nunenmacheri</i> | <i>M. sp. 12</i> |
| <i>M. nubila</i> | <i>M. wickhami</i> | <i>M. sp. 13</i> |
| <i>M. knausa</i> | <i>M. parva</i> | <i>M. sp. 14</i> |
| <i>M. ambusta</i> | <i>M. nigella</i> | |
| <i>M. subfucus</i> | <i>M. militaris</i> | |
| <i>M. indistincta</i> | <i>M. pallens</i> | |

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***Acanthochalcis nigricans* Cameron—
New distribution information, including Central America
(Hymenoptera: Chalcididae)**

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Abstract.—New distributional information for *Acanthochalcis nigricans* in Nevada, United States; Baja California Sur, Mexico; Quezaltepeque, El Salvador; and Guanacaste, Costa Rica is presented. Rubinistic color variation for *nigricans* is noted.

Acanthochalcis nigricans Cameron is the second largest chalcidid wasp in America north of Mexico. Its body length (males 10 mm, 8 to 11 mm; females 17 mm, 7 to 24 mm) is slightly shorter than its North American congener, *unispinosa* Girault. *Acanthochalcis* are predominantly black with reddish brown (or black) labrum, clypeus, legs, tegulae, sternites, and tergites (ventrally). Females are unique among all North American Chalcididae in having the ovipositor project posteriorly a distance equal to or greater than the length of the abdomen.

The genus *Acanthochalcis* contains three species: *nigricans*—Kansas, Oklahoma, Texas, New Mexico, Arizona, California, and Mexico; *unispinosa*—Texas, Arizona, and California; *gigas* Steffan—Madagascar (Burks 1979, Catalog of Hymenoptera in America north of Mexico, Smith, Instit. Press I: 860–874; Steffan 1959, Acta Entomol. Mus. Natl. Prague 33(549):306–309). Both North American species are presumed to be parasitoids of buprestid beetle larvae which inhabit oak trees (Halstead and Haines 1985, Pan Pacific Entomol. 61(3):227–228).

Recently I examined specimens of *nigricans* which include new range records for Nevada (United States), Baja California Sur (Mexico), El Salvador, and Costa Rica. DeSantis (1979, Comision de Investigaciones Cientificas de La Provincia de Buenos Aires, La Plata, Argentina, p. 66) listed *nigricans* from Mexico but no state information was presented. Type material is from the state of Sonora (Cameron 1884, Biol. Cent. Amer., Hym., I: p. 100). These new records represent a considerable southward range extension.

Locality data is as follows: UNITED STATES. NEVADA, Clark Co.: Las Vegas, 20.vi.39, on *Cersium*, P. Timberlake, 1♀, (UCR). MEXICO. BAJA CALIFORNIA SUR, Los Medanos, 10.3 mi. SW, elevation 0.4 m., 28.iii.64, on *Laria*, sand dune association, M. E. Irwin, 1♂, (UCR); Santiago, 11 km W, Canon de La Zorra, 285 m, 4–5.ix.77, E. Fisher and R. Westcott, 1♀, (CAS). EL SALVADOR. QUEZALTEPEQUE, 12.vii.61, 23.viii.61, M. E. Irwin, 3♂, (UCD). COSTA RICA, GUANACASTE, Palo Verde Station, 29 km WSW Canas, 10° 21'N, 85° 21'W, 10.vii.76, H. E. Hespeneheide, 1♀, (Hespeneheide personal collection).

The three specimens from El Salvador are rubinistic color forms (i.e., typically black colored areas are reddish brown). No color variation has previously been noted for *Acanthochalcis*.

Ecology of *Rhopalomyia californica* Felt at Jasper Ridge (Diptera: Cecidomyiidae)

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Abstract.—An ecological study of *Rhopalomyia californica* Felt (Diptera: Cecidomyiidae) was conducted at the Jasper Ridge Biological Preserve (Stanford University) during 1982–83. The midge, which develops in terminal galls on *Baccharis pilularis* DC, was relatively rare throughout the course of the study. Analysis of life-table data suggested that its predators and parasites played a major role in maintaining population density at comparatively low levels. The parasite guild consisted of seven hymenopteran species: *Torymus koebelei* (Huber) & *T. baccharidis* (Huber) (Torymidae), *Zatropis capitis* Burks & *Mesopolobus* sp. (Pteromalidae), *Tetrastichus* sp. (Eulophidae), *Eupelmus inyoensis* Girault (Eupelmidae), and *Platygaster californica* (Ashmead) (Platygastridae). Malathion-bait sprays applied to an adjacent area (Woodside) not only resulted in a massive midge outbreak, but also indirectly altered the spatial structure of the midge population. It is suggested that *R. californica*, when introduced without its natural enemies, may be an important biological-control agent against weedy *Baccharis* spp. in Texas and Australia.

Rhopalomyia californica Felt is a native cecidomyiid midge which develops in multi-chambered, terminal galls on *Baccharis pilularis* DC in California. Tilden (1951b) described the natural history of the midge and most subsequent investigations have dealt largely with the midge and its parasites as a model system for addressing basic issues in community ecology and applied biological control (Doutt, 1961; Force, 1974; Ehler 1982, 1985; and Hopper, 1984). The latest development concerns the use of *R. californica* as a biological-control agent for related *Baccharis* spp. which are rangeland weeds. In this regard, the midge is now well established in Queensland, Australia, where it shows considerable promise for eventually controlling *Baccharis halimifolia* L. in many parts of its range (McFadyen, 1985; W. A. Palmer, pers. comm.). It was also introduced into Texas during 1985 and 1986 (for control of several *Baccharis* spp.) and is now established at certain release sites (P. Boldt, pers. comm.).

The purpose of the present paper is to summarize available data on the ecology of *R. californica* at one site in its native range (Jasper Ridge Biological Preserve) in order to facilitate eventual comparative studies in Texas and Queensland. Details of the study sites, materials, and methods were given by Ehler et al. (1984).

ANALYSIS OF LIFE-TABLE DATA

From 30 March 1982 to 9 March 1983, the midge population at Jasper Ridge was relatively stable—i.e., density of galls never exceeded 2 per 100 terminals and larval density did not exceed 20 per 100 terminals (Ehler et al., 1984). Life tables were

constructed for six cohorts of *R. californica* galls collected on the following dates in 1982: 30 March ($n = 144$), 3 May ($n = 47$), 1 June ($n = 85$), 14 July ($n = 124$), 12 Aug. ($n = 41$) and 7 Oct. ($n = 83$). Because major trends in mortality/survival in each of the life tables were very similar, an average ($n = 6$) life table, based on 524 galls (5680 midge larvae), was calculated for a hypothetical cohort of 1000 individuals (Table 1). Three major sources of mortality were apparent: predation of eggs and neonate larvae, parasitization of endophagous larvae (i.e., inside the gall) and residual mortality of larvae. Midge survival from egg to adult was ca. 5% and the sex ratio was in favor of females.

The numbers of eggs and neonate larvae plus attendant mortality rates were estimated from figures given by Ehler et al. (1984). In this case, the value for l_x was derived from the average gall size (assuming 100% survival from egg to endophagous larva) in an adjacent area (Woodside) which was heavily sprayed with malathion bait during the medfly eradication campaign. These sprays presumably destroyed most of the predators of these host stages and this apparently resulted in the consistently larger galls found in this zone (see next section). The value for d_x was determined by subtraction. Because of the particular methods employed, the estimates obtained should not be viewed as giving a complete picture of events during this age interval. For example, predation was the only mortality factor estimated, even though other factors (e.g., infertility) are probably involved. In view of this, the value for l_x should be regarded as an underestimate and that for d_x as an overestimate. Nevertheless, the data do suggest that predation on eggs and neonate larvae (i.e., before gall formation) is of major importance in the population dynamics of the midge (see also Ehler et al., 1984). Although numerous predatory insects occur on the plant (Tilden, 1951a), it was not possible to determine which species were responsible for the mortality detected during this phase of the study.

Parasites destroyed ca. 38% of the endophagous larvae (25% real mortality). This overall parasitization rate is somewhat low and is not necessarily characteristic of the parasite guild in other parts of the host's range. Seven species of solitary parasites were reared from *R. californica* galls. *Torymus koebelei* (Huber) (Torymidae) is a primary ectoparasite; parasitization by this species ranged from 1 to 13%. A second torymid primary ectoparasite, *T. baccharidis* (Huber), was generally rare and never parasitized >2% of the host larvae. *Zatropis capitis* Burks (Pteromalidae) is a facultative secondary ectoparasite which parasitized from 0.9 to 6.5% of the hosts. The dominant species in the parasite guild was *Platygaster californica* (Ashmead) (Platygastriidae), an egg-larval, primary endoparasite. This species parasitized from 1 to 36.2% of the larvae. *Mesopolobus* sp., another pteromalid facultative secondary ectoparasite, parasitized >10% of the hosts in March, but seldom parasitized >1% thereafter. The two remaining species were consistently rare: *Tetrastichus* sp. (Eulophidae), a primary endoparasite, never parasitized >1.1% of the hosts whereas *Eupelmus inyoensis* Girault (Eupelmidae), another facultative secondary ectoparasite, was collected on only one date (Oct. 7). Over 5% of the larvae (range: 0.5–9.5) were parasitized, but due to the condition of the material, it was not possible to attribute host mortality to any particular species listed above. Finally, total parasitization rate and rates for individual species were relatively constant over time; there was no convincing evidence for temporal density dependence.

The third major category of mortality was the residual—i.e., mortality of larvae which could not be directly attributed to parasites. The residual mortality rate was relatively high and probably has several components. Some hosts are presumably

Table 1. Average life table for *Rhopalomyia californica* at the Jasper Ridge Biological Preserve from March to October, 1982.*

| x | lx | dxF | dx | 100qx | 100rx |
|---------------------|------|-------------------------|-------|-------|-------|
| Egg + neonate larva | 1000 | Predation | 355 | 35.5 | 35.5 |
| Endophagous larva | 645 | Parasitization | | | |
| | | <i>T. koebelei</i> | 41.9 | 6.5 | 4.2 |
| | | <i>T. baccharidis</i> | 9 | 1.4 | 0.9 |
| | | <i>Z. capitis</i> | 27.7 | 4.3 | 2.8 |
| | | <i>P. californica</i> | 106.4 | 16.5 | 10.6 |
| | | <i>Mesopolobus</i> sp. | 20 | 3.1 | 2.0 |
| | | <i>Tetrastichus</i> sp. | 2.6 | 0.4 | 0.3 |
| | | <i>E. inyoensis</i> | 3.2 | 0.5 | 0.3 |
| | | Undetermined | 34.8 | 5.4 | 3.5 |
| | | Total | 245.7 | 38.1 | 24.6 |
| | | Residual | 341 | 52.9 | 34.1 |
| Pupa | 58.3 | Residual | 6.2 | 10.6 | 0.6 |
| Adult | 52.1 | (0.61 ♀ ♀:0.39 ♂ ♂) | 947.9 | — | 94.8 |

*Key to symbols: x = developmental stage, lx = number entering stage x, dxF = mortality factor, dx = number dying during stage x, 100qx = dx ÷ lx for that stage (apparent mortality) and 100rx = dx/lx for the initial cohort (real mortality). See Ehler (1982) and Ehler et al. (1984) for details of materials and methods.

killed by adult parasites—e.g., by host feeding, probing with the ovipositor (see also Force, 1974)—and this would not be detected by the methods employed in this study. Supernumerary parasitization is common at times and this could possibly result in death of all occupants (host and parasites) in a given chamber. For these reasons, the data for parasitization in Table 1 are probably a conservative reflection of the actual impact of parasites. I also suspect that many gall inhabitants (both hosts and parasites) were inadvertently killed during collecting and processing of galls. Recent dissections of fresh galls (prior to midge emergence) collected in Yolo and Solano Counties revealed that up to 10% of the chambers were empty. In other words, some mortality had occurred prior to sampling, reinforcing the belief that residual mortality has numerous components, as opposed to being strictly an artifact of sampling technique.

IMPACT OF MALATHION-BAIT SPRAYS

A massive outbreak of *R. californica* occurred at Woodside following 24 applications of malathion bait. At the height of the outbreak (Oct. 1982), midge population levels were ca. 90X greater than those observed at Jasper Ridge. This classic secondary outbreak evidently resulted from the wholesale destruction of natural enemies of the midge (Ehler et al., 1984). I report here on a more subtle or indirect effect of the sprays. The destruction of natural enemies (probably predators) evidently allowed greater survival of eggs and neonate larvae which in turn allowed more larvae to enter available buds and this presumably resulted in comparatively larger galls in the spray zone. Although this effect was evident on all sample dates in 1982, the data for October were particularly striking (Figure 1). At Jasper Ridge, the

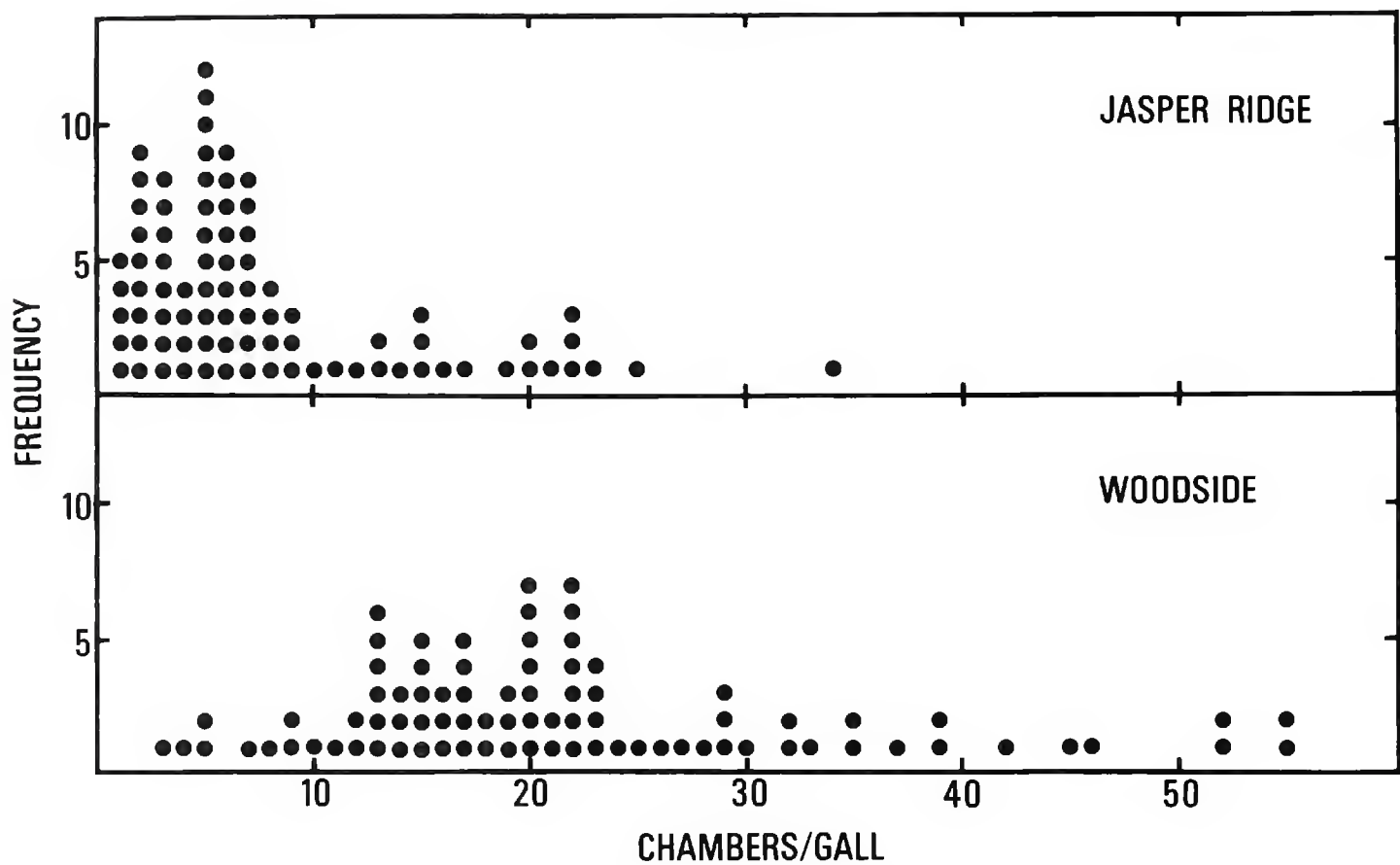


Figure 1. Frequency distribution of galls according to size (chambers per gall) at Jasper Ridge (control) and Woodside (medfly spray zone). Galls were collected on 7 October 1982; each dot represents one gall ($n = 83$ for both sites).

median number of chambers per gall was 5 compared to 19 at Woodside; the average number of chambers per gall at Woodside (21.9) was $> 2X$ that at Jasper Ridge (8.1). In other words, the malathion-bait sprays altered the spatial structure of the midge population. Conversely, the data suggest that natural enemies can play a major role in determining the spatial structure of a host population in nature. In view of these findings, the value of gall size as an index of host-plant quality, while perhaps intuitively appealing, must be questioned. This may also apply to midge populations in Texas and Australia because native generalist predators on related *Baccharis* spp. could produce a similar effect. Finally, the influence of an altered spatial structure of a host population on the behavior and performance of a natural enemy should be investigated.

RHOPALOMYIA AS A BIOLOGICAL-CONTROL AGENT

The results from Woodside suggest that *R. californica*, when introduced without its natural enemies, has considerable potential as a biological-control agent against weedy *Baccharis* spp. in Texas and Australia. The host plants at Woodside were so devastated (by the midge and other phytophagous species) that sampling had to be discontinued after October 1982. This can be taken as an indication of the kind of impact the midge might have in biological control of weeds. In future projects, deliberate disruption of herbivore populations in the native home of a target weed might serve as an aid in selecting candidate natural enemies for further study.

The selection of effective natural enemies for biological control of weeds has received considerable attention in recent years (Harris, 1973; Goeden, 1983). In this

context, the case of *R. californica* is relevant to a current controversy over the use of coevolved versus "new" exploiter-victim associations. Hokkanen and Pimentel (1984) argued that new associations should be the preferred method of selecting natural enemies; this recommendation was based on the hypothesized lack of coevolved, interspecific balance which attends such associations. However, Goeden and Kok (1986) challenged these findings and suggested that new exploiter-victim associations offer limited opportunities for biological control, especially for non-cactaceous weeds. Although controversial, I believe that the Hokkanen-Pimentel thesis should be carefully considered and empirically tested whenever possible. The introduction of *R. californica*, derived from *B. pilularis* in California, into Australia and Texas for control of related *Baccharis* spp. should provide some key information on this question.

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Male Swarms Discovered in Chalcidoidea (Hymenoptera: Encyrtidae, Pteromalidae)

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Abstract.—Male swarms have been discovered in three chalcidoid species: *Bothriothorax nigripes*, *Copidosoma* sp. (Encyrtidae), and *Pachyneuron* sp. (Pteromalidae). The swarms occurred around boulders at the top of a small ridge in southern California. *B. nigripes* males, and possibly the others, swarmed for the purpose of mating. The mating behavior of *B. nigripes* is described. This may be the first report of male mating swarms in the Chalcidoidea.

Males of three chalcidoid species were discovered swarming on and around five hilltop boulders near the University of California at Riverside campus. The aggregations were discovered on March 7, 1984 and were observed at least biweekly until their disappearance in mid-April of the same year. Examination of samples taken by aspiration and aerial sweepnetting from the same location on three different days revealed the following species and numbers (males:females): *Bothriothorax nigripes* Howard (Encyrtidae), 865:23; *Copidosoma* sp. (Encyrtidae), 291:14; *Pachyneuron* sp. (Pteromalidae), 522:0. The swarms daily contained several thousand individuals of each species. They formed anew each day after disappearing entirely from the sites during the night.

This report includes a brief description of the swarming and mating behavior of *B. nigripes*, *Copidosoma* sp., and of the swarming behavior of *Pachyneuron* sp. Greater emphasis is given to *B. nigripes*. A study was made to determine whether the *B. nigripes* aggregations were true mating swarms. The known literature on swarming in the parasitic Hymenoptera is included in the discussion.

Swarming and Mating Behavior

I chose to closely observe *B. nigripes* to ensure that its aggregations were true mating swarms. This species is the largest of the three and thus more easily observed in the field. Males began arriving near the boulders at around 7:00 A.M. and landed during intervals of low wind velocity. Throughout the day, many swarmed in flight while others congregated on the shaded north- and northwest-facing rock surfaces. The males' behavior on the rocks consisted of walking in irregular paths with frequent turns, and beating the substrate with the antennae in rapid, alternating strokes. Landing females remained relatively motionless with their antennae tucked close to their faces, or walked slowly for a short distance (< 10 cm) before becoming still. Males encountered them within a minute or two and began courting. A schematic summary of courtship and mating behaviors is presented in Fig. 1. Males appeared to sense a female's presence from a distance of 1 cm away, as they increased walking speed and headed directly toward her from that point. Uninterrupted courtship and copulation lasted about 40 seconds. In some instances other males

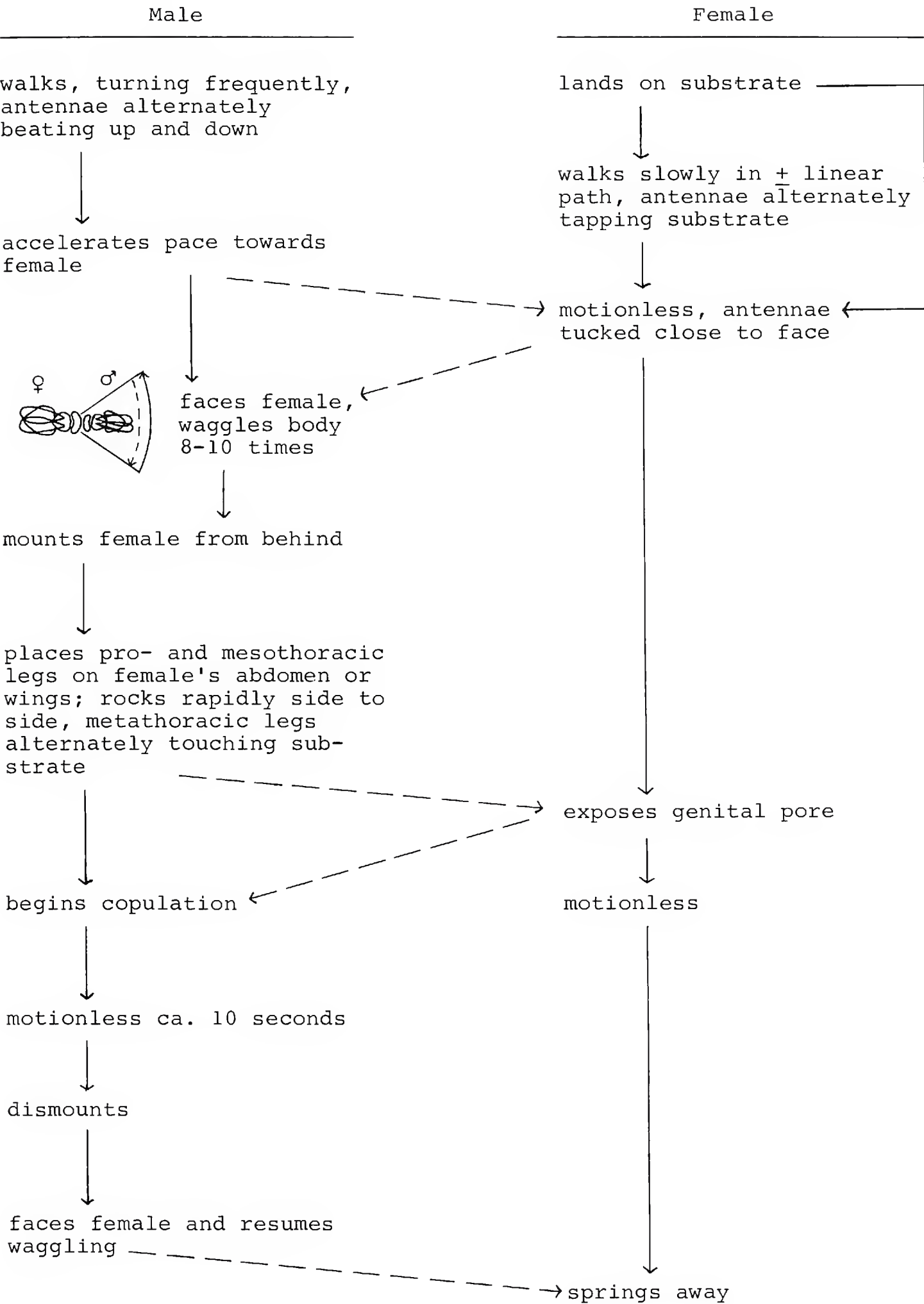


Figure 1. Schematic representation of uninterrupted courtship and mating in *Bothriothorax nigripes*.

approached a pair in apparent attempts to copulate with the female, in which case the female usually sprang away, often carrying one mounted male with her.

Females were never observed to spring away before mating or being mobbed by several males. They seemed, therefore, to arrive at the swarms specifically for the purpose of mating. To gain further evidence for this, I caught and dissected six newly-landed females (before male contact) and found that their spermathecae did not contain sperm. I paired four other newly-landed females with males in glass vials and found them to mate readily. Two of these females were dissected and found to have full spermathecae, and the remainder were paired with other males and found to reject a second mating during 9- and 18-hour video-recorded observation periods. Four additional females which were caught after they had mated naturally in the swarms also rejected subsequent mating attempts when paired with males in glass vials. Because newly-landed females mated readily both in the swarms and in the laboratory, while mated females rejected subsequent matings, *B. nigripes* females apparently join the male swarms in an uninseminated condition for the purpose of mating.

It was unlikely that females arrived in search of food; some swarm boulders were devoid of vegetation, and no feeding by either sex was observed on the few flowering plants that grew on and around the rest. It was also unlikely that females appeared in the area to search for their hosts, syrphid larvae, because none were detected on ridgetop vegetation.

I sporadically observed the other swarming species. Mating pairs of *Copidosoma* sp. were evident, often on rock-top vegetation, hence I also regarded the aggregations of this species as mating swarms. The males generally flew above or walked on the upper surface of vegetated boulders. *Pachyneuron* females, however, were neither seen nor collected. The males flew and walked around on the upper boulder surfaces, sometimes mixing with *Copidosoma*, but they also swarmed apart on the north- and northeast-facing surfaces. Although I did not observe mating within the *Pachyneuron* swarms, I suggest that, on the basis of the similarity in their aggregative behavior to the other species, the *Pachyneuron* assemblages were also mating swarms.

The Swarm Site

The most obvious factor distinguishing the swarm site, Coyote Ridge, is its situation as the only low yet abrupt peak within a 7.5 km radius. It rises 134 m above a base altitude of 335 m, and is surrounded by flat or gently sloping land. The Box Springs Mountains nearby peak at 920 m at 2.5 km to the east. A brief examination of Box Springs peaks at various heights, and of the nearest low, abrupt, hill in the area, Mount Rubidoux (165 m), revealed no chalcidoid swarms on March 24, 1984, although swarms were active that day on Coyote Ridge. Continuous and sometimes gusty winds may have contributed to the paucity of insects on the unpreferred peaks. Winds around Coyote Ridge were low and occasionally still, and perhaps more suited to controlled locomotion by the wasps.

DISCUSSION

Male mating swarms commonly occur in insects, especially in Diptera. They are generally believed to result from 1) males searching at sites with high probability of

encounter with receptive females, such as emergence, feeding, and oviposition sites, 2) active male aggregation for the purpose of enhancing attractivity toward females, or 3) localization of mating activity at landmarks (Thornhill and Alcock 1983). Among the parasitic Hymenoptera, male swarms have been reported in the Ichneumonoidea (Ichneumonidae: Rotheray 1981; Braconidae: Donisthorpe 1936, Stelfox 1944, Southwood 1957; Aphidiidae: Stary 1970) and possibly in the Bethyloidea (Dryinidae: Jervis 1979), but not in the Chalcidoidea. Large swarms of female *Cyclogastrella* (= *Pteromalus*) *deplanata* (Pteromalidae) have been reported from buildings in England (Scott 1919), and of female *Chrysocharis centralis* (Eulophidae) on vegetation in Madeira (Graham 1983), but there is no indication that these served a mating purpose. Recently, however, pteromalid mating swarms have been observed on citrus trees in China (J. K. Waage, personal communication).

The male chalcidoids on Coyote Ridge appeared to use either a landmark-based swarm site and/or to aggregate to increase their power to attract females. There was no indication that either sex arrived at the ridgetop to feed. Similarly, at least for *B. nigripes*, there was no indication that females arrived in search of hosts. Certainly, there was no indication that the ridgetop was in any way more profitable than the surrounding areas in terms of food or oviposition sites for any of the swarming chalcidoids. The ridgetop, however, offers a distinctive landmark which is also accompanied by slower winds than those which prevail on the nearest peaks. It is, therefore, not only conspicuous, but also allows controlled locomotion by the insects. These attributes of the ridge may have set the stage for the evolution or maintenance of a landmark-based mating system in the observed chalcidoids. It is also possible, however, that the males of each species aggregate because they thus have a greater chance of mating than if they remained solitary. Male aggregation pheromones are commonly implicated in the formation of insect swarms and in the attraction of females (Thornhill and Alcock 1983). It is not impossible that the aggregation pheromones, if they exist, of the three studied chalcidoid species are similar; this would explain why these presumably rare swarms occurred together. Much more work is necessary to reveal why and how the swarms occur, but at this point the observations indicate that they are part of a landmark-based mating system or the result of a male tendency to aggregate, or both.

Chalcidoid mating swarms have been reported here for the first time, but is this because little attention has been given to parasitoid mating behavior in nature, or is it because the swarms are truly rare? As far as I know, there have been no focused studies on the mating systems of non-inbreeding parasitic Hymenoptera beyond the confines of the laboratory. This is unfortunate from both a practical and theoretical standpoint. Such studies may aid the evaluation of biological control agents; introduced exotic chalcidoids, for example, may fail to become established because of the absence of proper mating sites. As I showed in this study, readiness to mate in the laboratory gives no indication of the species' mating system: *B. nigripes* mated readily in glass vials. If chalcidoid mating swarms are truly rare, however, we should search for a general tendency in the Chalcidoidea to mate at the emergence site rather than to mate after dispersal. Many chalcidoid species have a preponderance of females (Gordh 1979), and this has been linked, in theory, to pre-dispersal mating (Hamilton 1967, Charnov 1982, Waage 1982). The discovery of chalcidoids which mate away from their natal site paves the way for testing the relationship between

mating system and sex ratio in this group. In any event, the study of chalcidoid mating systems should provide a rich store of information for both practical and theoretical work.

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The *Drosophila* Fauna of a Native California Forest (Diptera: Drosophilidae)

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INTRODUCTION

During the years since *A.D.* 1492 and especially during the past 150 years the *Drosophila* fauna of North America has undergone considerable change. Two major factors have contributed to this change: (1) a number of *Drosophila* species from other continents have become introduced into the fauna, e.g. *D. melanogaster* and *simulans* and recently *D. subobscura*; and (2) larval substrates have changed both qualitatively and quantitatively. Numerous fruits and vegetables from other continents have been introduced, e.g. European grapes, apples, and citrus, all of which provide substrates for native polyphagous species, e.g. *obscura* species group. In contrast urbanization, agriculture and lumbering have reduced the volume of substrates provided by forest fungi, slime fluxes, cacti and fermenting bark. It is reasonable to assume that the population sizes of most oligophagic and monophagic species have been reduced. The *virilis* species group provides a clear example of such a reduction in population size (Spieth 1979).

Blodgett Forest

The Blodgett Forest Research Station of the University of California Department of Forestry and Conservation is located in the Eldorado National Forest on the western slope of the Sierra Nevada Mountains. Consisting of 2,961 acres (1198 hectares) located between 4,100 and 4,600 feet (1250–1400 m) elevation, it is a “mixed conifer” forest which supports ponderosa pine, sugar pine, white fir, incense cedar, douglas fir, black oak, tan oak and native shrubs and forbs. The forest is totally surrounded by the Eldorado National Forest. The sole access to Blodgett is via a narrow two lane road that originates at Georgetown, a small town located 10 air miles west of Blodgett. Continuous forest exists from Georgetown to Blodgett. A number of dwellings, mostly summer homes plus camping areas, exist along the access road, mainly along the western portion. Agricultural activities are absent along the road and in the surrounding forest.

The Blodgett Station was established in 1933, and since its inception *all* introduced plants have been systematically eliminated. Thus, as a result of the Blodgett Station’s location within the National Forest and the efforts of the foresters, it can reasonably be assumed that the forest approaches closely the habitat that existed when Columbus reached America.

Systematic collecting of the *Drosophila* fauna was undertaken during the years 1981–84 in order to determine both the species composition and size of the *Drosophila* fauna of the forest.

Collecting Procedures

Blodgett Forest is an irregularly shaped rectangle with a north-south axis of circa 4.5 mi (7.2 km.). A network of unpaved dirt roads facilitates access to various

portions of the forests. Five sites along a north-northwest to south-southeast transect were selected.

Two sites, 1 and 1A, at the northern end of the forest, with elevations of 1310 m and 1320 m, are located 375 m apart. The forest is of medium density with numerous individuals of the native black oak, *Quercus kelloggii*, which are scattered among the conifers.

Site 2, elevation 1365 m, is located 2.6 km southward of sites 1 and 1A. It slopes westward and has a grove of *Q. kelloggii* surrounded by a coniferous forest amongst which are numerous oaks and shrubs.

Site 3, elevation 1292 m, located 840 m south-eastward of site 2, is beside a stream in a dense forest of mature conifers. Oaks are totally absent and daily temperatures are consistently 2–3°C lower than at any other area of the forest.

Site 4, elevation 1310 m, is located 1.31 km. south of site 3. The terrain slopes south-eastward. Soil depths in the western part of the area are shallow with numerous rocky outcrops. Numerous young *Q. kelloggii* oaks and *Ceanothus sp.* dominate this upper, drier and rocky western portion of the area while old mature oaks and a mixture of young oaks and conifers are present in the lower eastern portion.

Plastic, red colored buckets, height 26 cm, dia. 21.5 cm, were used as bait traps, and fermenting, yeasted bananas as bait. Three buckets spaced 100–200 m apart were used at each of the five sites. The bait buckets were suspended from tree branches 0.5–1.5 m above the forest floor. Collections were scheduled to be accomplished at two-week intervals from mid-April to early October during 1981, '82, '83 and '84. Each collection consisted of an “evening” collection followed by a “morning” collection on the following day. The bait buckets and baits were removed at the termination of the “morning” collections. Occasionally one or both collections were nonproductive due to environmental conditions such as low temperatures, high temperatures or the rare passage of a weather front through the area.

All specimens collected at each of the 15 baits were returned to the laboratory for identification. Since the four species of the *D. obscura* species group cannot be effectively separated visually, individuals belonging to the group were identified by electrophoretic techniques.

Blodgett Forest Species

During the four years, 1981–84 inclusive, adults of 13 species belonging to three subgenera, i.e. *Dorsilopha*, *Drosophila* and *Sophophora*, were collected (Table 1).

Subgenus *Dorsilopha* Sturtevant

A single male specimen of *D. busckii* Sturtevant was collected 6.vi.82 (Table 1). *D. busckii* is a cosmopolitan “garbage” species. This single individual can reasonably be considered to have been a migrant into the Blodgett Forest.

Subgenus *Sophophora* Sturtevant

Adults of two species of the *melanogaster* species group and four species of the *obscura* species group were collected during each of the four years (Table 1).

SUMMARY OF SPECIES

Table 1

| Subgenus | Species | 1981 | | 1982 | | 1983 | | 1984 | |
|-------------------|---------------------------|------|------|------|------|------|------|------|------|
| | | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| <i>Dorsilopha</i> | <i>D. busckii</i> | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| <i>Sophophora</i> | | | | | | | | | |
| | <i>D. melanogaster</i> ♂♂ | 5 | — | 4 | — | 5 | — | 38 | — |
| | <i>D. simulans</i> ♂♂ | 53 | — | 6 | — | 104 | — | 165 | — |
| | <i>D. melanogaster</i> ♀♀ | | | | | | | | |
| | <i>D. simulans</i> ♀♀ | | 118 | | 32 | | 262 | | 1387 |
| | <i>D. azteca</i> | | | | | | | | |
| | <i>D. miranda</i> | 1290 | 1410 | 1049 | 1040 | 1500 | 2170 | 1075 | 973 |
| | <i>D. persimilis</i> | | | | | | | | |
| | <i>D. pseudoobscura</i> | | | | | | | | |
| <i>Drosophila</i> | | | | | | | | | |
| | <i>D. californica</i> | 7 | 7 | 11 | 14 | 378 | 282 | 84 | 47 |
| | <i>D. immigrans</i> | 2 | 35 | 0 | 5 | 9 | 53 | 0 | 3 |
| | <i>D. montana</i> | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| | <i>D. occidentalis</i> | 143 | 129 | 51 | 34 | 162 | 143 | 167 | 138 |
| | <i>D. pinicola</i> | 249 | 20 | 56 | 67 | 60 | 50 | 38 | 45 |
| | <i>D. subfunnebris</i> | 4 | 13 | 0 | 1 | 3 | 10 | 3 | 14 |

Melanogaster species group

D. melanogaster Meigen and *D. simulans* Sturtevant

During all four years adults of both species were absent from the collections during the months of April, May, June and July (Table 2). Presumably they were also absent during the winter and early spring. Only two males, one of each species, plus 32 females were collected during August and 30 of these females during August of 1984 (Table 2). In each of the four years the number of females greatly exceeded the number of males collected, i.e., 4.7 females for each male. Also the number of *simulans* males greatly exceeded the number of *melanogaster* males.

Blodgett Forest is located in the drainage of the Sacramento Valley. At the lower elevations vast acreages of the valley are devoted to vineyards, orchards and vegetable crops, especially tomatoes. Each year huge populations of both *D. melanogaster* and *D. simulans* develop in these agricultural areas. The *simulans* populations greatly exceed in size the *melanogaster* populations. Areas located about 15–20 miles southwest and west of Blodgett are known to produce large populations of both of these species. After the fruits and vegetables are harvested the adults must seek other food and ovipositional sites. The appearance of adults of the two species in the Blodgett Forest in September and October during each of the four years suggests that these individuals were migrants from lower elevations and that they must have migrated at least 15–20 miles. Further, the lack of individuals of both

Table 2

| Species | | Year | Apr | May | June | July | Aug | Sept | Oct | Totals |
|------------------------|-----|------|-----|-----|------|------|-----|------|-----|--------|
| <i>D. melanogaster</i> | ♂ ♂ | 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 |
| | | 1982 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 4 |
| | | 1983 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 5 |
| | | 1984 | 0 | 0 | 0 | 0 | 1 | 37 | 0 | 38 |
| | | | | | | | | | | 52 |
| <i>D. simulans</i> | ♂ ♂ | 1981 | 0 | 0 | 0 | 0 | 0 | 38 | 15 | 53 |
| | | 1982 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 6 |
| | | 1983 | 0 | 0 | 0 | 0 | 0 | 8 | 96 | 104 |
| | | 1984 | 0 | 0 | 0 | 0 | 1 | 162 | 2 | 165 |
| | | | | | | | | | | 328 |
| <i>D. melanogaster</i> | ♀ ♀ | 1981 | 0 | 0 | 0 | 0 | 2 | 94 | 22 | 118 |
| <i>D. simulans</i> | | 1982 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 32 |
| | | 1983 | 0 | 0 | 0 | 0 | 0 | 95 | 167 | 262 |
| | | 1984 | 0 | 0 | 0 | 0 | 30 | 1352 | 5 | 1387 |
| | | | | | | | | | | 1749 |

species during the months of April through July indicates that the migrants that reach Blodgett during the months of August through October of the preceding year were not able to survive in the forests during the winter months.

Obscura species group

Four species of the *obscura* group are residents of the Blodgett Forest: i.e. *D. azteca* Sturtevant and Dobzhansky, *D. miranda* Dobzhansky, *D. persimilis* Dobzhansky and Epling and *D. pseudoobscura* Frolowa. Numerically they are the dominant species of the forest (Table 1).

Morphologically, individuals of *D. persimilis* and *D. pseudoobscura* are essentially indistinguishable. Undersized individuals of *D. miranda* can be confused with large sized individuals of *persimilis* and *pseudoobscura*. Only the males of *azteca* can be confidently identified. The electrophoretic patterns of each of the four species, however, are species specific and therefore were utilized to determine the specific identity of the flies (Table 3). *D. pseudoobscura* and *D. persimilis* are numerically the dominant members of the *obscura* species constituting more than 70% of the *obscura* flies collected during 1981, '82 and '83 but receding to 61% in 1984. In comparison *D. miranda* increased from 6.88% in 1981 to 23.26% in 1984. *D. miranda* is a “northern” species whose range extends from Canada to the southern portion of California. In comparison *D. azteca* is a “southern” species whose range extends from Guatemala to northern California. From 1981 to 1983 the *azteca* populations decreased sharply but recovered in 1984 (Table 3).

No specimens of the recently introduced *D. subobscura* were collected during the years 1981–84. During 1985 a few collections were made in the forest and *D. subobscura* appeared in one of these.

Table 3
D. obscura group species

| | 1981 | 1982 | 1983 | 1984 |
|-------------------------|--------|--------|--------|--------|
| <i>D. pseudoobscura</i> | 36.28% | 27.16% | 44.35% | 30.85% |
| <i>D. persimilis</i> | 34.64% | 47.83% | 32.66% | 30.29% |
| <i>D. miranda</i> | 6.88% | 13.74% | 20.80% | 23.26% |
| <i>D. azteca</i> | 22.20% | 11.27% | 2.19% | 15.60% |

Subgenus **Drosophila**

Six species of the subgenus were collected (Table 1). Each of these is a member of a different species group.

D. californica Sturtevant

D. californica, a member of the *repleta* species group, was described by Sturtevant (1923) on the basis of 1 ♂ and 4 ♀♀ collected at Pacific Grove, California. Subsequent collecting has indicated that the species is apparently restricted to California. Its larval substrate is unknown and it is considered to be a “rare” species since it appears infrequently and usually in small numbers in *Drosophila* collections.

The volume of the larval substrate present in any area is positively correlated with the size of adult populations of the species that breeds in the substrate; i.e., with rare exceptions *Drosophila* females are capable of producing and ovipositing large numbers of fertile eggs during their normal life spans. Thus the major factor controlling population size is the availability of suitable larval substrate(s).

During 1981 only 14 individuals (Table 4) were collected, 11 of which were collected during July and August. In 1982 25 individuals were collected, but, in 1983, 660 specimens of *californica* were collected. Clearly the amount of larval substrate suitable for *D. californica* increased dramatically in 1983. In 1984 the population receded and only 131 individuals were collected.

D. immigrans Sturtevant

This cosmopolitan species is similar to *D. melanogaster* and *D. simulans* in that it cannot overwinter in the forest. During the four years 107 specimens, 11 ♂♂ and 96 ♀♀, were collected. Of these 1 ♂ and 3 ♀♀ were collected during the months of April through August while the remaining 103 were captured during September and October.

The yearly variation was great: e.g., only three specimens, all females, were captured in 1984, 62 individuals of which nine were males in 1983, five females and no males in 1982 and 35 females and 2 males in 1981. It can reasonably be concluded that all of these individuals were migrants from lower elevation.

D. montana Patterson and Wheeler

Only three females, one each in 1982, 1983 and 1984, were captured. This species utilizes the fermenting bark of the aspen of its larval substrate. Since aspen is lacking

Table 4
D. californica Sturtevant

| | Apr | | May | | June | | July | | Aug | | Sept | | Oct | | Totals | | T |
|------|-----|---|-----|---|------|----|------|----|-----|----|------|-----|-----|----|--------|-----|-----|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂♂ | ♀♀ | |
| 1981 | 1 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 1 | 4 | 0 | 0 | 0 | 0 | 7 | 7 | 14 |
| 1982 | 0 | 0 | 0 | 0 | 3 | 3 | 5 | 6 | 1 | 3 | 2 | 2 | 0 | 0 | 11 | 14 | 25 |
| 1983 | 0 | 1 | 3 | 1 | 11 | 19 | 54 | 51 | 88 | 77 | 148 | 117 | 74 | 16 | 378 | 282 | 660 |
| 1984 | 1 | 0 | 10 | 9 | 3 | 2 | 11 | 7 | 34 | 22 | 24 | 7 | 1 | 0 | 84 | 47 | 131 |
| | | | | | | | | | | | | | | | 480 | 350 | 830 |

Table 5
D. immigrans Sturtevant

| | July | | Aug | | Sept | | Oct | | Totals | | T |
|------|------|---|-----|---|------|----|-----|---|--------|----|-----|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂♂ | ♀♀ | |
| 1981 | 0 | 1 | 0 | 0 | 0 | 33 | 2 | 0 | 2 | 34 | 37* |
| 1982 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 5 |
| 1983 | 1 | 0 | 0 | 1 | 6 | 46 | 2 | 6 | 9 | 53 | 62 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 3 | 3 |

*one ♀ coll. 4 April 81

from the Blodgett Forest these three specimens appear to be migrants from higher elevations where aspen and *D. montana* are both common.

D. occidentalis Spencer and **D. pinicola** Sturtevant

Both species utilize fungi as larval substrates. The Blodgett Forest has a Mediterranean type climate with only scant and unpredictable precipitation during the summer months. As a result the area becomes increasingly desiccated during the summer and early fall. The fungal populations reach their peak during April and May and steadily decline during the remainder of the year. Fungi do exist during the summer months along stream banks and at the outflows of a few permanent springs.

D. occidentalis populations peak during June and July. Except for 1982 its populations were similar in size during each of the other three years (Table 6). In contrast the *pinicola* populations reach their peak during May. *D. pinicola* females become sterile when subjected to temperatures above 18°C (Spieth and Heed 1975). In the Blodgett Forest the *pinicola* populations were largest during May (Table 7) and declined rapidly during the following months, and this decline may be due to temperature constraints. Further, the *pinicola* populations, for unknown reasons, declined drastically during each of the following years after 1981.

D. subfunbris Stalker and Spencer

During the four years only 48 specimens of *subfunbris* were collected (Table 1) and it appears to be the rarest of the native species in the Blodgett Forest. Since,

Table 6
D. occidentalis Spencer

| | Apr | | May | | June | | July | | Aug | | Sept | | Oct | | Totals | | T |
|------|-----|----|-----|----|------|----|------|----|-----|----|------|----|-----|----|--------|-----|-----|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂♂ | ♀♀ | |
| 1981 | 19 | 10 | 36 | 16 | 31 | 25 | 44 | 39 | 3 | 8 | 4 | 9 | 10 | 12 | 147 | 119 | 266 |
| 1982 | 1 | 0 | 15 | 5 | 22 | 10 | 10 | 12 | 3 | 3 | 0 | 4 | 0 | 0 | 51 | 54 | 105 |
| 1983 | 0 | 0 | 8 | 17 | 34 | 28 | 62 | 51 | 9 | 18 | 4 | 23 | 15 | 2 | 132 | 139 | 271 |
| 1984 | 0 | 0 | 6 | 47 | 39 | 27 | 39 | 46 | 22 | 17 | 4 | 3 | 3 | 4 | 113 | 138 | 251 |

Table 7
D. pinicola Sturtevant

| | Apr | | May | | June | | July | | Aug | | Sept | | Oct | | Totals | | T |
|------|-----|----|-----|-----|------|----|------|----|-----|---|------|---|-----|---|--------|-----|-----|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂♂ | ♀♀ | |
| 1981 | 20 | 18 | 205 | 136 | 6 | 21 | 12 | 18 | 0 | 2 | 3 | 3 | 3 | 8 | 249 | 206 | 455 |
| 1982 | 22 | 32 | 28 | 14 | 2 | 5 | 2 | 6 | 1 | 2 | 0 | 0 | 0 | 0 | 55 | 59 | 114 |
| 1983 | 3 | 10 | 29 | 11 | 8 | 9 | 16 | 3 | 0 | 3 | 0 | 2 | 7 | 2 | 63 | 40 | 103 |
| 1984 | 0 | 1 | 15 | 12 | 12 | 6 | 5 | 14 | 1 | 8 | 0 | 4 | 3 | 0 | 36 | 45 | 81 |

however, only 10 of the specimens were males it is possible that adult individuals, especially males, are only marginally attracted to fermenting bananas and that the populations may have been considerably larger than the present data indicate.

Larval Substrates

As the summer progresses the forest becomes increasingly desiccated. Thus the stream beside which collecting site 3 is located has sufficient volume to support trout during the months of April and May but ceases to flow during August and September. The stream bed remains somewhat moist and *D. occidentalis* and *D. pinicola* tend to congregate in the area but other species such as *D. californica*, *D. subfunnebris* and the four *obscura* species, i.e. *azteca*, *miranda*, *persimilis* and *pseudoobscura*, do not. These species consistently occupy all parts of the forest and this indicates that their larval substrates and food sources are distributed throughout the forest. Clearly the adults of these species are able to find adult nutrients and larval substrates in a desiccated environment which appears to lack any free liquid. It should be noted that climatic conditions in the forest are such that no dew forms during the summer and fall months and none of the plants exhibits guttation.

Carson (1951), Carson et al. (1956) investigated sixty-four slime fluxes on the California black oak *Quercus kelloggii* at Mather, California, which is located 90 miles southeast of and at approximately the same altitude as Blodgett. Twenty-two of the sixty-four fluxes they examined were utilized by *D. persimilis* and/or *D. pseudoobscura* and four by *D. californica*. Slime fluxes are relatively rare at Blodgett, a fact which was confirmed by J. Powell who visited Blodgett. The Blodgett fluxes were consistently inspected during the four years but neither adults nor larvae of any species were found on or in the fluxes.

Quercus kelloggii produces vast numbers of acorns. The majority of these are parasitized by either the coleopteran *Curculio occidentalis* or the lepidopteran *Melissopus latiferreanus*. The larvae of these two species feed on the cotyledons and embryo of the acorn. Shortly after the acorn is shed from the tree the larvae reach maturity and they then cut a small circular escape hole through the shell of acorn, escape and pupate in the soil. Remaining in the parasitized acorn is a mass of soft frass. Acorns, both parasitized and unparasitized, quickly desiccate. Foresters in rearing oaks find it necessary to pluck the mature acorns from the trees, in order to insure that the oak embryo is viable.

In the laboratory if the parasitized acorns are kept moistened *D. melanogaster*, *D. immigrans* and *D. pseudoobscura* females readily oviposit into the acorn, via the parasite's exit hole and/or the base of the acorn where the vascular elements of the acorn are located. Normal adult flies eventually emerge from such acorns.

D. pseudoobscura and *persimilis* are widespread in California. At lower elevations (e.g. Davis, elevation 50 ft.), they can be collected throughout the year but the populations are small during the summer and early fall months. Both species reach peak population size during the late winter and spring, i.e., during the time of major precipitation.

Dr. William Marshall provided me with a liter of acorns which he had collected during February and March 1983 at Oakmont, California, elevation 250 ft. From these 20 ♂♂ and 12 ♀♀ *obscura* spp. and 4 ♂♂ and 8 ♀♀ of *D. immigrans* emerged. This suggests that at the lower elevations in California acorns during the late winter and early spring probably serve as ovipositional sites.

Basically, *Drosophila* adults have pigmentary patterns that blend with the background of their feeding-ovipositional substrates, e.g. *D. virilis* group species on fermenting bark, *D. mulleri* group species on fermenting cacti. The melanistic coloration of the *obscura* species suggested that perhaps their ovipositional substrates might be on or in the forest soil. Dobzhansky once remarked that he could regularly sweep individuals from the forest floor under oak trees at Mather. A number of species of subterranean fungi exist in the California forests but the number of fruiting bodies are few in comparison to the fungi (mushrooms) whose fruiting bodies are above the surface of the soil. Rodents avidly feed on such fungi and can detect the presence of the hidden fruiting bodies, but human collectors must find them by digging up areas of the forest floor. Such digging at various sites in the forest, totalling more than 100 sq. meters, produced six fruiting bodies representing two specimens each of three different species. Five of the fungal bodies were bisected to determine that they did not contain larvae when collected. These were then immersed in moist sand in one-liter glass jars and allowed to decay. Adults of either *D. pseudoobscura* or *D. persimilis* were then added to the jars. One species of fungus was totally ignored by the females of both species. *D. pseudoobscura* females readily oviposited into the other two species of fungi and more than 150 adults were reared from the fungi. If the fungal material was completely immersed in the sand the females then oviposited their eggs into the sand overlying the fungal body and the emerging larvae then migrated to the fungal material.

D. persimilis essentially ignored the fungi. No F₁ *persimilis* emerged from any of the fungi although dissection of one fungal mass showed a few larvae to be present but none matured to adulthood.

In sum, fungi, acorns and slime fluxes can serve as larval substrates for species of the *obscura* group, but the size of the populations in the Blodgett Forest and elsewhere indicates that there must be other, as yet undiscovered, endemic larval substrates.

SUMMARY

Adults of thirteen species of *Drosophila* were collected in the Blodgett Forest during the years 1981–84. Eight of these species, i.e. *D. azteca*, *miranda*, *persimilis*, *pseudoobscura*, *californica*, *occidentalis*, *pinicola* and *subfunnebris* are residents. Adults of the other five species, i.e. *D. busckii*, *melanogaster*, *simulans*, *immigrans*, and *montana* are migrants into the forest.

Numerically the four species of the *obscura* group are the dominant species in the forest. Intensive search was made for the larval substrates of these species. A few slime fluxes on *Quercus kelloggii* were found but none was used by the flies. Most of the acorns of *Q. kelloggii* are parasitized by either a coleopteran or a lepidopteran. Such acorns, if they are kept moist after the parasite larva has emerged from the acorn, are readily used by *D. persimilis* and *D. pseudoobscura* as larval substrates. Further, some subterranean fungi also can serve as larval substrates for *D. pseudoobscura* but these fungi were not attractive to *D. persimilis*.

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**On the Rearing of *Microchridium minutum* and Its Probable
Host—*Ammoplanellus* (*Ammoplanellus*) *umatilla*
(Hymenoptera: Chrysididae, Sphecidae)**

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Abstract.—Rearing information for *Microchridium minutum* and *Ammoplanellus* subg. *Ammoplanellus umatilla* from old *Andricus quercuscalifornicus* (Cynipidae) galls on valley oak is presented. The probable parasite-host relationship between *M. minutum* and *A. umatilla* is noted.

During a study of insects inhabiting old *Andricus quercuscalifornicus* (Bassett) galls (Hymenoptera: Cynipidae), more commonly referred to as “oak apples,” fourteen specimens of *Ammoplanellus* subg. *Ammoplanellus umatilla* Pate and a female specimen of the monotypic *Microchridium minutum* Bohart were reared. The purpose of this paper is to present this rearing information and to note the probable parasite-host association between *M. minutum* and *A. umatilla*.

The wasps emerged from 250 *A. quercuscalifornicus* galls which were collected from a large, isolated valley oak (*Quercus lobata* Nee) in a residential backyard located at 4557 East Dakota, Fresno, Fresno County, California. The galls ranged from 2.5 to 10 cm (1 to 4 inches) in diameter, most possessed a few to many insect emergence holes of various sizes, and were located at a height of 2 to 3.3 m (6 to 10 feet) upon branches near the trunk of the oak. The galls were collected on 18 January 1982 and held outdoors in a sealed cardboard box until 27 December 1982, then the box was opened and examined for insects that failed to emerge. The *Microchridium minutum*, named so because of its small size (about 2 mm), and *A. umatilla* (about 3 mm) were dead lying amongst the galls on the bottom of the box. This data represents the first rearing records for both *M. minutum* and *A. umatilla*.

Bohart and Kimsey (1980) indicated the habitat of *minutum* as desert areas of Arizona and California. However, it was also recorded from Nebraska, Nevada, and Baja California, Mexico and thought possibly to be widespread west of the 100th meridian (Bohart 1980, Bohart and Kimsey 1982). The only biological information for *minutum* involves collection data on mats of *Euphorbia* (Bohart and Kimsey 1982).

No biological information is recorded for the five North American species of *Ammoplanellus*, though Pate (1945) proposed that the two species in the subgenus *Ammoplanellus* may nest in pre-existing holes or crannies and provision their burrows with Thysanoptera (thrips) as do *Ammoplanus*.

Over 40 years ago, Pate (1945) noted an undescribed genus of minute chrysidid

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wasp that was flying about holes in a chair from which *Hesperorhipis mirabilis* Knull (Coleoptera: Buprestidae) had emerged. Many *A. xila* Pate were also flying about these holes and presumably were nesting within the buprestid burrows. Though no specimens were reared, the observer indicated that the chrysidid was possibly a parasite of *A. xila*. This chrysidid was not described because the specimen Pate received was in poor condition (Pate 1939), but it is possible that it was a specimen of the recently described *M. minutum*.

It is postulated that *A. umatilla* nests in old *A. quercuscalifornicus* galls in pre-existing holes and *M. minutum* enters active nesting holes to parasitize it. Additional rearing and observation will be needed to substantiate this association.

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Probing Behavior of *Aphis helianthi* (Homoptera: Aphididae) and Its Preference for *Pittosporum tobira* Leaves of Different Ages

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Abstract.—A natural infestation of *Aphis helianthi* Monell exhibited a bimodal distribution on actively growing shoots of *Pittosporum tobira* Aiton. Peaks of abundance occurred on the youngest and oldest foliage. Aphids were also common on the mature leaves of year-old shoots that were producing new growth at their apices. Preference tests on leaf disks indicated a strong attraction to young leaves but not to mature or senescent leaves. Probing behavior was observed on young and mature leaves and duration of test probes was significantly longer on mature than on young leaves (median = 44.0s vs. 20.5s; $p = 0.0002$). The cuticle and outer epidermal cell walls of *P. tobira* were significantly thicker on mature than on young leaves (cuticle: 3.14μ vs. 1.08μ ; cell walls: 6.60μ vs. 1.75μ ; $p < 0.0001$). The results of the probing behavior experiments were not consistent with previous reports of probing behavior on *Citrus* and probable causes for the difference are discussed.

Although there have been many studies comparing aphid probing behavior among host and non-host or resistant and non-resistant plants, there have been few studies comparing probing behavior among different aged leaves of the same plant species. In one such study on *Citrus sinensis* (Linnaeus) Osbeck (Zettler et al. 1969), the duration of test probes by four species of aphids (*Aphis gossypii* Glover, *A. spiraecola* Patch, *A. craccivora* Koch, and *Myzus persicae* [Sulzer]) was extremely brief on mature leaves (over 60% of the probes were only 1–15 sec. in duration) in contrast to longer probes on succulent, immature leaves. Because of the extreme brevity of these probes, the authors concluded that some quality of mature citrus cuticle and/or outer cell wall of the epidermis was repellent to probing aphids and that this quality was either chemical in nature or merely an impenetrability of the thick mature cuticle. This differs from the conventional explanation that leaf age preference by aphids is primarily a function of nutritional quality of phloem sap (Kennedy 1958). Since there is a paucity of probing behavior studies on leaves of different ages, it was of interest to determine if aphid preference of young over mature leaves could be associated with repellency by mature cuticle and/or outer epidermal cell walls in other plant species. This would be of particular interest in plants with traits similar to citrus that might be associated with thick, tough mature leaf cuticles: evergreen perennials with long-lived leaves that thrive in xeric conditions of southern California. *Pittosporum tobira* Aiton, a common ornamental plant in southern California, meets these criteria. An infestation of *Aphis helianthi* Monell on *P. tobira* in Riverside, California, provided an opportunity to determine 1) if this aphid exhibited leaf age preference on *P. tobira*; 2) if nonpreference of a leaf

age was associated with very brief test probes; and 3) if the duration of test probes was correlated with cuticle thickness.

MATERIALS AND METHODS

Natural distribution.—A single *P. tobira* plant infested with *A. helianthi* was used for examining the distribution and leaf age preference of this aphid. This particular plant, unlike most ornamental *P. tobira*, was not shaped into a dense hedge and was therefore ideal for this study because it had long, actively growing terminals with a variety of leaf ages present on the same terminal. Effects of leaf age on the natural distribution of *A. helianthi* were evaluated during March 1985. Aphids were counted on the upper and lower surfaces from all leaves, from base to apex, on each of 6 actively growing terminals and each of 3 terminals from the previous year's growth. These 9 terminals comprised the bulk of the infestation on this plant.

Leaf age preference.—Aphids from this natural infestation were used to evaluate their leaf age preference. A cork borer (1.3 cm diameter) was used to cut leaf disks from leaves that were young (Y) (light green; not fully expanded; from near the apex of an actively growing terminal), mature (M) (fully expanded; dark green; hardened), or senescent (S) (mostly green but beginning to turn yellow on the upper leaf surface; lighter green on lower surface than mature leaves). Only one disk was cut per leaf. In each test, two leaf disks from each of two leaf ages were placed adaxial side down on moistened filter paper in a 5 cm diameter glass Petri dish. The 4-leaf disks were arranged in a square pattern so that leaf ages alternated and the edges of adjacent disks were in contact. Using an aspirator, 4 apterous aphids of various instars were carefully placed on each of the 4-leaf disks per Petri dish. There were four such dishes per test for a total of 64 aphids/test. The tests were conducted at room temperature and after 3.5–4.5 hrs. (except in one test: ca. 8.5 hrs.) numbers of aphids on each leaf disk were recorded.

Probe duration.—The durations of probes by *A. helianthi* on young and mature leaves were recorded using leaves collected from several field grown *P. tobira* plants. Leaves with intact petioles were collected by removing them from twigs and immediately immersing them in water. All tests were completed within 12 hrs. of picking the leaves. Leaves were placed individually in 1-dram shell vials filled with water and saturated cotton. The petioles were immersed in the saturated cotton and the blades extended erect above the vials. Parafilm was used to seal the opening of the vials around the protruding leaves such that the vials were water tight. The vials were held by a test-tube holder on a ring stand and could be easily rotated to facilitate microscopic viewing of the aphids on both leaf surfaces. Immediately prior to use, a thin barrier of petroleum jelly/mineral oil was placed on the base of the leaves to confine the aphids on the leaves.

Aphids were collected from a field plant in the morning (ca. 9–11 A.M.) and were held in glass Petri dishes without a food source until they were used in the experiment (two 10-min. periods between 1 P.M. and 10 P.M.). Using an aspirator, aphids (apterous adults and final nymphal instars) were carefully placed on the leaves and were observed for 10 min. with a Wild M5A stereomicroscope. A Volpi Intralux 5000 fiber optic ringlight provided a uniform and cool light source. The duration of each probe on the abaxial surface was recorded. If a probe started prior to the end of the 10-min. observation period and extended beyond it, the full duration of the probe

was recorded. The duration of a probe was defined as the time which the aphid was in characteristic "probing posture": labium extended perpendicular to the body plane and its tip touching the leaf surface. After the 10-min. testing period, each aphid was returned to a glass Petri dish without food. The next aphid was then tested on the alternate leaf age. After all aphids were tested once, each aphid was retested using a leaf age that was opposite to that used in its first test. There were 8 replicates, each conducted on a different day with different aphids. The first 4 replicates were conducted in April-May 1985 and the second 4 replicates in February-March 1986. The time involved in setting up the experiments resulted in only 5-9 aphids being used in any one replicate.

Duration of aphid probes (abaxial surfaces only) were analysed two ways. First, for each replicate, the duration of probes recorded on each leaf age was compared by the Mann-Whitney U test. Second, data from the 8 replicates were pooled and the median probe duration for each aphid on each leaf age was calculated. Median probe durations on young and mature leaves were paired for each aphid and were compared using the Fisher distribution-free sign test (Hollander and Wolfe 1973). Since test probes and not prolonged feeding probes were of major interest in the study, probe durations > 5 min. were truncated and given values of 5 min. prior to all analyses (such probes accounted for only 3% of all probes and had negligible effect on the medians).

Cuticle thickness.—Young and mature *P. tobira* leaves were collected for histological sectioning on 18, 19, and 23 April and 22 May 1985 (the same time period that replicates 1-4 of the probe duration experiment were conducted). These were fixed in FAA, embedded in paraffin, sectioned at 10 μ , and stained with hemalum and safranin. The thickness of the cuticle and outer epidermal cell walls on the lower leaf surfaces were measured with an ocular micrometer at 1000X.

RESULTS

Natural distribution.—On actively growing terminals, *A. helianthi* tended to be bimodally distributed with respect to leaf position (leaf age) on the terminals. Peaks of aphid abundance occurred at the basal (oldest) and/or apical (youngest) leaf positions. Fig. 1 illustrates the aphid distribution on an actively growing terminal where the bimodality was pronounced. The growth pattern of *P. tobira* is such that in the spring, groups of several new actively growing terminals tend to rise from the apex of a terminal from the previous year's growth. In addition to being present on actively growing terminals as described above, *A. helianthi* was also found in large numbers on some of the previous year's terminals that had actively growing terminals arising from their apices. The leaves on the previous year's terminals ranged from senescent at the base to mature at the apex. The limited number (3) of the previous year's terminals that were found infested with aphids prevents conclusions from being made, but it is important to note that aphids were found in large numbers on mature foliage of these terminals. In each of the 9 terminals that were examined, *A. helianthi* was found in greater numbers on lower leaf surfaces than on upper surfaces. In 7 of these 9 terminals the difference was significant ($p < 0.05$, Wilcoxon signed rank test).

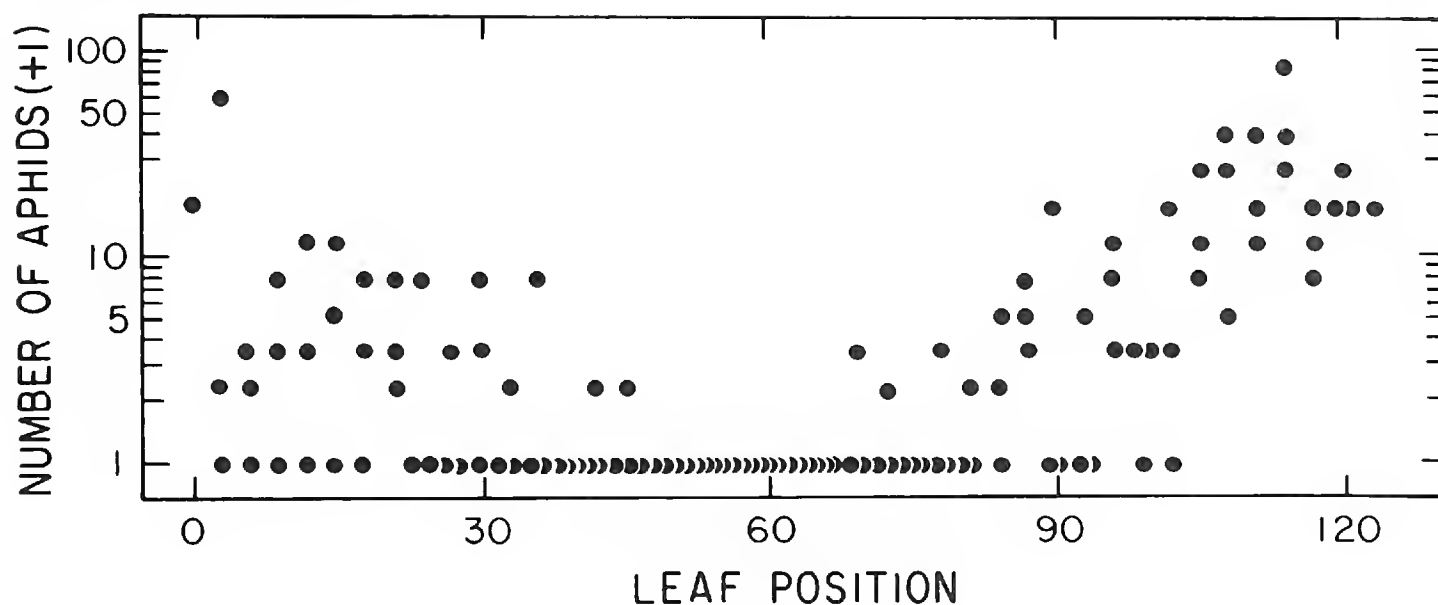


Figure 1. Numbers of *A. helianthi* found on leaves along the length of a long actively growing *P. tobira* terminal. Leaves are numbered from base to apex; number of aphids is plotted in a log scale (# aphids + 1).

Leaf age preference.—Table 1 shows that leaf disks cut from young leaves were preferred over those from mature or senescent leaves. In tests where no young leaf disks were included (M vs. S, Table 1), few aphids settled on any disk; most were on the moist filter paper or on the sides and top of the glass Petri dish. There was no consistent preference observed in the M vs. S tests although significantly more aphids were found on the mature disk than on the senescent disk after 4 hours in replicate 2 of the M vs. S comparison (Table 1). However, after 11 hours in this replicate there was no significant difference between the two ages of leaf disks (5 aphids were on each). The results presented in Table 1 did not significantly change over time in any of the other tests.

Probe duration.—Median probe duration of *A. helianthi* was greater on mature leaves than on young leaves in all 8 replicates (Table 2). The difference was significant at the $p = 0.10$ level in 7 of the 8 replicates and significant at the $p = 0.05$ level in 5 of the 8 replicates. When median probe durations on young and mature leaves were calculated for each aphid and analysed by paired analysis (pairing by aphid), probes on mature leaves were significantly longer ($p < 0.05$) than those on young leaves for the pooled data of each year of testing and the pooled data of both years combined (Table 2).

Cuticle thickness.—Histological examination of young and mature *P. tobira* leaves revealed that on lower leaf surfaces, the cuticle was significantly thicker on mature than on young leaves ($3.14\mu \pm 0.13$ vs. $1.08\mu \pm 0.20$; mean \pm SE; $p < 0.0001$, t test). In addition, there was also a significantly thicker outer cell wall of the lower epidermal cells on mature leaves as compared to young leaves ($6.60\mu \pm 0.21$ vs. $1.75\mu \pm 0.47$; $p < 0.0001$, t test). The differences between lower leaf surfaces of young and mature leaves is illustrated in Fig. 2.

Table 1. *Aphis helianthi* preference for *Pittosporum* leaf disks cut from young (Y), mature (M), and senescent (S) leaves

| Comparison | Leaf age | Number of settled aphids ^a | | |
|------------|----------|---------------------------------------|-----------|-----------|
| | | Rep. 1 | Rep. 2 | Rep. 3 |
| Y vs. M | Y | 42 *** | 36 *** | 29 *** |
| | M | 5 | 3 | 2 |
| Y vs. S | Y | 42 *** | 48 *** | — — |
| | S | 8 | 6 | — |
| M vs. S | M | 9 n.s. | 15 * | — — |
| | S | 6 | 4 | — |

^aTotal of 64 aphids (assorted instars) in each replicate; only those that settled on a leaf disk were used for analysis. Significance levels based on the binomial distribution and $H_o = P_o = 0.5$ are: *** $p < 0.0002$; * $0.01 < p < 0.005$; n.s. not significant.

Table 2. Median probe duration of *A. helianthi* on young and mature leaves of *P. tobira*.

| | Median probe duration (sec.) and (N) ^a | | Significance level |
|---------------------------------|---|-------------|--------------------|
| | Young leaf | Mature leaf | |
| Replicate 1 | 20.0 (22) | 54.0 (25) | .0087 ^b |
| Replicate 2 | 16.0 (26) | 40.0 (23) | .0003 ^b |
| Replicate 3 | 32.0 (43) | 48.5 (32) | .0002 ^b |
| Replicate 4 | 24.5 (32) | 39.0 (30) | .0275 ^b |
| Pooled rep. 1–4 (1985 tests) | 23.5 (29) | 52.0 (29) | .0207 ^c |
| Replicate 5 | 22.0 (29) | 23.5 (26) | .9194 ^b |
| Replicate 6 | 14.5 (34) | 35.0 (14) | .0001 ^b |
| Replicate 7 | 18.5 (46) | 36.0 (30) | .0607 ^b |
| Replicate 8 | 23.0 (43) | 42.0 (36) | .0982 ^b |
| Pooled rep. 5–8 (1986 tests) | 19.0 (31) | 35.0 (31) | .0011 ^c |
| Pooled rep. 1–8 | 20.5 (60) | 44.0 (60) | .0002 ^c |

^aN=number of probes for Mann-Whitney comparisons and N=number of aphids for Fisher distribution-free paired comparisons.

^bMann-Whitney U-test.

^cFisher distribution-free sign test.

DISCUSSION

Natural distribution.—The bimodal distribution of *A. helianthi* on actively growing terminals of *P. tobira* (Fig. 1) was not unexpected since this distribution pattern is commonly seen in the Aphididae as a group (Kennedy 1958). However, it was unexpected to find large numbers of aphids on mature leaves from some of the

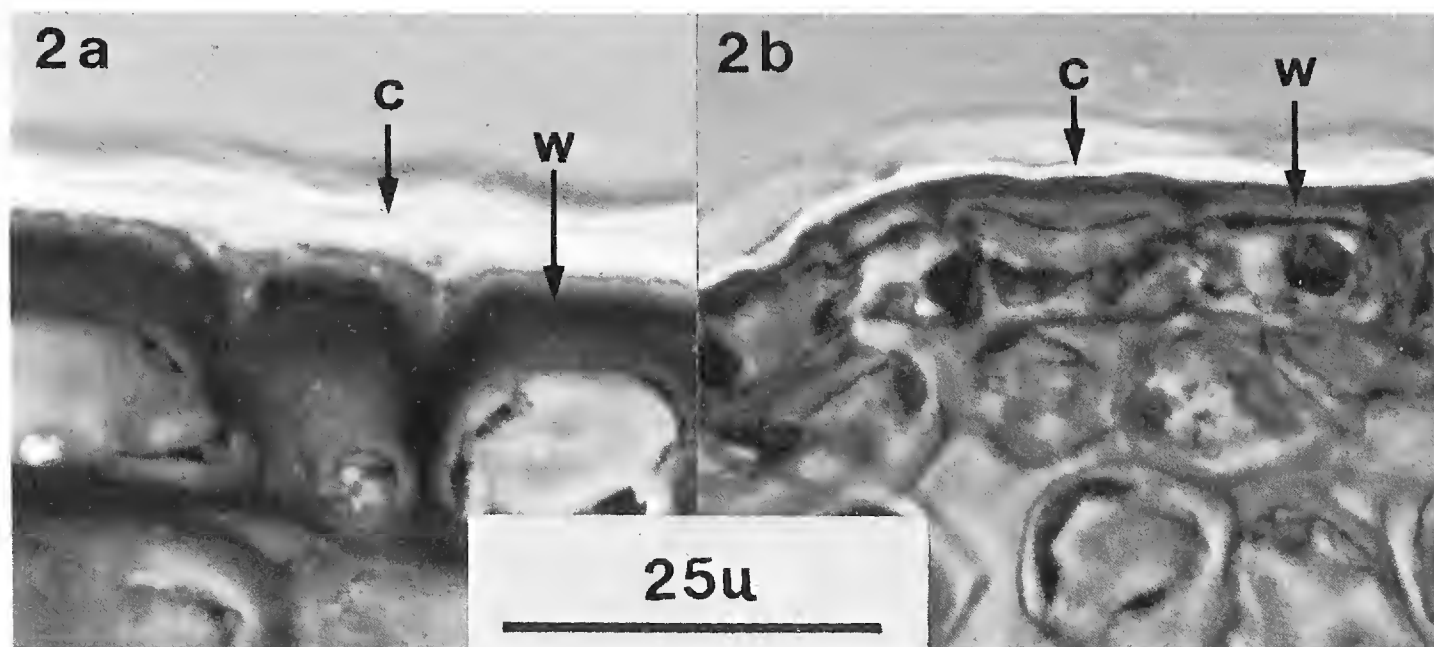


Figure 2. Lower leaf surface of *P. tobira* leaves. A: mature leaf. B: young leaf. c: cuticle. w: cell wall.

previous year's terminals that bore new, actively growing terminals at their apices. Perhaps these leaves were mobilizing nitrogen to supply the new, growing terminals and were consequently more nutritious for the aphids.

Leaf age preference.—*A. helianthi* showed a distinct preference for leaf disks cut from young *P. tobira* leaves vs. mature or senescent leaf disks (Table 1). This finding offers at least partial explanation for the great abundance of *A. helianthi* observed on young *P. tobira* leaves in nature (Fig. 1). Aphids did not readily settle on senescent leaves even though aphid abundance appeared to increase on senescent leaves in the field. However, Kennedy and Booth (1951) demonstrated that as leaves progress from the beginning of senescence to complete senescence, the preference of aphids for these leaves changes. Thus, the failure of the preference tests to detect preference of senescent over mature leaves may be a result of my criterion for choosing senescent leaves (slightly yellowed) not corresponding to the criterion that aphids presumably was (high amino acid concentration in the phloem). Alternatively, preferences observed on intact plants are not always detectable when using excised plant parts (Risch 1985) and may explain the discrepancy between the natural distribution and the preference tests. Nonetheless, both the natural distribution and preference tests suggested preference for young over mature leaves. Therefore, the probing behavior was studied in detail on these two age classes.

Probe duration and cuticle thickness.—The duration of probes by *A. helianthi* was significantly greater on mature *P. tobira* leaves than on young leaves. In contrast, Zettler et al. (1969), observed that probe duration of four species of aphids on *Citrus sinensis* was shorter on mature leaves than on young leaves. It is important to emphasize that most of the probes in both this study and in Zettler et al. (1969) were "test probes" and not phloem feeding probes since most were less than one minute and aphids require approximately a minute to penetrate the epidermis and considerably longer to reach the phloem (Pollard 1977). Both plant species are characterized by possessing a thin immature leaf cuticle and a thick mature leaf cuticle (*P. tobira*: Fig. 2, *Citrus sinensis*: Walker, unpublished observations).

Therefore, the mere greater thickness of mature cuticle compared to immature cuticle is not likely to be, by itself, the cause for the extremely brief probes observed on mature *Citrus*. This contention also is supported by Zettler et al. (1969) who observed that fully expanded *Crotalaria spectabilis* Roth leaves (which had cuticles similar in thickness to mature *Citrus* leaves) did not elicit the large proportion of brief probes seen on mature *Citrus* leaves. They did not compare young and mature *Crotalaria* leaves.

Clearly, the process of discrimination between young and mature leaves differs between aphids feeding on *P. tobira* and those on *C. sinensis*. I hypothesize that *A. helianthi* does not discriminate between young and mature *P. tobira* leaves until its stylets penetrate the cuticle and it can sample the internal constituents of the leaf, and that the greater duration of test probes on mature leaves is a consequence of the extra time required to penetrate the extremely thick mature cuticle and outer epidermal cell wall. This hypothesis is congruous with the widely held belief that aphid leaf age preference is primarily a function of the nutritional quality of the leaf. However, in the case of citrus, aphids probably discriminate between young and mature leaves before their stylets penetrate the cuticle and hence mature leaves are rejected after very brief test probes. In citrus, the epicuticular wax or other surface components may contain probing repellents or lack required probing stimulants (Klingauf et al. 1978, Jördens-Röttger 1979).

ACKNOWLEDGMENTS

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A New Genus of Naucoridae (Hemiptera) from the Philippines, with Comments on Zoogeography

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Abstract.—The genus *Sagocoris* Montandon is endemic to New Guinea with the supposed exception of a single species, *S. usingeri*, described by La Rivers from Luzon. A recent examination of the type of this species reveals that it is not congeneric with *S. biroi*, the type-species of *Sagocoris*. A new genus, *Philippinocoris*, is thus proposed to hold the Philippine taxon, and notes are given on the relationships of the Philippine naucorid fauna to that of New Guinea and Asia.

We thank Dr. R. T. Schuh of the American Museum of Natural History (AMNH) for the loan of the types of *S. usingeri*, and Dr. Wayne Gagne for the loan of material held in the Bishop Museum, Honolulu (BPBM). All additional material is held in the J. T. Polhemus collection, Englewood, Colorado (JTPC). Measurements are given in millimeters. This research was supported in part by a grant from the National Geographic Society, Washington, D.C.

Philippinocoris n. gen.

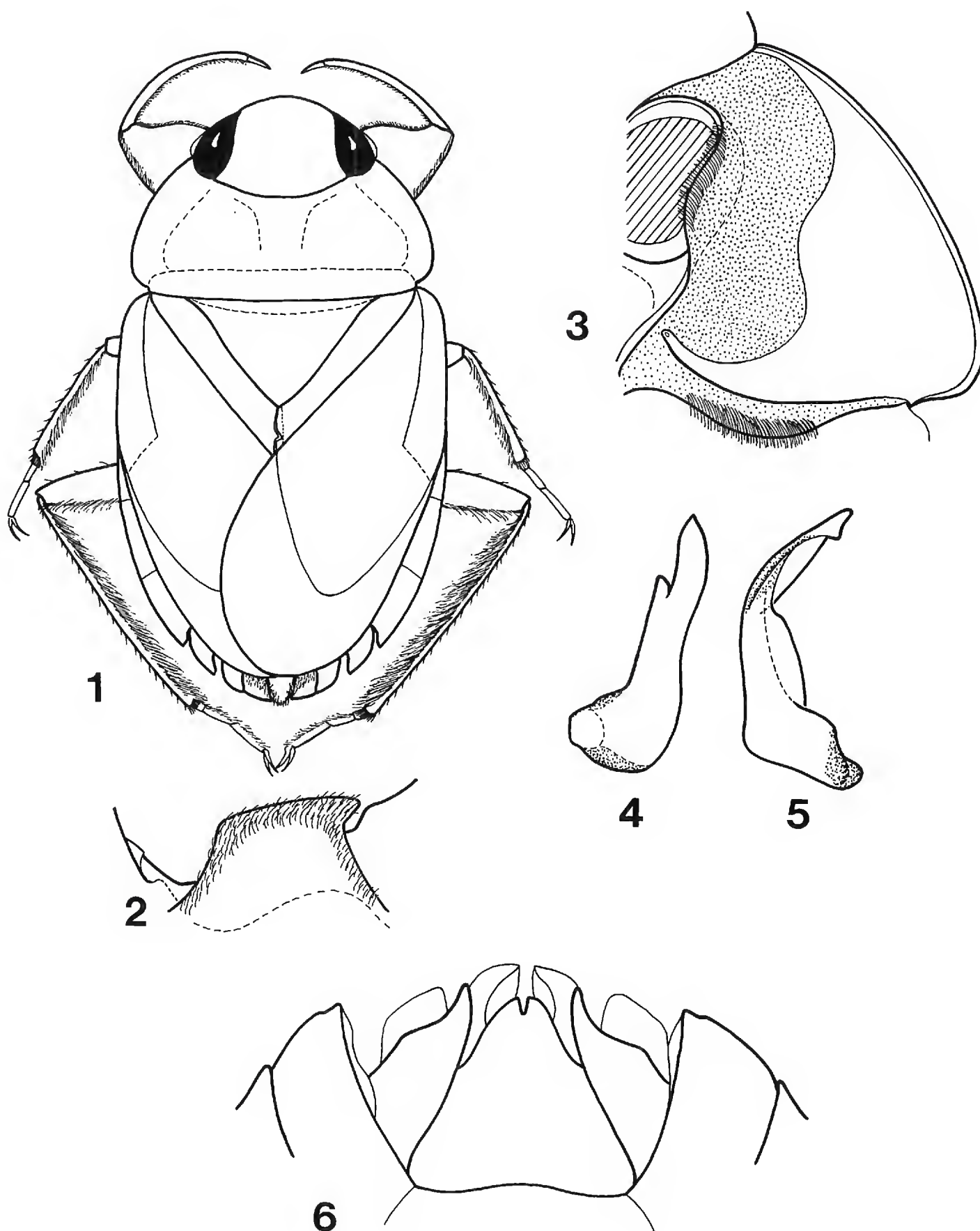
Description.—Form oblong with sides subparallel, widest across abdomen (Fig. 1).

Head broad, produced ahead of eyes for over .25 the length of an eye, anteclypeal margin gently rounded, vertex produced for short distance behind eyes, posterior margin gently curving; eyes twice as long as wide, with small lateral flange; labrum large, well developed, arising behind anterior margin of anteclypeus; maxillary plates vertically oriented, tips pointed, exceeding base of labrum; rostrum arising well behind anterior margins of eyes when viewed laterally, occupying cavity formed by maxillary plates and carinate margins of tectiform gula; antennae with segment I short, segment II enlarged, segments III and IV slender, covered with long setae.

Pronotum evenly domed, not sulcate medially behind head, lateral margins broadly rounded, posterolateral angles obtuse. Scutellum shallowly and transversely sulcate basally, with several backwardly angling shallow sulci apically to either side of smooth medial surface. Hemelytra complete, attaining base of genital segment, surface shining, finely rugose, bearing granular white microstructure; embolium, clavus and claval vein well defined, embolar margin not expanded, nearly straight, lacking setae.

Abdomen with connexivum evenly rounded, posterolateral angles not prominent, posterior margin of tergite V in males weakly sinuate, posterolateral angles of tergite VI in females angled sharply downward.

Ventral surface with prosternum carinate medially, exposed for entire length, anteromedial portion angled forward over base of gula (Fig. 2); propleural plates not touching medially, widely separated by exposed prosternum, posterior margins and



Figures 1–6. *Philippinocoris usingeri* (La Rivers). 1. Male, dorsal habitus. 2. Prosternal keel, lateral view. 3. Prothorax, right side as viewed ventrally. 4. Male left paramere. 5. Male right paramere. 6. Female subgenital plate (setiferation omitted).

flanges bordering fore coxal cavities fringed with gold setae (Fig. 3), inner portions adjoining fore coxal cavities darkened, pruinose; mesosternal plate reflexed anteromedially, tumescent posteromedially, tumescence bearing long gold setae; metasternal plate glabrous, cruciform, with sharp longitudinal carina medially; abdominal venter thickly clothed with gold hydrofuge pile, paratergites bearing paired elongate glabrous depressions adjacent to spiracles.

Legs with fore tarsus single segmented, bearing single minute claw, middle and hind tibia bearing numerous short stout spines along anterior margins, long fine swimming hairs present on middle and hind femora, tibiae and tarsi, parempodia setiform.

Male genitalia with asymmetrical parameres of roughly equal size (Figs. 4, 5); vesica slender, tapering, asymmetrical, sclerotized, coming to acute point apically.

DISCUSSION

Philippinocoris n. gen. is most closely related to *Stalocoris* and *Asthenocoris*, all three genera being endemic to the Philippines. These genera share a common plan in the male genitalia, possessing a slender, tapering, asymmetrical sclerotized vesica and distinctively shaped left parameres of much the same form as those found in the genus *Naucoris*. In the Papuan *Sagocoris*, by contrast, the vesica, though still asymmetrical, bears a broadly expanded, partially membranous lobe apically and the left paramere is reduced to a small truncate stub, character states also found in the closely related Papuan genus *Aptinocoris*. Additional characters present in *Philippinocoris* and absent in *Sagocoris* are the large dark pruinose area on the inner portion of the propleura adjoining the fore coxae, the fringes of gold setae along the posterior margin of the propleura and on the flange adjoining the fore coxal cavity, the mesosternal tumescence covered with long gold setae and the strongly carinate cruciform metasternal plate. In *Sagocoris* the rostrum arises ahead of the anterior margin of the eye when viewed laterally, while in *Philippinocoris* the rostrum is set farther back, arising behind the anterior eye margin. Abdominal asymmetry is present in both sexes of *Sagocoris*, the males having a distinct offset notch in the posterior margin of tergite V and the females of most species having the posterolateral angles of tergites VI and VII prolonged on the left side when viewed from above. In *Philippinocoris* the posterior margin of tergite V in males is only weakly sinuate, lacking a deep notch, and the female tergites are symmetrical.

Philippinocoris is quite closely allied to *Stalocoris*, from which it may be separated by the greater degree of prolongation of the head in front of the eyes. In *Stalocoris* the head is produced beyond the eyes for only .11 the length of an eye while in *Philippinocoris* it extends anteriorly for .27 of the eye length. In addition the apices of the maxillary plates in *Stalocoris* do not exceed the base of the labrum as in *Philippinocoris*, due to the labrum being recessed less deeply beneath the anteclypeus, and the posterior margins of the propleurae lack a fringe of gold setae. *Stalocoris* species are also much smaller, averaging 6 mm. in length while specimens of *Philippinocoris*, at over 10 mm., are nearly twice as large.

As noted above, the three endemic genera of Philippine Naucoridae appear to be a closely related monophyletic group derived from the Naucorinae. One can trace a progressive modification of head structures from the primitive state in *Naucoris*, in which the labrum and rostrum arise essentially at the front of the head, to *Stalocoris*, in which both are slightly recessed, and on through *Philippinocoris* to *Asthenocoris*; in this latter taxon the labrum is recessed well under the anteclypeus and the rostrum has moved far back into a cavity on the underside of the head. The head structure in *Asthenocoris* is similar to that encountered in the Asian Cheirochelini and was considered evidence for a relationship between the Philippine and Indochinese taxa by Usinger (1938), but this resemblance is more likely the result of convergent evolution since the Cheirochelini have a distinctive symmetrical vesica and parameres quite unlike anything seen in the Philippine genera, as well as numerous

other synapomorphies distancing them from any Philippine or New Guinea species (D. Polhemus, in press). The endemic Philippine taxa are distinguished by the anterior projection of the prosternum, which angles forward over the base of the gula when viewed laterally (Fig. 2); this character state is not shared with the New Guinea taxa, in which the prosternal keel and gula meet evenly or show a weak projection of the gula posteriorly over the prosternum.

Although the naucorid faunas of the Philippines and New Guinea are allied, they appear to represent independent insular radiations from a common ancestral taxon near the present day *Naucoris*. Neither fauna shows an exceptionally strong relationship with either continental Asia or Australia. New Guinea is geologically younger than the Philippines but the degree of generic differentiation there has been far higher, producing seven endemic genera as compared to only three in the Philippines. This may be in part attributable to competition from other naucorid lineages in the latter region. *Aphelocheirus* has diversified extensively on Luzon but is represented by but a single species in New Guinea. In the southern Philippines laccocorine naucorids, the dominant subfamily on the Asian continent and through the Greater Sunda Islands, have managed to invade Mindanao via the Sulu Archipelago but occur no farther north than Leyte, and have not differentiated, being represented only by the abundant *Laccocoris hoogstraali*, a species closely related to taxa present in north Borneo; this subfamily does not occur on New Guinea.

Philippinocoris is known only from Luzon, which harbors an extremely rich and entirely endemic naucorid fauna; most of the distinctive Philippine elements appear to have arisen here and dispersed southward through the archipelago, but their influence is not felt beyond Mindanao. The large island of Celebes, lying between the Philippines and New Guinea, has a surprisingly impoverished naucorid fauna containing only the widespread genera *Naucoris* and *Aphelocheirus* despite an abundance of favorable habitats, a situation also pertaining in Australia. Why these two areas should not have developed radiative faunas similar to those found in the Philippines and New Guinea is puzzling and indicates that the latter two areas may have had a geological association predating the present juxtaposition of land masses in Wallacea.

***Philippinocoris usingeri* (La Rivers) New Combination**

Sagocoris usingeri La Rivers, 1970: 167.

The original description of the species by La Rivers (1970) is quite complete, but was based only on male specimens. We now have female examples, which are quite similar to the males in general structure and coloration. The subgenital plate is trapezoidal with a small, deep notch apically (Fig. 6), and the posterolateral angles of abdominal tergite VI are sharply downturned, usually to a greater degree on the left side when viewed from above. All specimens so far examined, of both sexes, have complete hemelytra but only partially developed hind wings and would appear to be incapable of flight. At present *P. usingeri* has been found only in the Cordillera Central of northern Luzon, where it inhabits cold, crashing, unpolluted rocky streams. The insects were found only in a few of the many streams sampled, but then in great numbers clinging to submerged vertical rock faces or root tangles along the margins of protected pools sheltered from the full force of the current, a habitat similar to that preferred by the related genus *Stalocoris*.

Material examined.—PHILIPPINES, Luzon, **Benguet Prov.**: 13 males, 20 females, 3 nymphs, rocky stream nr. km. 230 on Kennon Rd., 20 km. S. of Baguio City, 613 m. (2000 ft.), vii.8.85, CL 1966, J. T. and D. A. Polhemus (JTPC); 52 males, 33 females, 1 nymph, stream below Camp John Hay hydro plant, S. of Baguio City, 920 m. (3000 ft.), vii.8.85, CL 1968, J. T. and D. A. Polhemus (JTPC). **Mountain Prov.**: 2 males (holotype and paratype), Benguet, vii15.46, D. G. Frey (AMNH). **Ifugao Prov.**: 1 male, 1 immature, Jacmal Bunhian, 24 km. E. of Mayoyao, 800–1000 m. (2624–3280 ft.), iv.25.67, H. M. Torre Villas (BPBM).

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A Review of the Genus *Nesostethus* Kirkaldy (Hemiptera: Lygaeidae: Lygaeinae)

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Abstract.—The genus *Nesostethus* Kirkaldy is reviewed, and the known species, *N. niger* China and *N. ornatus* Kirkaldy, are redescribed. Four new species are described: *N. bipartitus* and *N. variegatus* from Fiji, *N. fuscus* from the New Hebrides, and *N. lunatus* from Tonga.

Kirkaldy (1908) described *Stalagmostethus ornatus* as a new species from Fiji (Rewa) and placed it in a new subgenus that he named *Nesostethus*. He characterized this by color and by the following structural features: fourth labial segment longer than third; scutellum with T-shaped carina; hemelytra with strong veins; pronotum with keel, but this obsolete anteriorly.

China (1930) elevated *Nesostethus* to generic rank and described a new species *N. niger* from Samoa. However, he was unsure of the generic placement, stating “the present Samoan species has been referred to it, in spite of the fact that there are certain differences which Stål and Kirkaldy have regarded as of subgeneric importance. This course seems to be preferable (for the time being at any rate) to that of creating still another genus.” Since this time, there has been no reference to the genus, except for the citation in Slater (1964).

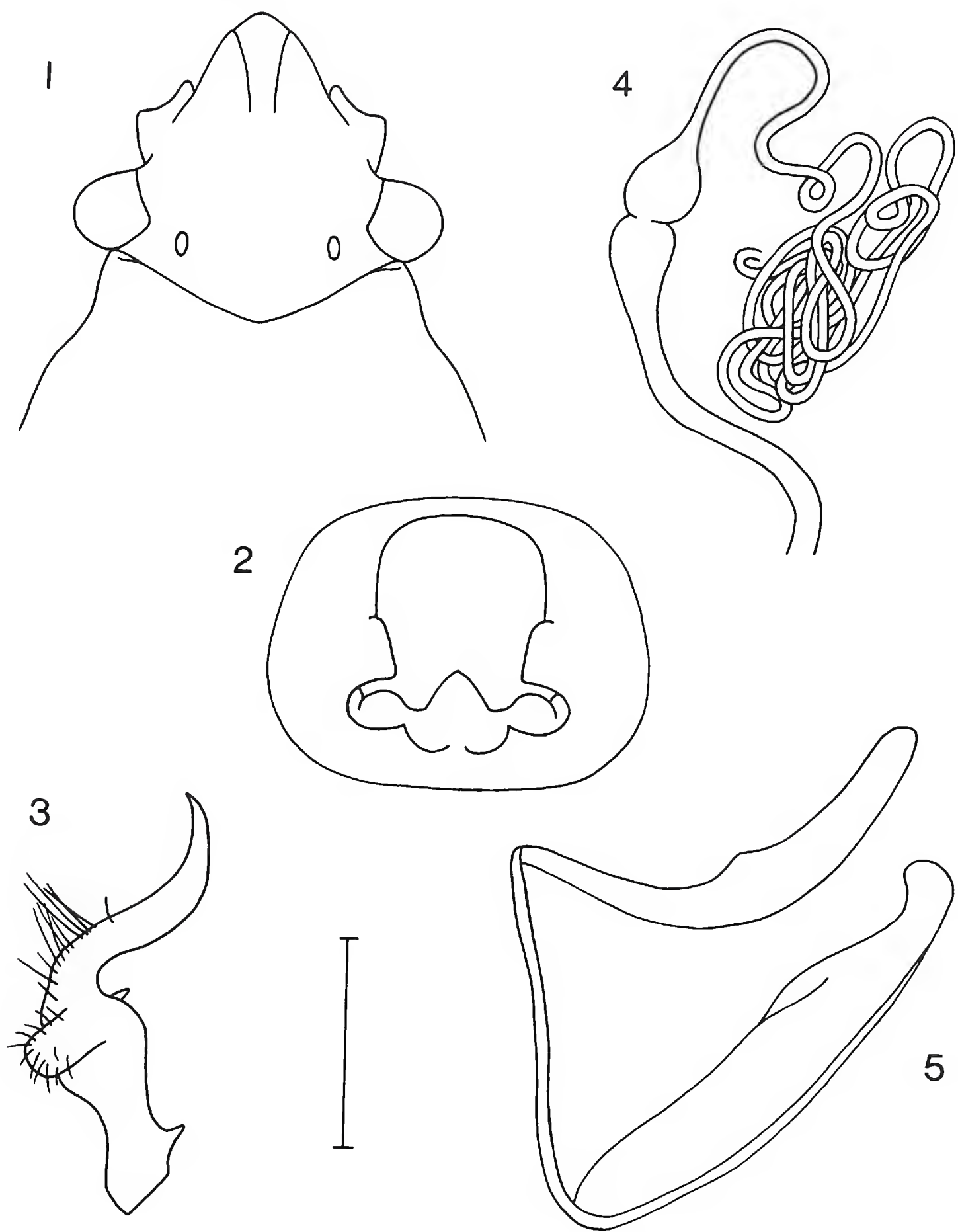
In my ongoing study of the Pacific Lygaeinae, I have needed to clarify the identity of the genus. In the study of available material, I have found four new species. I herein redescribe the genus, the known species and the new taxa.

Nesostethus Kirkaldy

Stalagmostethus sg. *Nesostethus* Kirkaldy 1908, Proc. Linn. Soc. N.S.W. 33:355.
Nesostethus; China 1930, Ins. Samoa, Pt. 2, Hemipt. 3:115.

Moderate to large (7.7–11.1 mm), variously colored orange, red and black insects; macropterous, body matt with head, lateral margins of pronotum, costal margin of corium, legs and abdomen shiny. Dorsum at most with short, curved, decumbent pubescence.

Head (Fig. 1) moderately declined, and in line with pronotum; wider than long; eyes not stylate; eyes close to anterior margin of pronotum; vertex gently convex and smooth; ocelli closer to eyes than to each other; antennal tubercles visible from above; bucculae prominent anteriorly, tapering posteriorly, and extending to level of middle of eye. First antennal segment surpassing apex of head by about half of length; third segment gradually thickening apically; fourth antennal segment usually slightly longer than second. Rostum reaching to or just beyond hind coxae; first segment slightly thicker than second and just surpassing anterior margin of prosternum; fourth segment longer than third.



Figures 1–5. *Nesostethus ornatus*. 1. Head and anterior part of pronotum. 2. Caudal view of male genital capsule. 3. Right clasper. 4. Spermatheca. 5. Second gonocoxa and gonopophysis. Scale line = 0.50 mm for Fig. 1, 0.33 mm for Fig. 2 and 0.165 for Figs. 3, 4 and 5.

Pronotum at most weakly punctate anteriorly; anterior margin without collar, concave in centre and appearing rather sinuate; posterior margin straight or slightly concave, with shallow impression on either side of scutellum; lateral margins rounded, straight and somewhat convergent anteriorly; disc gently convex, with median longitudinal carina behind callal area, and slight transverse impression

one-third way from anterior; callal area flat or gently convex, the calli sinuate and slightly oblique.

Scutellum flat with tumid T-shaped carina; laterally impunctate and fovea not distinct; apex roundly pointed. Ostiolar peritreme auriculate.

Hemelyta reaching just beyond end of abdomen; costal margin straight or gently sinuate; clavus and corium with veins strongly raised; basal third of costal margin and claval commissure hirsute.

Legs unarmed; coxae hirsute. Abdomen without laterotergites, but with sternum II exposed; sterna III-VI with anterior dorso-lateral "apertures." Male genital capsule and parameres as in Figs. 2-3; spermatheca as in Fig. 4; second gonapophysis with upturned tip (Fig. 5).

Type species: *Stalagmostethus (Nesostethus) ornatus* Kirkaldy 1908 (Monobasic).

Structurally the head and pronotum are similar to *Melanerythrus* Stål, but *Nesostethus* differs by having less elevated bucculae, strongly raised venation on the corium and clavus, the fourth rostral segment longer than the third, and the scutellum with a T-shaped tumid elevation rather than a longitudinal central carina.

Although nothing is known about the biology, specimens of *N. ornatus* have been found to contain cardenolides in very high concentrations (Scudder and Duffey 1972). The genus may thus be associated with Asclepiadaceae and the abdomen appears structurally capable of releasing cardenolides as in *Oncopeltus fasciatus* (Scudder and Meredith 1982).

Nesostethus bipartitus NEW SPECIES

Male.—Head, dorsally and ventrally, red with apex of clypeus black; antennae black; rostrum black with first segment and base of second, orange-red. Pronotum orange-red with humeral angles and median longitudinal streak on hind margin, black. Scutellum orange-red. Clavus black; corium black with costal half of apical two-thirds red; membrane black with apical margin narrowly white. Prosternum, thoracic pleura and ostiolar peritreme, orange-red. Coxae orange-red; rest of legs black. Abdomen red. Head width 1.60 mm; antennal measurements 0.77: 2.13: 1.67: ? mm; rostrum reaching to posterior margin of hind coxae. Pronotal width 2.47 mm, pronotal length 1.58 mm. Anterior half of pronotum punctate. Corium with very sparse, short decumbent pubescence; costal margin of corium sinuate. Thoracic pleura with scattered, short, semi-erect hairs. Total length 8.8 mm.

Holotype.—♂, FIJI, Matuku I., 5.vii.24 (E. H. Bryan, Jr.) (Bishop Museum).

Similar to the species herein described as *N. variegatus*, but differing in the color pattern of the corium and membrane.

Nesostethus fuscus NEW SPECIES

Female.—Insects completely black, except for ostiolar peritreme and abdomen which are yellow; anterior dorso-lateral corners of sterna III-VI with small fuscous spots. Head width 1.70 mm; antennal measurements 0.83: 2.17: 1.60: 2.23 mm; rostrum attaining hind coxae. Pronotal width 3.07 (2.95-3.07) mm; pronotal length 2.00 (1.90-2.00) mm. Pronotum anteriorly vaguely punctate; corium with scattered, short, decumbent pubescence; costal margin of corium sinuate. Thoracic pleura with distinct decumbent, sericeous pubescence. Total length 10.5 (9.8-10.5) mm.

Male.—Color and structure as in female. Head width 1.60 (1.53-1.70) mm;

antennal measurements 0.74 (0.67–0.83): 2.05 (1.93–2.20): 1.53 (1.50–1.60): 2.18 (2.10–2.74) mm. Pronotal width 2.58 (2.37–2.80) mm; pronotal length 1.71 (1.57–1.90) mm. Total length 8.5 (8.3–9.3) mm.

Holotype.—♀, NEW HEBRIDES, Maewo I. Sounwari, 15° 23' S 168° 07' E, 0–400 m, 4–5.ix.79 (W. C. Gagne) (Bishop Museum).

Paratypes.—2♂ 1♀, NEW HEBRIDES (but labelled Solomon Is.), Epi (H. W. Simmonds); 1M, NEW HEBRIDES, Malekula, Ounua, ii.29 (L. E. Cheesman); 1M, NEW HEBRIDES, Espirito Santo, 12.iii.43; 1♀, NEW HEBRIDES, Epi I., Valmali, 80–150 m, 11–18.viii.67 (J. & M. Sedlacek); (Bishop Museum; British Museum [Nat. Hist.]; Scudder Coll.).

This species can be separated from *N. niger* by the moderately dense, decumbent pubescence to the corium and thoracic pleura, the sinuate costal margin, and the yellowish ostiolar peritreme and abdomen.

Nesostethus lunatus NEW SPECIES

Male.—Head, dorsally and ventrally orange-red, with apex of clypeus and v-shaped mark between ocelli, black; antennae black; rostrum fuscous with most of first segment orange-red. Pronotum and scutellum orange-red. Corium and clavus completely black; membrane black with apical margin narrowly white, and basal angle with white area. Prosternum, thoracic pleura and ostiolar peritreme, orange-red. Legs black with coxae orange-yellow. Abdomen orange-yellow.

Head width 1.50 mm; antennal measurements 0.67: 1.90: 1.53: 2.03 mm; rostrum reaching to middle of hind coxae. Pronotal width 2.23 mm, pronotal length 1.42 mm. Pronotum vaguely punctate. Corium with sparse, short, decumbent pubescence; costal margin of corium almost straight. Thoracic pleura with scattered, short, semi-erect hairs. Total length 7.7 mm.

Holotype.—♂, TONGA IS., Vavua I., Neiafu, ii.56 (N. Krauss) (Bishop Museum).

Similar to *N. ornatus*, but differing in the coloration of the membrane.

Nesostethus niger China

Nesostethus niger China 1930, Ins. Samoa, Pt. 2, Hemipt. 3:113.

Female.—Insects completely black, except for posterior and dorsal areas of metapleuron and ostiolar peritreme, which are dusky orange, and abdomen, which is orange-red.

Head width ♀ 1.75 mm; antennal measurements ♀ 0.34: 2.50: 1.80: 2.30 mm; rostrum reaching to hind coxae. Pronotal width ♀ 2.65 mm, pronotal length ♀ 2.00 mm. Pronotum anteriorly vaguely punctate. Corium almost glabrous, with at most scattered, short, decumbent pubescence, the costal margin straight. Thoracic pleura virtually glabrous. Total length ♀ 9.3 mm.

Material examined: 1♀ (type) SAMOA, iii–viii.21 (F. W. O'Connor) (British Museum [Nat. Hist.]).

N. niger can be recognized by the predominantly black color and orange-red abdomen, with the corium rather glabrous and the costal margin straight. The species herein described as *N. fuscus* differs in having the costal margin of the hemelytra sinuate and surface of corium and thoracic pleura with a moderately dense, short, decumbent pubescence.

Nesostethus ornatus Kirkaldy

Stalagmosthethus (Nesostethus) ornatus Kirkaldy 1908, Proc. Linn. Soc. N.S.W. 33:355.

Nesostethus ornatus; China 1930, Ins. Samoa, Pt. 2, Hemipt. 3:115.

Head, dorsally and ventrally orange-red, with apex of clypeus and v-shaped area between ocelli, black; antennae black; rostrum black with basal half of first segment orange-red. Pronotum and scutellum orange-red, the humeral angles of pronotum sometimes slightly dusky. Hemelytra, including membrane, completely black. Prosternum, thoracic pleura and ostiolar peritreme, orange-red. Legs black, with coxae orange-yellow. Abdomen pale greenish.

Head width ♂ 1.65 (1.60–1.70) mm, ♀ 1.79 (1.70–1.85) mm; antennal measurements ♂ 0.73 (0.70–0.75): 2.08 (2.00–2.15): 1.60 (1.55–1.70): 2.33 (2.20–2.45) mm, ♀ 0.78 (0.75–0.80): 2.32 (2.25–2.35): 1.73 (1.70–1.75): 2.15 mm; rostrum reaching to middle of hind coxae. Pronotal width ♂ 2.50 (2.30–2.65) mm, ♀ 3.06 (2.80–3.30) mm; pronotal length ♂ 1.65 (1.55–1.70) mm, ♀ 2.01 (1.85–2.15) mm. Pronotum anterior vaguely punctate; corium almost glabrous; costal margin of corium sinuate. Thoracic pleura with scattered, short, semi-erect hairs. Total length ♂ 8.4 (8.2–8.5) mm, ♀ 10.8 (10.5–11.1) mm.

Material examined.—1♀, FIJI, Cuvu, 1.i.17 (R. Veitch) (BM); 1♂, FIJI IS., Levuka, v.21 (H. W. Simmonds) (British Museum); 1♂ 1♀, FIJI, Ovalau, v.22 (H. W. Simmonds) (BM); 1♂, FIJI IS., Viti Levu, Colo-i-Suva, 28.vi.24 (E. H. Bryan, Jr.) (Bishop Mus.); 1♀, FIJI, Colo. Emb., 10.iii.42 (R. A. Lever) (British Museum); 1♀, Ins. Viti (Stockholm).

Similar to the species herein described as *N. lunatus*, but with a completely black membrane.

Nesostethus variegatus NEW SPECIES

Male.—Head, dorsally and ventrally, orange-red with apex of clypeus black; antennae black; rostrum black, the first segment orange-red with extreme apex black. Pronotum and scutellum orange-red. Clavus black; corium with basal half black and apical half red; membrane black with apical third fading through ochraceous to pale apical margin, the basal angle with a pale white triangular mark. Prosternum, thoracic sterna and ostiolar peritreme orange. Coxae orange; trochanters dusky orange; rest of legs black. Abdomen red.

Head width 1.53 mm; antennal measurements 0.67: 1.87: ?: ? mm; rostrum reaching to sternum II. Pronotal width 2.00 mm, pronotal length 1.33 mm. Pronotum anteriorly vaguely punctate; thoracic pleura with scattered, short, semi-erect hairs; corium with scattered, short, decumbent pubescence; costal margin of corium sinuate. Total length 7.3 mm.

Holotype.—♂, FIJI, Lau, Fulanga, 5.viii.24 (E. H. Bryan, Jr.) (Bishop Museum). Museum).

Similar to the species herein described as *N. bipartitus*, but differing in color pattern of the corium and membrane.

Key to Species of *Nesostethus*

1. Head, pronotum, scutellum, thoracic pleura and coxae, black 2
- Head, pronotum, scutellum, thoracic pleura and coxae, orange-red 3

- 2. Dorsum more or less glabrous; costal margin of corium straight; abdomen red *niger* China
- Dorsum with distinct, decumbent, sericeous pubescence; costal margin of corium sinuate; abdomen pale yellow *fuscus* Scudder
- 3. Corium completely black 4
- Corium not completely black 5
- 4. Membrane completely black *ornatus* Kirkaldy
- Membrane black with margin narrowly pale, and with white triangular area at basal angle *lunatus* Scudder
- 5. Corium with basal half black, apical half red *variegatus* Scudder
- Corium black with costal half of apical two-thirds red ... *bipartitus* Scudder

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***Rhyacionia zozana* (Lepidoptera: Tortricidae), Host of *Hockeria tenuicornis* (Hymenoptera: Chalcididae) in Oregon**

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Abstract.—A new parasite-host record of *Hockeria tenuicornis* (Girault) from *Rhyacionia zozana* (Kearfott), a pest of pines, is presented. This information represents the first host report and a new state record (Oregon) for *Hockeria tenuicornis*.

Hockeria tenuicornis (Girault) is one of ten species of *Hockeria* Walker that occur in North America (Halstead, unpublished). This wasp, described by Girault, (1918) is known from Arizona, California, and Montana (Burks 1979). The hosts only three North American species of *Hockeria* have been recorded: larvae of *Myrmeleon immaculatus* DeGeer and *Myrmeleon* sp. (Neuroptera: Myrmeleontidae) for *Hockeria eriensis* (Wallace); pupae of *Neodiprion excitans* Rohwer and *Neodiprion* sp. (Hymenoptera: Diprionidae) for *Hockeria unipunctatipennis* (Girault); and *Harrisina brillians* Barnes and McDunnough (Lepidoptera: Zygaenidae) for *Hockeria rubra* (Ashmead) (Burks 1979).

The genus *Rhyacionia* contains several species that are economically important pests of pines (*Pinus* spp.) in nurseries, ornamental plantings, and in natural and planted reforestation projects (Powell and Miller 1978). One such species, *Rhyacionia zozana* (Kearfott), attacks various species of pines (*Pinus ponderosa*, *jeffreyi*, *contorta*, *edulis*, *monophylla*, *monticola*, and *flexilis*) in the western United States (Stevens et al. 1980, Powell and Miller 1978). The parasites of *Rhyacionia* have been the subject of many studies (see Harman and Kulman 1973, Yates 1967).

During studies on the parasite complex of *Rhyacionia zozana*, five female specimens of *Hockeria tenuicornis* were reared. One wasp was obtained from a collection of 729 third and fourth instars and the other four specimens from a collection of about 7,000 cocoons. All wasps emerged from *Rhyacionia zozana* cocoons the spring after their collection.

One voucher specimen (#001) of *Hockeria tenuicornis* is deposited in the United States Museum of Natural History, Washington, D.C. The rearing data are as follows: Cave Mountain, Klamath County, Oregon, exit *Rhyacionia zozana* on ponderosa pine, *Pinus ponderosa*, 18.v.85, Christine Niwa collector.

These data represent two new records for *Hockeria tenuicornis*, a host in North America, and its occurrence in Oregon (new state record).

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A New *Microcalyptris* Species from California (Lepidoptera: Nepticulidae)

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Abstract.—A new species of *Microcalyptris* Braun, is described from Antioch, California. The adult, larva and mine are illustrated. The larval chaetotaxy of a *Microcalyptris* species is figured for the first time. The larva forms a serpentine mine in the stem epidermis of *Lotus scoparius* (Nutt. in T. & G.) Ottley. Stem mining has not been reported for *Microcalyptris*.

The eight described species of *Microcalyptris* are restricted to North America (Wilkinson 1979). A new species, *Microcalyptris lotella* is described from Antioch Dunes National Wildlife Refuge, which is a remnant of a once extensive dune system along the San Joaquin River near its confluence with the Sacramento River. The new species shares most characters of the genus as defined by Davis (1978) and Wilkinson (1979). Unlike other *Microcalyptris* species, *M. lotella* is a stem epidermis miner.

Microcalyptris lotella New Species

Description.—External features for male and female (Fig. 1): Forewing length 2.0–3.3 mm. Vertex and frons whitish to tan, scales occasionally dark-tipped; eyecap large, nearly concolorous with vertex. Antenna 42–45 segmented; flagellum shiny dark brown. Dorsum of thorax and forewing irrorated with grayish scales, darkened apically; fringe tan. Hindwing shiny whitish gray; basal third covered with ochraceous androconia; fringe tan. Forewing venter uniformly silver gray-brown, basal third with ochraceous androconia between costal and anal veins. Abdomen with shiny grayish buff scaling. Legs smooth, grayish. Venation (Fig. 2): Forewing with six veins reaching the wing margin (nomenclature follows Wilkinson 1979); radius three-branched (R1, R2 + 3 and R4 + 5), R4 + 5 ending at wing tip; median unbranched, arising from R4 + 5; cubitus absent; anal vein bent basally. Hindwing narrow; five veins reaching wing margin.

Male Genitalia (Figs. 3–5): Tegumen (pseuduncus) hoodlike enclosing the uncus, posterior margin truncate to shallowly emarginate, bearing 20–26 curved setae. Uncus with dorsal knob; gnathos broadly V-shaped with a large medial, dorsally projecting spine. Lateral support rods (Davis 1978) elongate triangular, obliquely truncate posteriorly. Valva simple, elongate, length ca. 4X width; inner surface shallowly concave bearing numerous setae, setae thickened distally. Juxta (Fig. 4) simple, distal portion very lightly sclerotized. Vinculum narrow medially; lobes of saccus about as long as broad. Transtilla well developed, fused, mesad. Aedeagus (Fig. 5) large, elongate, slender; distal end with two subequal, strongly pigmented, curving processes; cornuti increasing in size toward insertion of larger distal process;



Figure 1. Adult male of *Microcalyptris lotella*.

lateral tooth arising at about $\frac{2}{3}$, bearing numerous minute spines at its base; phallobase elongate, broadly rounded.

Female Genitalia (Fig. 6): posterior apophyses long, nearly 2X length of anterior apophyses. Corpus bursae narrowly ellipsoid, with two large signa that run entire length of bursa, composed of quadrangular spinose plates. Vesicle large, elongate, broadest anteriorad; distinct vestibule intercalated between vesicle and helical ductus spermathecae.

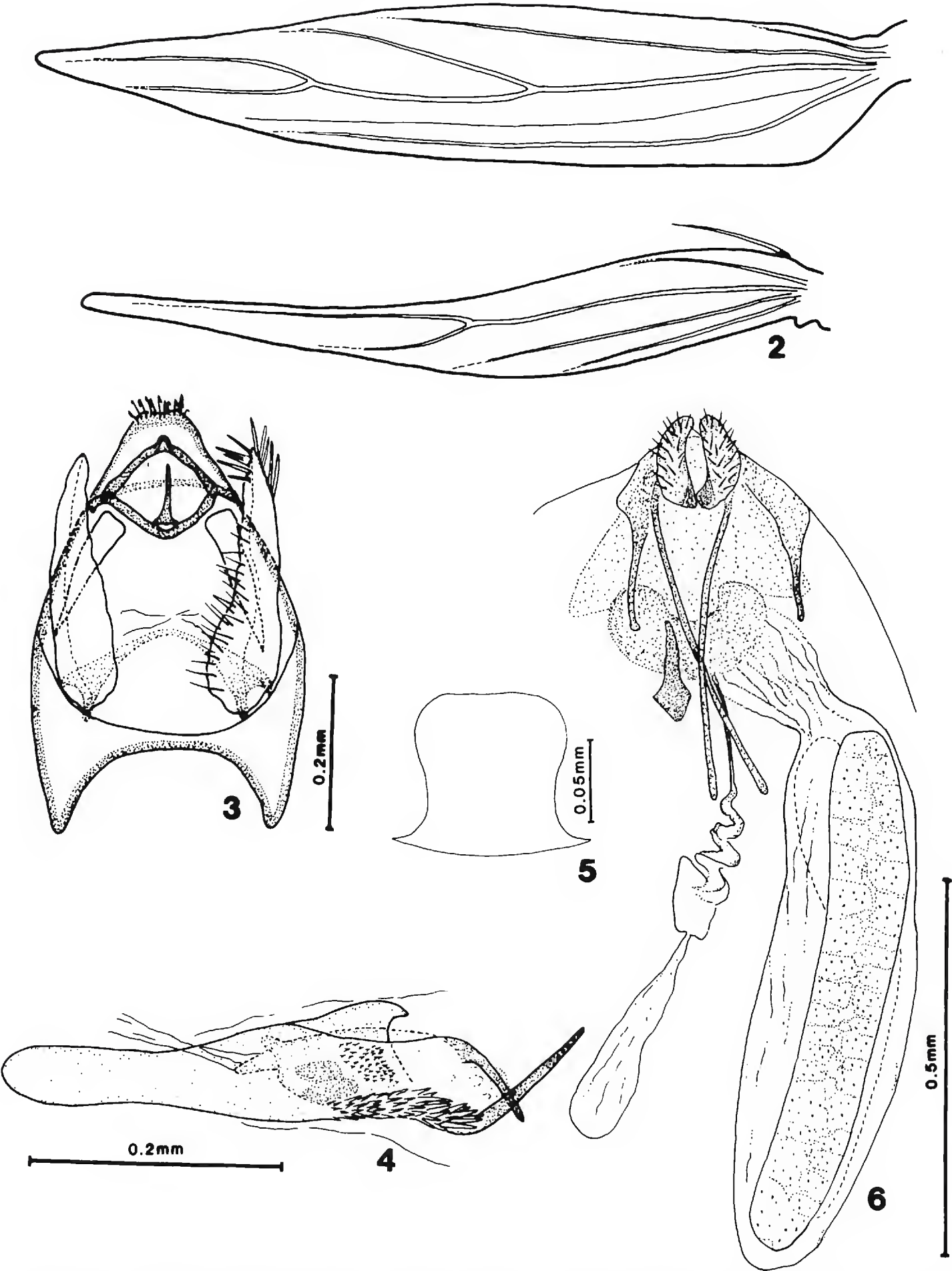
Diagnosis.—Forewings uniformly gray, irrorate. Male with androconia over basal third of DHW and VFW. Saccus lobes as broad as long; juxta weak, simple; tegumen (pseuduncus) with 20–26 curved hairs; valva bearing thickened apical setae; aedeagus with two large apical processes, a lateral tooth and large cornuti. Female with two very large signa running length of corpus bursa.

Holotype.—Male, California, Contra Costa Co., Antioch Dunes National Wildlife Refuge, 15.iii.85, D. L. Wagner, reared from *Lotus scoparius*, imago issuing 14.iv.85, male genitalic slide DLW 86-01, in the Essig Museum of Entomology, University of California, Berkeley.

Paratypes.—California, Contra Costa Co., Antioch Dunes National Wildlife Refuge, 15.iii.85, D. L. Wagner, J. A. Powell and J. W. Brown collectors, reared from *Lotus scoparius*, imagos issuing 7.iv–13.v.85, 42 males and 57 females. DLW Slide Numbers: larva: 85-22 and 85-23; wing: 85-27, 85-33, 85-40, 85-41 and 85-46; male: 85-45, 86-02 and 86-23; and female: 85-47, 86-06, 86-08, 86-39 and 86-40.

Ovum: Egg laid on epidermis of upper shoots of *Lotus scoparius*. Ovum oval, packed with reddish purple to reddish brown frass, elevated above the epidermal tissue.

Larva (Figs. 7, 8): Fully mature larva elongate, 6.5–7.5 mm in mine, contracting upon removal; yellow with dark brown head capsule. Cranial nomenclature and chaetotaxy follows Gustafsson (1981). Caudal margin of head capsule deeply

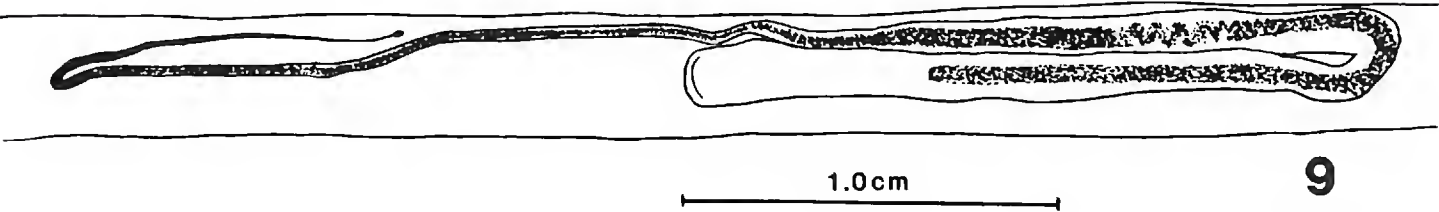
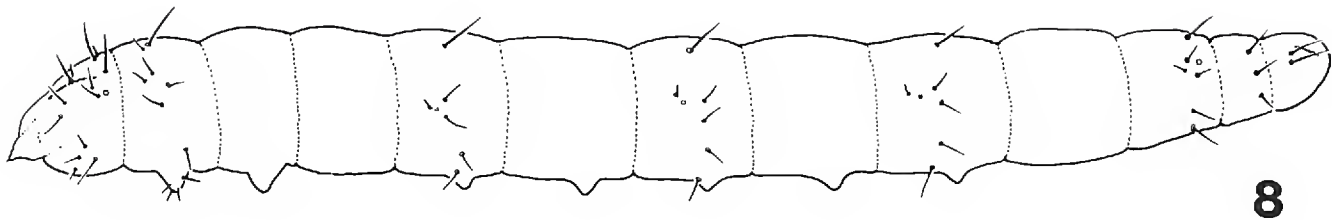


Figures 2–6. *Microcalyptris lotella*: 2. Wing venation. 3. Male genitalia. 4. Aedeagus. 5. Juxta. 6. Female genitalia.

emarginate, lateral lobe extending posteriorad $> 1.5 \times$ basal width at tentorial bridge, caudal margin of lobe distinctly thickened; epistomal ridge quadrangular, bulging anteriorad, posterior margin convex; tentorial arms reduced, anterior arms < 0.5 width of bridge; labial palpus 2-segmented, basal segment subequal to apical. Prothorax with two weak dorsal sclerites, all setae present; mesothorax with two SV



Figure 7. Head capsule of *Microcalyptris lotella*, ventral aspect.



Figures 8, 9. *Microcalyptris lotella*. 7. Larva. 8. Mine.

setae, L3 absent; ambulatory warts on segments T2, T3 and A2-6. Abdominal segments 1–8 with six setae; A9 with three setae and A10 with two (Fig. 8).

Mine (Fig. 9): Early portion densely packed with dark frass; later frass deposited as broad central band, lateral areas remaining frass-free. Mine elongate, 3.5–7.3 cm in length, making one to three switchbacks; track rarely anastomosing except in very narrow shoots. Larva mines in green bark, usually in shoots one to three years of age; rare or absent from areas of reddish bark or the most recently formed shoots. Larva fully visible beneath epidermis, leaving the mine through a crescent-shaped slit to pupate in surface litter.

Cocoon: Cream to fuscous, loose, broadly pyriform.

DISCUSSION

Microcalyptris lotella appears to be most closely related *M. punctulata* (Braun), the only other member of the genus recorded from California. Shared features include the comparatively large signa and the uniformly pale irrorate forewings (the male genitalia of *M. punctulata* have not been described or illustrated).

The wing venation of *M. lotella* differs from that of *M. scirpi* and other *Microcalyptris* species in lacking a vestigial Cu vein in the forewing. The juxta is simple and very weakly developed in *M. lotella*, unlike some members of the genus which possess a large, relatively complex juxta (e.g., *M. bicornutus* Davis). The lateral support rods characteristic of the genus are well developed in this species.

Little is known about the life history of any *Microcalyptris* species. All apparently form serpentine tracks, and leave the mine prior to pupation. *Microcalyptris scirpi* Braun is a leaf miner in the blades of *Scirpus paludosus* A. Nels. (Braun 1925). Braun (1910) reared *M. punctulata* (Braun) from mines in the leaves of *Ceanothus cuneatus* (Hook.) Nutt. *M. lotella* is unusual in that the larva is a stem miner, feeding in the green epidermal layers of *Lotus scoparius*. Among the Nearctic nepticulids only one other genus, *Ectoedemia* Busck, is known to mine in bark. Curiously, in the Palearctic region, the stem epidermis of *Lotus* is mined by unrelated nepticulids in the genus *Trifurcula* Zeller.

Presumably this species is single brooded as I have been unable to locate active mines from April through July.

The type locality, Antioch, California, is a unique sand dune habitat along the San Joaquin River. The once extensive dune system at Antioch was home to many endemic plants and insects (Powell 1981). What remains of this threatened habitat is now protected as a National Wildlife Refuge managed by the United States Fish and Wildlife Service. Although *M. lotella* is presently known only from this unique locality, abandoned mines which may represent this species were found near Briones Reservoir in Contra Costa County and near Virner, El Dorado County, California.

Stilbosis extensa Hodges (Cosmopterigidae) was reared from the same collections that produced *Microcalyptris lotella*. The larvae of *S. extensa* were frequently found boring in the pith of the upper shoots, beneath mines of the *Microcalyptris*.

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Life History of *Trupanea conjuncta* (Adams) on *Trixis californica* Kellogg in Southern California (Diptera: Tephritidae)

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Abstract.—*Trupanea conjuncta* is monophagous on the desert shrub, *Trixis californica* (Asteraceae), in southern California. Each female oviposits an average of five eggs in a single cluster in a single immature flower head each day. The larvae feed and develop gregariously and pupariate clustered in central cavities in flower heads. This tephritid may be either univoltine or bivoltine; consequently, the adults may live as long as a year. Unique among *Trupanea* spp. and other flower head-infesting Tephritidae as known to date, this species is a facultative gall former. If flower heads are absent or rare from a lack of local rainfall, gravid females may oviposit in apical buds and the larvae develop to maturity gregariously in the galls so induced. Thus, another reason for gall formation by insects has been discovered, i.e., as an alternative mode of reproduction and development by a flower head-infesting species. Egg resorption also may have evolved as a mechanism for extending the ovipositional period and host-searching capacity of this fly. *Eurytoma vernonia* Bugbee (Eurytomidae) and *Pteromalus purpuriventrus* (Ashmead) (Pteromalidae) are reported as probable, primary, hymenopterous parasites of the larvae and pupae.

Little heretofore was known about *Trupanea conjuncta* (Adams), except taxonomically. I recently studied this distinctive tephritid in conjunction with a faunistic survey of the desert shrub, *Trixis californica* Kellogg (Asteraceae), in southern California (Goeden and Ricker, unpublished data).

Taxonomy.—First described as *Urellia conjuncta* by Adams (1904). *T. conjuncta* additionally was described and illustrated in part by Malloch (1942) (as a *Trypanea*), Foote (1960a) and Foote and Blanc (1963) (as a *Trupanea*).

Distribution and hosts.—Before publication of the initial host-plant rearing record for this tephritid from flower heads of *T. californica* (Goeden 1983), *T. conjuncta* was described as “rarely collected” from only a few locations in Arizona and California (Foote 1960, Foote and Blanc 1963). This fly presumably also ranges into Mexico like its host-plant (Shreve and Wiggins 1964), the sole representative of the genus *Trixis* (Tribe Mutisieae) in the Sonoran Desert flora of Arizona (Kearney and Pebbles 1964) and California (Munz and Keck 1959, Munz 1974). Additional species of *Trixis* in the Sonoran Desert in Mexico (Shreve and Wiggins 1964) represent potential hosts.

I have reared *T. conjuncta* only from flower heads (and terminal-bud galls, as described below) of *T. californica*, among 77 genera and 182 species of California Asteraceae sampled to date. Thus, *T. conjuncta* apparently is monophagous in California (Goeden 1985). My rearing records from *T. californica* flower heads

collected on the dates indicated include the following: Imperial County: Indian Well, one male and two females, 12.iii.86; Mountain Spring, two males, 20.iii.86; Riverside County: Desert Center, 108 males and 108 females, 14.iii.84; Graham Pass, 47 males and 41 females, 21.iii.84; San Bernardino County: Coxcomb Mountains, 40 males and 39 females, 20.iii.84; Sheephole Mountains, 14 males and 19 females, 14.iii.84; San Diego County: Coyote Canyon, one male and one female, 29.ii.84; Yaqui Pass, three males and three females, 11.i.84. Goeden (1983) recorded *T. conjuncta* from Chino Canyon, ca. 1 km NW of Palm Springs, Riverside County, where most field observations reported herein were made and flower head samples collected for dissection during 1983–86.

Biology

Egg.—Newly laid eggs (Fig. 1a) are smooth, shiny, white, and elongate ellipsoidal, with a reduced, button-like, anterior pedicel, like those of *T. bisetosa* (Coquillett) (Cavender and Goeden 1982). The posterior end narrows to a smoothly rounded point and usually is covered and partly obscured by a whitish secretion that glues together this end of several eggs deposited in a packet (Fig. 1a). Thirty-four field-collected eggs averaged 0.77 ± 0.008 (\pm SE) mm in length and 0.18 ± 0.003 mm in greatest width. The pedicels averaged 0.03 mm in length and width. The eggs of *T. conjuncta* are slightly longer and narrower, the pedicels slightly shorter than those of *T. bisetosa* (Cavender and Goeden 1982).

Unlike the eggs of *T. nigricornis* (Coquillett) and *T. bisetosa*, which are deposited singly (unpublished data, and Cavender and Goeden 1982, respectively), the eggs of *T. conjuncta* usually are deposited in groups glued together posteriorly and along part of their lengths. The egg clusters were easily lifted as units from the tips of the floral tubes among the pappus hairs where the eggs usually are oviposited with their long axes perpendicular to the receptacle surface. The “glue” loses its stickiness with time. One or more outer eggs in a packet may also be glued to the inner curve of a receptacle bract or to the adaxial surface of an inner phyllary. As these bracts subsequently elongate, the attached cluster of egg chorions (by then usually empty) is lifted upwards and away from the receptacle. All eggs in a packet are deposited together by one female at a single insertion of her ovipositor, which usually penetrated one or more of the leaves surrounding the young flower head and one or two of the enveloping, alternately arranged phyllaries. The path of the ovipositor was marked by circular punctures ca. 0.15 mm in diameter ringed by brown necrotic tissue. Some oviposition occurred through the opening at the apex of a young flower head where the tips of the phyllaries met. Only five (8%) of 60 infested heads examined contained two egg packets (Fig. 1a), apparently laid by different females or at least at different times, judging from the numbers and patterns of the egg punctures as well as the different stages of development of the eggs in each pair of egg clusters. The number of eggs in 65 clusters from field-collected heads averaged 4.5 ± 0.1 (range: 3 to 7). The most eggs found in an infested head was 12. Females preferred early-stage flower heads only 3 to 5 mm long for oviposition; this stage lasted only two or three days in the field. Oviposition did not always follow probing, as evidenced by punctured phyllaries of uninfested heads. Caged females were not deterred from laying a superabundance of eggs in single buds. At least one egg mass was observed that had been deposited atop another mass in nature. This behavior

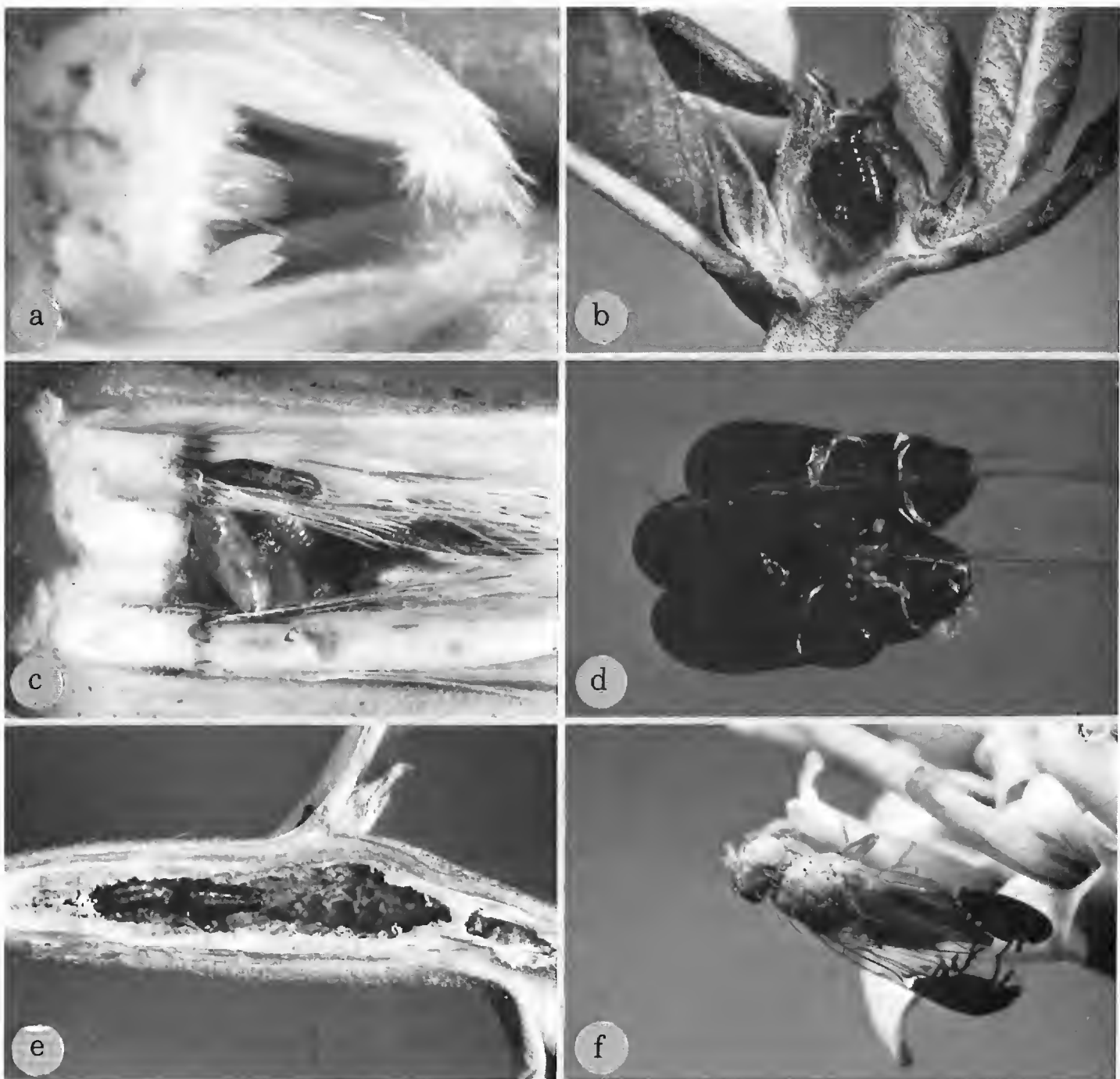


Figure 1. Life stages of *Trupanea conjuncta*. (a) Two egg clusters in young flower head, 16x. (b) Subspheroidal gall containing puparia, 4.3x. (c) Third instars feeding gregariously in flower head, 6.4x. (d) Cluster of empty puparia from flower head, 9x. (e) Ellipsoidal gall containing puparia, 4.3x. (f) Adult female at rest on flower head of *Trixus californica*, 6.6x.

suggested that the short duration of the attractive stage of development of the young heads, not the use of a marking pheromone as occurs with certain frugivorous Tephritidae (Prokopy 1972), limits egg deposition in heads. Females of *Tephritis dilacerata* Loew (Berube 1978) and *Trupanea bisetosa* (Cavender and Goeden 1972) also apparently did not recognize or avoid immature flower heads that already contained eggs.

The clustering of eggs by *T. conjuncta* apparently is an adaptation for a unique feature of its life history, i.e., the capacity for facultative gall formation, a feature never before reported for any flower head-infesting tephritid. No other species of *Trupanea* is known to form galls; however, this behavior provides additional ecological evidence linking this genus to the closely related genus *Tephritis*, several

species of which are gallicolous (Quisenberry 1951, Foote 1959, 1960a, 1960b). This behavior may have gone undetected if an associate and I had not concurrently surveyed the insect fauna of *T. californica* at various desert locations (Goeden and Ricker, unpublished data) while I studied the life history of this fly. When surveying plants in Grapevine Canyon, NE San Diego County, in early February, 1984, I found terminal bud galls on branches of plants that had not yet experienced rainfall that winter, and probably not since the previous winter. Field and subsequent laboratory examinations showed that these galls contained tephritid puparia from which *T. conjuncta* adults subsequently were reared (Fig. 1b). If gravid mature females cannot find young flower heads generated on host plants in response to winter or late summer rainfall, they apparently will oviposit small groups of eggs in the apical buds. Facultative gall formation seems to be a mechanism that this flower head-infesting tephritid has evolved to insure its reproduction for at least another generation under conditions of inadequate rainfall or flower head availability. No galls were formed on *Trixis* which flowered in February through April, 1984, in response to rainfall received at the Chino Canyon site in January and the preceding December. Thus, gall formation was a localized, facultative activity. However, several old, woody galls were observed on the stems at Chino Canyon, which indicated that gall formation also had occurred there about two growth periods beforehand. No other species of insect produces galls on stems of *T. californica* in southern California (Goeden and Ricker, unpublished data).

Twenty-four eggs hatched after six to eight days' incubation at $27 \pm 2^\circ\text{C}$ and 100% relative humidity in the laboratory. When denied their usual ovipositional sites during solitary greenhouse cagings on non-flowering branches of *Trixis*, individual, field-collected, sexually mature and mated females stored their eggs internally for as long as a week. This denial of ovipositional sites occasionally resulted in the insertion of some eggs in apical buds, the prerequisite for gall formation in nature. If immature flower heads were resupplied to these caged gravid females after several days, eggs were laid within the heads in large clutches, e.g., 18, 22, and 30 eggs, and various stages of embryony, including those that hatched only one or two days after deposition. Thus, embryony continued within the oviduct, as apparently did egg resorption, as indicated by the oviposition of empty egg chorions together with partly reabsorbed, flaccid eggs and viable, turgid eggs. Whether egg resorption occurs in gravid females of *T. conjuncta* in nature is unknown. Conserving egg metabolites in this manner would be another mechanism for extending the reproductive life and host-searching capacity of this desert-inhabiting tephritid, which is solely dependent for its reproduction on a localized, fairly uncommon, single species of host plant growing suboptimally at the northernmost extension of its range. In January, 1985, a severe winter frost killed the top growth and delayed or prevented flowering of many *T. californica* in southern California, an event of the type which egg resorption and the resultant extended female ovipositional period may have evolved to counter.

In flower heads, the embryo rotated 180° just before hatching, so that the mouthparts of the first instar usually were immediately in contact with a floral tube upon leaving the egg through a posterior-longitudinal slit in the chorion. The duration between eclosion of the first and last individuals from a single egg clutch was ca. one day.

Larva.—The larvae of *T. conjuncta* usually fed gregariously. I observed only one instance in flower heads in which the newly hatched larvae from a single cluster had

split into two feeding groups that attacked separate florets. All larvae newly hatched from an egg cluster usually entered the elongating floral tube of a single floret together and tunneled basipetally into the immature achene. After consuming the contents of this first floret, the larvae together transferred to an adjacent floret which they entered through the base of its floral tube. Feeding within a series of florets continued in this manner through the second stadium; however, most feeding and larval growth occurred during the third stadium. The third instars fed in a central ellipsoidal cavity (6 to 9 mm long) ca. 3 mm wide, formed among the stumps of achenes, the scored receptacle, and the distal remnants of the pappus hairs of the central florets excised 2 to 3 mm from their tips, all surrounded by a ring of scored or undamaged florets (Fig. 1c). As many as 12 third instars fed in a compact mass within a moist, central cavity, the walls of which were covered with yellowish, liquid feces (Fig. 1c). When fully grown, the larvae pointed their mouthparts acropetally, ceased movement, and pupariated in a compact cluster (Fig. 1d).

The galls of *T. conjuncta* are initiated when a female oviposits in a terminal bud. The round ovipositional scar was seen on the surface of some galls. Upon hatching, the larvae feed on the surrounding tissues and extend the gall cavity into the pith of the branch tip. If this feeding killed the apical meristem, the branch ceased to elongate and a subspheroidal gall resulted (Fig. 1b). If the apical meristems remained intact, the gall assumed a spindle shape as the branch continued apical growth (Fig. 1e). Twenty-one field-collected, current season's galls measured 9.7 ± 0.6 (range: 6 to 16) mm in length and 4.6 ± 0.1 (range: 3.6 to 5.5) mm in greatest width. The larvae fed on the parenchymatous pith tissue, expanding the gall cavity in length and width until, eventually, two to five shortened internodes were incorporated in the fully formed galls. The central cavities of 13 fully formed galls averaged 6.3 ± 0.4 (range: 3.3 to 9.0) mm in length and 2.6 ± 0.2 (range: 1.0 to 3.5) mm in width. The cavities were ellipsoidal (Fig. 1e) or subspheroidal (Fig. 1b), smooth-walled, and free of frass. none, several, or all of the axillary buds along the length of the gall, instead of or as well as the terminal bud, may break dormancy and grow into branches. The vascular cylinder is incorporated in the wall of the gall, which remains green and photosynthetic while the gall remains occupied. The fully grown larvae cut one or two short emergence tunnels, usually laterally in the distal half of the galls, through the 0.75–1.25 mm thick walls, leaving a thin flap of epidermis covering each future exit hole. The larvae usually pupariate with their head directed acropetally towards an exit tunnel. Some larvae pupariated in a partially overlapping linear row and formed only a single, common exit hole (Fig. 1e).

It is but one evolutionary step for a species to gall axillary buds in addition to terminal buds as occurs with other genera and species of Tephritidae, e.g., *Aciurina*, *Procecidochares*, and some *Tephritis* (Foote 1960b, Silverman and Goeden 1980, Steyskal 1984). Moreover, facultative gall formation, as expressed by *T. conjuncta*, indicates one means by which a flower head-infesting species of Tephritidae may have evolved sympatrically into a gallicolous species occupying a different niche on the same host plant, or vice versa. In a separate paper, I will describe an apparent example of facultative gall formation in the genus *Tephritis*. Whether oviposition of egg clusters and gregarious larval and pupal development are adaptations reflecting a gall-forming ancestry or facilitating reproduction in galls by a flower head-infesting

species, or are prerequisites thereof, I leave to evolutionary ecologists and systematists to interpret.

Pupa.—Pupation occurs in a puparium within the central cavity in a flower head or gall (Fig. 1e). The puparium (Fig. 1d) is black, ellipsoidal, smoothly rounded at both ends, but with a flattened, posterior, perispiracular plate, superficially smooth, but very finely punctate, and slightly flattened or concave ventrally. Twenty-one field-collected puparia measured 3.1 ± 0.1 (range: 2.3 to 3.8) mm in length by 1.3 ± 0.04 (range: 1.0 to 1.6) mm in greatest width. Adults emerged through an anterior, two- or three-part fracture of the puparium. A very thin, whitish, translucent pupal exuvium, left behind within the puparium, also helps to distinguish unparasitized individuals. Adults emerged by pushing through the loose plug of excised tips of pappus hairs of the central florets, or by breaking through the epidermal windows covering the exit holes of galls.

Adult.—The adult (Fig. 1f) of both sexes is readily distinguished from other species of *Trupanea* by the unbroken dark to light-brown area in the distal anterior quarter and proximal half of the wing (Foote 1960a, Foote and Blanc 1963). Newly emerged adults are sexually immature and apparently do not mate. Judging from the rearing records reported above and my recovery of 394 males and 315 females (1.25:1) from 22 flower head samples collected at Chino Canyon during 1983–85, the sex ratio of *T. conjuncta* appears to be slightly male biased ($X^2 = 8.79$, $p < .005$, 1 df). Males outnumbered females in 15 of the 22 samples, whereas females outnumbered males in only five samples. *T. conjuncta* males were not observed to emerge from flower heads before females, as Silverman and Goeden (1980) reported for *Procecidochares* sp. from bud galls on the desert ragweed, *Ambrosia dumosa* (Gray) Payne. The latter tephritid also showed a male-biased sex ratio.

The adults of *T. conjuncta* probably are long-lived. They apparently pass the summer at higher elevations, moving upward along streams and washes into the surrounding mountains as flowering ceases and their perennial hosts become dormant. A portion may reach mountain meadows by midsummer, as occurs with the more common, also monophagous, desert species, *Trupanea imperfecta* (Coquillett) (unpublished data). As fall and colder weather approaches, the adults migrate towards lower and warmer elevations, where they eventually rendezvous on their host plants. I have not observed mating, which may occur in the field at this time or earlier at higher elevations. If summer rainfall stimulates a second bloom in the fall, these flower heads are used as oviposition sites. If their host plants remain dormant for lack of rainfall, I suspect that rather than form galls at this time, the flies remain inactive through the fall and early winter, awaiting the more dependable occurrence of winter rainfall and the resulting main flowering period. Consequently, mating either occurs in the fall in response to unknown stimuli to host flowering, or if no rain falls, is delayed until winter, or recurs then. Both sexes were swept from actively growing hosts before bud formation and oviposition commenced.

Oviposition was observed only once in the field at 10:21 A.M. on February 17, 1984, and lasted only 35 seconds. Oviposition is not commonly observed with this tephritid because (1) the adults *per se* are uncommonly observed or swept (Foote and Blanc 1963), even in close proximity to or directly from their host plants (personal observation); (2) most of that portion of their adult lives that is spent on or near their hosts appears to involve resting motionless (characteristically with wings slightly

parted but mostly overlapped atop the abdominal dorsum [Fig. 1f]) while hidden and sheltered within the crowns (especially when it is windy, as so commonly is the case in the winter and early spring on the Colorado Desert); and (3) each female apparently oviposits on the average only once a day in a single flower head. The last-named behavior is extrapolated from the results of greenhouse cagings of field-collected, gravid females mentioned above. Five females individually caged between March 6 to April 25, 1986, for one to 11 days each on single, flower bud-bearing branches of potted plants laid a total 387 eggs over a total of 75 days of cagings for an average of 5.2 eggs laid per female per day. This daily oviposition rate approximated the mean number of 4.5 eggs per cluster found in field-collected heads as reported above. The most eggs laid by a single caged female were 137. She apparently died prematurely and produced fertile eggs up to her death. As she probably had oviposited before being collected, this number of eggs underestimated her fecundity.

Seasonal history.—Munz (1974) described the flowering period of *T. californica* as February to April in southern California. I have reared *T. conjuncta* from mature flower heads collected on May 13 and 25, June 7, and October 3, 1983, in addition to February to April, 1983, 1984, and 1985, at Chino Canyon. Thus, this tephritid and its host plant had two reproductive periods in 1983, but only one in 1984 and 1985.

On March 7, 1985, 50, 50, 30, and 50 flower heads on four plants, respectively, were tagged individually by slipping rubber bands attached to number tags over the heads in the early stage favored for oviposition by *T. conjuncta*. The development of each of these heads subsequently was followed and correlated with tephritid adult emergence. From oviposition in young heads to adult emergence from mature flower heads with faded yellow or white florets that contained fully formed achenes, the immature stages of *T. conjuncta* and flower head development lasted about five weeks under field conditions. As discussed above, the adults appear capable of living as long as 12 or 13 months under field conditions in southern California.

Mortality factors.—The larvae of an apparently undescribed microlepidopteran, *Homeosoma* sp. (Pyralidae), each destroyed the contents of several young flower heads during the course of their development, occasionally including heads infested by *T. conjuncta*. Jumping spiders (Araneida: Salticidae) and crab spiders (Araneida: Thomisidae) appeared to be the most common potential predators of adults observed on preblossom and flowering host plants. Two species of Hymenoptera, both reared from flower heads of *T. californica*, were probable parasites of immature *T. conjuncta* and two other synphagous species of Tephritidae, *Tomoplagia cressoni* Aczel and *Trupanea actinobola* (Loew) (unpublished data). They were *Eurytoma vernonia* Bugbee (Eurytomidae), probably a solitary, primary, larval or larval-pupal endoparasite, and *Pteromalus (Habrocytus) purpuriventris* (Ashmead) (Pteromalidae), probably a solitary, primary, larval ectoparasite. *Eurytoma vernonia* also were reared from puparia in apical bud galls, so adoption of this facultative mode of reproduction by *T. conjuncta* does not confer “enemy-free space” (Zwölfer 1983, Price et al. 1986); however, this could provide a measure of relative protection from natural enemies. Both chalcidoids parasitize *Trupanea imperfecta* in flower heads of *Bebbia juncea* (Bentham) Greene, another shrubby, perennial, desert Asteraceae that often grows in association with *T. californica*. The life history of *T. imperfecta* will be described in a separate paper.

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**The Status of *Efferia similis* (Williston), with Descriptions of Three
New Nearctic *Efferia* Species in the Albibarbis Group
(Diptera: Asilidae)**

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Abstract.—The nomenclatural history of *Efferia similis* (Williston) and its relationship to *E. tagax* (Williston) are discussed. Examination of the syntype of *similis* discloses it actually to be *tagax*. *Similis* (Will.) is therefore placed as a synonym of *tagax*, and the species currently known as *similis* is renamed *neosimilis*. Two related *Efferia* species of the Albibarbis group (*incognita* from Texas and New Mexico and *sonorensis* from Mexico) are described.

Efferia similis and *E. tagax* were described from Arizona by Williston (1885). The identity of *E. similis* (based on an extremely brief description) and its taxonomic relationship with *E. tagax* have long been a source of confusion and misidentification. The confusion has been compounded by the presence in west Texas and New Mexico of a third closely related *Efferia* species described below. Strangely, Williston compared *similis* not with *tagax*, which had nearly identical wing venation, but with a specimen near *E. staminea* (Will.), which was also described in the same paper. Hine (1919), noting that *similis* had not been seen since its description, justifiably considered it a synonym of *tagax*, but his associated discussion of *tagax* suggested that his material contained more than one species. Wilcox and Martin (1965) also treated *similis* as a synonym of *tagax*. Wilcox (1966) showed, however, that a second species, closely related to *tagax*, does in fact occur in southern Arizona. Assuming this entity to be Williston's *similis*, Wilcox described or redescribed both sexes of it and *tagax*, describing for the first time the relatively uncommon "*similis*" male.

Although *E. similis* was described from one female (not a male as indicated by Wilcox, 1966), Kansas University has two female "syntypes" which bear a printed label "Arizona/C.U. Lot 35" and a handwritten orange label "*Erax similis* Will." Neither of these specimens is *similis* auct.; one is *E. triton* (Osten Sacken), which on the basis of wing venation could not have been Williston's "type." The other, although the ovipositor is broken, appears to be *E. tagax*: the femora, trochanters, and scutellum are reddish, and the black bands on tergites 3–6 are triangular and are narrowed successively with each segment. This specimen agrees with Williston's description, including the 24 mm length (with the broken ovipositor).

E. tagax was described from a male, with a brief comparative description of two "rubbed" females appended. The location of these "syntypes" is unknown, but the detailed male description is recognizable. Based on the superiority of the *E. tagax* description, *E. similis* (Will.) is placed as a synonym of *E. tagax* (Will.), and *E.*

similis sensu Wilcox (1966) must be named. As Wilcox presumed he was redescribing Williston's *similis* (based on Williston's type), his account does not constitute a formal description, and this species is named below.

The three species described here, along with *E. armata* (Hine), *E. bicolor* (Bellardi), *E. grandis* (Hine), and *E. tagax* form a distinct subgroup of the Albibarbis group in the southwestern United States and Mexico. These species are characterized by large size, black, bulbous, male genitalia, modified hind tibiae in males (except in *bicolor* and *grandis*), and shrub perching behavior, which appears to be nearly obligate in *bicolor* and *grandis*. *E. leucocoma* (Williston) may also belong here but its habits are unknown. There are a number of described and undescribed neotropical members of this subgroup, particularly in Mexico.

Measurements in the following descriptions follow the procedures of Bullington and Lavigne (1984), with "body length" being exclusive of the epandrium or ovipositor.

Efferia neosimilis, NEW SPECIES (Fig. 5)

(This description is in part based on Wilcox's (1966) redescription of *E. "similis,"* in which the male hypopygium and hind tibia and female ovipositor are figured.)

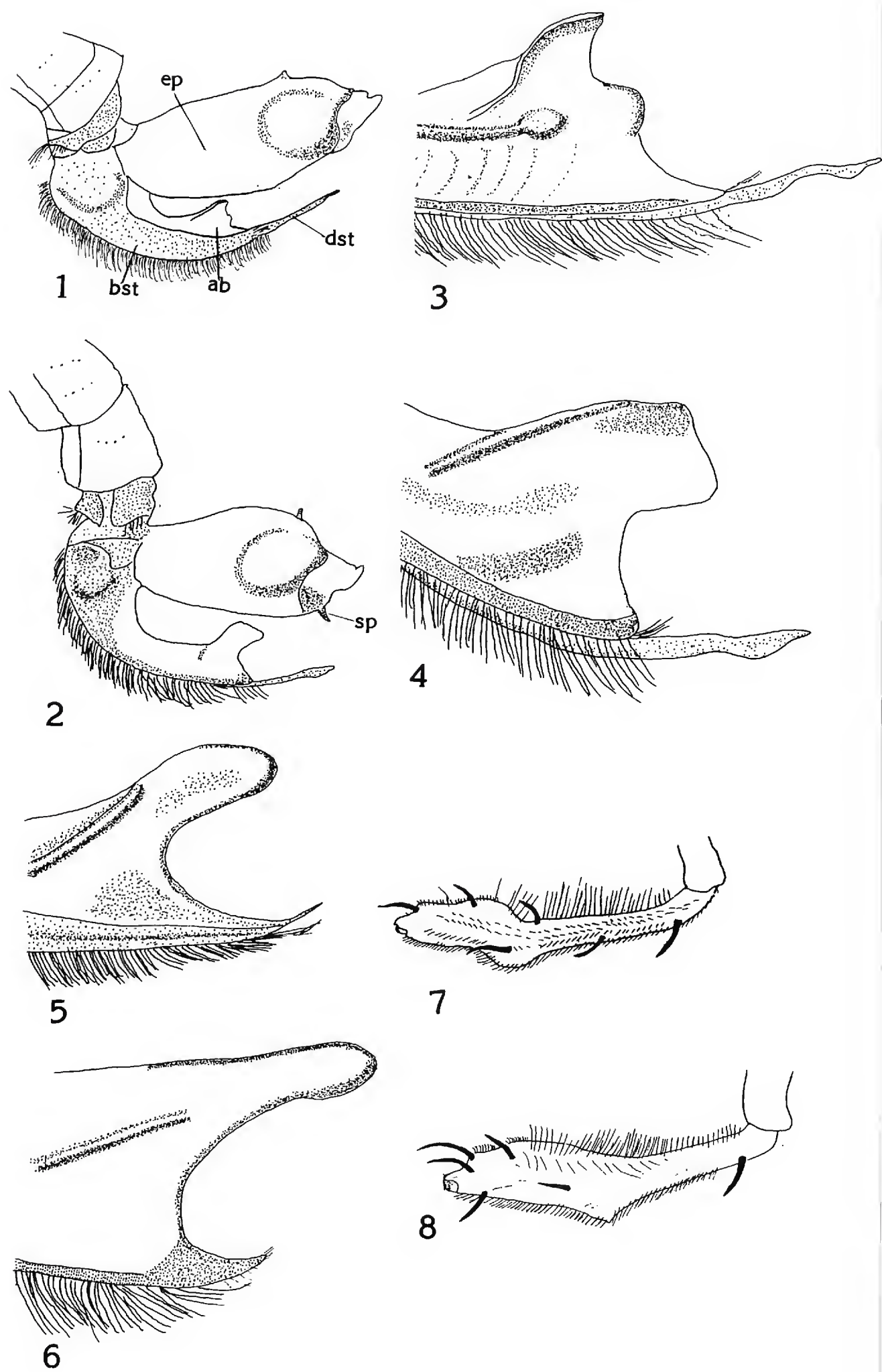
Male.—Body length 18.0–25.0 mm (holotype 23.0 mm); head ground color black to red-black, thinly white tomentose, tomentum often very thin white on gibbosity, vertex, antennae, and ocellar tubercle, tomentum dense white between gibbosity and compound eye margin; proboscis shining black; antenna (including base) and area adjacent to ocellar tubercle black to red-black; hairs on scape and pedicel mostly white, sometimes mixed black/white dorsally; ocellar tubercle black with two black bristles and 3–5 black or mixed black/white hairs; mystax white (some bristles yellow-white) with black hairs (7 in holotype) in upper $\frac{1}{3}$ of gibbosity, variable black bristles and hairs occur along lower lateral margins of gibbosity to oral margin; beard white; palpi black with white basal hairs and black apical bristles; upper occipital bristles white to partly black (6 and 7 black on each side in holotype).

Mesonotum black, brownish-gray tomentose, usually with a broad black stripe, divided by gray tomentum, on either side of meson (these stripes reddish in some specimens); humeral callosity red-brown, hairs white anteriorly, black posteriorly; anterior mesonotal hairs black, shorter than scape, posterior hairs black on upper slope and as long as pedicel, shorter white on lower slope; scutellum thin gray tomentose, hairs on disk mostly black, sometimes white basolaterally, 6–10 black marginal bristles (10 in holotype); pleura gray-white tomentose, hairs mixed black and white; halteres yellow-brown.

Coxae and trochanters grayish white tomentose, femora black (sometimes very dark red-black) reddish apically, hairs mostly white, bristles black; tibiae reddish brown, nearly black at apices, bristles black, apical portion of hind tibia with rounded dorsal and ventral swellings (Wilcox, 1966, Fig. 44), hairs long white ventrally on basal $\frac{2}{3}$ of hind tibia, short dense black on ventral swelling, short dense white or orange on dorsal swelling; tarsi red-brown, bristles and hairs black, hairs black, hairs short dense orange and black on first tarsomere of hindleg, claws black, red basally, empodia and pulvilli light reddish brown.

Wings hyaline, light brown apically and along veins, veins brown, subcostal cell dark brown adjacent to dilated costa.

Tergites 2–5 broadly black dorsally, laterally edged with brown tomentum,



Figures 1-4. 1 Male terminalia of *E. incognita*. 2 Male terminalia of *E. sonorensis*. 3-6. Apex of basistylus of (3) *E. incognita*, (4) *E. sonorensis*, (5) *E. neosimilis*, (6) *E. tagax*. 7 Hind tibia of *E. incognita*. 8 Hind tibia of *E. sonorensis*. Terms: ab = apex of basistylus, bst = basistylus, dst = dististylus, ep = epandrium, sp = subapical process of epandrium.

gray-white tomentose apically, dark brown at apical edges; venter, tergites 2–5 laterally, and 6–7 entirely gray-white tomentose, hairs of tergites white, longer dorsolaterally on 2–3, short black dorsally on 2–5 and sometimes 6; erect white hairs on sternites 1–5, short white on 6, longer white at apex of 7, sternite 8 black with apical black hairs.

Terminalia black, hairs black, some hairs reddish dorsoapically on epandria, ventral fringe with dense black hairs; inner margin of basistylus red-brown; epandrium 3.2 to 3.7 mm long (3.7 mm in holotype), with a ventroapical “tooth”; basistylus forked apically with shorter upper lobe (Fig. 5).

Female.—Body length 16.5–24.0 mm (allotype 19.0 mm); allotype with 6 black scutellar bristles; tergite 7 black, dorsal hairs short black; sternite 7 with erect mixed black and white hairs; ovipositor black, 3.9–4.5 mm long (4.0 mm in allotype); black hairs and bristles in mystax reduced, most bristles yellow-white; lateral gray tomentum on tergites 3–6 more extensive, narrowing dorsal black bands in some specimens; subcostal cell hyaline to light brown in middle; otherwise similar to male.

Etymology.—Use of the name *neosimilis* in part conserves the familiar name *similis* (sensu Wilcox and subsequent authors).

Diagnosis.—Male: The combination of broad black bands on the tergites, subapical epandrial process, shape of the basistylus, and rounded hind tibial swellings will identify *E. neosimilis*. Female: The very short ovipositor will readily separate *E. neosimilis* from related species except for extremely small specimens of *E. bicolor*. See Table 1.

Habitat.—*E. neosimilis* occurs in southeastern Arizona, extreme southwestern New Mexico, and undoubtedly northern Sonora and Chihuahua, from the upper elevation limits of saguaro-ocotillo well into oak-pine habitat. It is sympatric with *E. tagax* at the base of the Santa Rita (and possibly Santa Catalina) Mts., and tends to replace *tagax* at higher elevations. Both species occur on shrubs or other elevated perches (frequently ocotillo); *neosimilis* perches on acacias, grass (i.e. *Sorghum*) stems, manzanita, and oaks. In Pinery Canyon, Chiricahua Mts., *neosimilis* was found in late afternoon on low rocks, in grassy clearings among oaks and junipers.

Holotype male and allotype.—Ruby Rd. at Summit Motorway, 4 mi. W of Peña Blanca Lake (1424 m), Santa Cruz Co., Arizona, 31 July 1979 (G. S. Forbes).

Paratypes.—same data: 1 male, 2 females; 7 July 1985, 2 males, 10 females; ARIZONA: Graham Co.: Stockton Pass (1648 m), 18 July 1970, 1 male (S. Draper, J. Bigelow, O. Francke, M. Cazier) (CAS). Cochise Co.: top of Huachuca Mts., 10 Aug. 1940, 1 female (E. S. Ross) (CAS); Bernardino, 23 July 1966, 3 males, 5 females (J. Davidson, M. Cazier) (1 male, 2 females from CAS); Lower Pinery Canyon, Chiricahua Mts., 23 June 1985, 4 males, 2 females (GSF); Chiricahua Mts., Cave creek, 6.5 mi. W Portal, 11 July 1981, 1 female (H. Hespenheide); Peloncillo Mts., Clanton Draw Rd. 3.1 mi. W NM line, 5 July 1985, 2 females (GSF); Pima Co.: lower Madera Canyon, 200 m NE of Proctor Ranch Rd. Jct, 6–7 July 1985, 4 males, 10 females (GSF) (sympatric with *E. tagax*); Box Canyon Rd., 1 mi. NE Santa Rita Ranch, 7 July 1985, 1 female (GSF) (with *E. tagax*). Santa Cruz Co.: Washington Mts., 15 July 1920, 1 male (J. A. Kusche) (CAS); NEW MEXICO: Hidalgo Co.: Clanton Draw, Peloncillo Mts., 9.5 mi. W Rt. 338 (1635 m), 5 July 1985, 2 males (GSF). OTHER ARIZ. LOCALES: Cochise Co.: Sunnyside Cyn., Huachuca Mts.; W. Entrance, Ft. Huachuca; Miller Cyn., Huachuca Mts.; Pima Co.: Sabino Cyn., Santa Catalina Mts.; N. of Gibbon Mtn. (1420 m), S. Catalina Mts.; Box Cyn., Santa

Rita Mts.; Florida Cyn., S. Rita Mts.; Santa Cruz Co.: 1 mi. SW Peña Blanca Lake; Ruby. See also Wilcox (1966).

Holotype, allotype, and paratypes labelled CAS will be returned to the California Academy of Sciences.

Specimens reported as *E. "tagax"* from the Davis Mts., Texas, (Bromley, 1934) and New Mexico are here recognized as a distinct species in the *Albibarbis* group.

***Efferia incognita*, NEW SPECIES (Figs. 1, 3, 7)**

Male.—Body length 19.0–23.0 mm (holotype 21.5 mm); head color and tomentum differ from *E. neosimilis* as follows: head ground color black, tomentum variably thin white or brown-white on antennae, ocellar tubercle, and vertex; antennal base, scape, and pedicel black, apex of scape and pedicel usually reddish-brown; flagellomere and stylus black; hairs on scape and pedicel predominantly black dorsally, white ventrally; mystax white, with numerous black hairs on upper $\frac{1}{3}$ of gibbosity and a variable row of black hairs and bristles along lower margins of gibbosity to oral margin; ocellar tubercle with two black bristles and 3–9 predominantly black hairs; 4–8 black upper occipital bristles on each side (4 and 5 in holotype).

Mesonotum brownish-gray tomentose, dorsum usually with two broad lateral brown stripes and one narrow central brown stripe, delineated by areas of grayish-white tomentum, mesonotal hairs and bristles black, anterior hairs subequal in length to scape, posterior hairs as long as antenna; humeral callosity reddish, hairs white anteriorly, black posteriorly; pleura gray-brown tomentose (thinly so on anepisternum), hairs and bristles black (a few may be white or orange-red); postalar callosity reddish-brown, gray tomentose; haltere brownish-white; scutellum light brown tomentose, hairs on disk black, sometimes white basolaterally, margin of scutellum with 6–11 black bristles (8 on holotype) and with black submarginal bristlelike hairs, $\frac{2}{3}$ – $\frac{4}{5}$ as long as bristles.

Femora black, reddish at apex, spines black, hairs mostly white, long white ventrally on fore femora; tibiae reddish-brown, darker at apices, with rounded swellings distally on hind tibiae (Fig. 7); tibial bristles mostly black, hairs variable: long white dorsally, often short dense black on ventral swelling, hairs on remainder of tibia mostly white; short, dense, orange pile may be present on tibiae and tarsomeres (especially first tarsomere) on fore and hind legs; tarsi dark red-brown, tarsal spines black, claws black, reddish basally; empodia and pulvilli yellowish white.

Wings as in *E. neosimilis*.

Tergites 1–5 laterally and 6–7 entirely silver-white tomentose, tergites 2–5 dorsally dull black, the black margined laterally with brown tomentum; the posterior $\frac{1}{4}$ to $\frac{1}{3}$ of tergites white tomentose, brown tomentose on extreme posterior margin; tergite 2 often entirely black dorsally; hairs white laterally, mostly black dorsally; sternites 1–7 gray-white tomentose with erect white hairs; sternite 8 black with long black apical hairs.

Terminalia black, hairs black (sometimes reddish white on apex of epandrium), dense black on ventral margin of basistyli; epandria lacking ventral subapical process; inner margin of basistyli reddish-brown; basistyli with a subapical rounded lobe and dorsal triangular flange (Fig. 3). Epandrial length 3.4–4.0 mm (3.7 mm in holotype).

Female.—Body length 17.5–22.0 mm (allotype 20.5 mm); tergite 7 dark brown-black dorsally, sometimes brown tomentose laterally; ovipositor black, 5.2–6.3 mm long (allotype 5.7 mm); lateral gray tomentum on tergites 2–5 may be extensive, narrowing the dorsal black bands; sternite 7 black-haired; black bristles and hairs often much reduced in mystax; allotype with 9 black scutellar bristles; hind tibiae not swollen, dense orange pile on fore and hindlegs may be absent or much reduced; subcostal cell variable from nearly hyaline to brown in middle, but not as dark as in male; otherwise similar to male.

Etymology.—From the Latin for “unknown” or “hidden,” with reference to its long confusion with *E. tagax*.

Habitat.—*E. incognita* occurs in foothill and montane habitats in northern Chihuahua, Mexico, west Texas, and New Mexico. A disjunct population occurs in Union Co., NM. A record from Grant Co., NM is near the range of *E. neosimilis*. *E. incognita* is unrecorded from the Guadalupe Mts. of NM/Texas but probably occurs there. Specimens labelled *E. bicolor* or *E. tagax* from Santa Fe, NM, are probably *incognita*. The species typically occurs in oak-juniper woodland, perching on low rocks, fallen branches, grass stems, and occasionally shrubs, although shrubs are apparently not a preferred perching site.

Diagnosis.—Male: The shape of the apical basistylus is distinctive. The broad bands on the tergites and rounded hind tibial swellings (Fig. 7) are shared with *E. neosimilis*, but that species has the toothed processes on the epandria. *E. tagax* has redder femora and weakly enlarged hind tibiae. Female: Very similar to *E. neosimilis*, but with a longer ovipositor. *E. tagax* has generally narrower tergal bands and redder femora. See Table 1.

Holotype male and allotype.—Davis Mts., S. side Rt. 166, 6.3 mi. SW jct. with Rt. 118 (1790 m), Jeff Davis Co., Texas, 27 June 1985 (G. S. Forbes).

Paratypes.—Same data as holotype and allotype: 13 males, 12 females; TEXAS: Brewster Co.: Road Summit, Green Gulch, Chisos Mts., 8 June 1985, 2 males (D. Lightfoot); Chisos Basin Campground, 29 June 1985, 1 male (D. Lightfoot); Green Gulch, 5–6 mi. S Panther Jct. Rd., 29 June 1985, 7 males, 1 female (GSF); Chisos Basin, 14 August 1976, 1 female (L. Bezark collection). Jeff Davis Co.: Rt. 118, 19.7 mi. S Kent, 2 July 1985, 1 female (GSF); Rt. 166, 6 mi. SW jct. Rt. 118 (1790 m), 19–20 June 1977, 3 males, 1 female (E. M. Fisher); Limpia Crossing, Davis Mts., 28 June 1985, 1 female (D. Lightfoot). NEW MEXICO: Grant Co.: Mimbres, 25 July 1986, 1 male (E. and W. MacKay). Lincoln Co.: Nogal, 21 July 1952, 1 female (H. H. and L. D. Beamer, W. LaBerge, C. Liang) (KU); 5 mi. N. Angus (2136 m), Highway 37, 7 August 1965, 1 male, 1 female (H. B. Leech) (CAS); NM 214, 1.7 mi. N Rt. 70 (NE of Ruidoso) (1760 m), 9 July 1986, 2 males, 2 females (GSF). Union Co.: Clayton Lake, 12 mi. N Clayton (1545 m), 23 July 1965, 2 males (G. W. Beyers) (KU). MEXICO: Chihuahua: Rancho Experimental La Campana (80 km N of Chihuahua City), 27 June 1981, 1 male.

The holotype and allotype are deposited in the California Academy of Sciences. One male and female paratype are deposited in the following: U.S. National Museum, American Museum of Natural History, and San Diego Natural History Museum. The Bezark, CAS, Fisher, and Kansas University paratypes are returned.

Eric M. Fisher has kindly provided specimens from western Mexico of a third undescribed *Efferia* of the *Albibarbis* group.

Efferia sonorensis, NEW SPECIES (Figs. 2, 4, 8)

Male.—Body length 20.5 to 24.5 mm (holotype 22.0 mm); head with these differentiating characters: ground color reddish black, scape and pedicel of antenna black, red apically; flagellomere red basally, reddish black apically; style reddish; hairs on antennae white, a few may be black dorsally; 4 to 8 (5 and 6 in holotype) of occipital bristles on each side are black or mixed black and yellow; ocellar tubercle with 2 long black bristles and 4–7 mixed black and white hairs; mystax white, with stout yellow-white bristles above and on oral margin; 5–10 black bristles present on upper $\frac{1}{3}$ of gibbosity centrally, variable black hairs and bristles along lower margin of gibbosity to oral margin.

Mesonotum red, mostly white tomentose with brown tomentum above near central stripe; meson with a broad brown-black longitudinal stripe, which is often subdivided centrally by areas of gray-white tomentum; humeral callus reddish, hairs white anteriorly, black posteriorly; postalar callus reddish; anterior mesonotal hairs black, subequal in length to scape, posterior hairs black, some as long as scutellar bristles; scutellum black, white tomentose, reddish basolaterally, with 4–7 marginal bristles (4 on holotype) and black or white submarginal hairs (some as long as bristles), discal hairs mixed black and white, $\frac{1}{4}$ to $\frac{1}{3}$ as long as bristles.

Pleura reddish, thin grayish white tomentose, anepisternum tending to be black anteriorly; hairs fine, mostly white, with individual hairs black or yellow, usually black on posterior anepisternum; stem and knob of haltere reddish-brown.

Wings as in the previous species.

Tergites black or reddish-black, 1–5 laterally and 6–7 entirely grayish white tomentose, tergites 2–5 with dull shining brownish-black areas, margined with brown tomentum dorsally, tergite 2 often entirely black dorsally, posterior $\frac{1}{4}$ to $\frac{1}{3}$ of dorsum of tergites 3–5 white tomentose, becoming reddish apically, tergite 6 often with a small, elongate dorsal brown spot; hairs on tergites white laterally, mostly black on dorsal bands; sterna grayish-white tomentose with erect white hairs on sternites 1–4, shorter and sparser on 5–7, 8 with long apical white hairs.

Terminalia variable from black to reddish-brown, especially dorsally (epandria dark red-brown on holotype); epandria with a curved, apically directed subapical process (Fig. 2), length 3.7–4.2 mm (3.7 mm in holotype); basistylus black or red-brown, light red-brown on inner margin; genitalic hairs mostly black, some reddish-white apically on epandria; basal hairs of basistylus black or white, ventral fringe dense black; apex of basistylus in lateral view is forked, with a broad, apically truncated upper lobe (Fig. 4).

Femora light reddish-brown dorsally, black ventrally, red-brown at apices, spines black on middle and hind femora, hairs mostly white, some black, especially dorsoapically; tibiae light reddish-brown basally, dark red-brown at apices, most hairs white, some black hairs dorsoapically; hind tibia with acute dorsal and slightly rounded ventral swellings (Fig. 8); fore and hind tibiae with short, dense, yellow-white to orange pile dorsally; tarsi dark red-brown, spines black, hairs mixed white and black, claws black, empodia light red-brown; tarsomeres (especially the first) on fore and hindlegs may have dense ventral red-orange pile.

Female.—Body length 19.5 to 25.0 mm (allotype 20.5 mm); tergite 7 dully shining brown-black dorsally with black hairs, the hairs usually white laterally (longer near apex) and mixed black and white on sternite 7; ovipositor 5.9 to 6.8 mm long (5.9 mm

Table 1. Comparison of Nearctic shrub-perching *Efferia* of the Albibarbis group (females). Lengths in mm.

| | <i>neosimilis</i> | <i>incognita</i> | <i>tagax</i> | <i>sonorensis</i> | <i>armata</i> | <i>bicolor</i> | <i>grandis</i> |
|------------------------|-------------------------------|-------------------------------|--------------------------------------|-------------------|---------------------------------------|-----------------------------|--------------------------------|
| Body length | | | | | | | |
| mean | 21.2 | 20.0 | 23.1 | 21.8 | 25.0 | 20.8 | 23.8 |
| range | 16.5–24.0 | 18.0–22.0 | 21.0–28.0 | 19.5–25.0 | 21.5–29.0 | 14.0–27.0 | 20.0–27.5 |
| n | 7 | 7 | 8 | 5 | 13 | 15 | 13 |
| Ovipositor length | | | | | | | |
| mean | 4.2 | 5.6 | 5.8 | 6.3 | 5.3 | 5.4 | 6.2 |
| range | 3.9–4.5 | 5.2–6.3 | 5.3–6.2 | 5.9–6.8 | 4.4–6.1 | 3.8–6.2 | 5.6–6.8 |
| n | 16 | 9 | 18 | 5 | 13 | 15 | 13 |
| Mystax | White w/blk brist | White w/blk brist | White w/blk brist | Mostly white | Yellow to yellow-wht | White w/blk brist | Mostly black |
| Scutellar hairs | Black | Black | Black | Black | Mostly white | White | Black |
| Femur color | Black to red-black | Black | Red | Red to orange | Black | Black | Black |
| Characters of tergites | Tergites 2–4 broadly black | Tergites 2–4 broadly black | Bands often narrow, triangular | Variable | Tergite 6 usually broadly black | Banding weak, gray-brown | Tergites 6–7 entirely black |

on allotype), usually reddish-black; subcostal cell hyaline basally but often dark brown in middle; females also show a tendency to narrowed black banding on the abdomen and to fewer black bristles in the mystax (especially below laterally).

Diagnosis.—Male: The truncated upper lobe of the apical basistylus will separate *E. sonorensis* from related species. *E. tagax*, although having a reddish thorax and femora, lacks the subapical epandrial process. The acute ventral swelling of the hind tibia is much more pronounced in *E. armata*. *E. incognita* and *E. neosimilis* have much blacker femora, thoracies, and tergites. Female: the orange tone of the femora and thorax separate *E. sonorensis* from most related Albibarbis group species. Characters that consistently separate females of *sonorensis* and *tagax* were not found. The pleura in *tagax* tend to be more densely white tomentose and the femora a darker red.

Habitat.—Sonoran desert scrub and thorn scrub in Sonora and Sinaloa. Fisher (pers. comm.) suggests this is also a shrub perching species. Two of the CIS males were collected at blacklight.

Holotype male and allotype.—17 mi. N of El Caballo (S of Hermosillo), Sonora, Mexico, 20 May 1962, (E. Michelbacher) (California Insect Survey collection).

Paratypes.—Same data as above, 4 males, 2 females. MEXICO: Sonora: 23 mi. S Navajoa, 8 Sept. 1965, 1 female (A. H. Gillogly) (CIS); 7 km NW Navajoa, 7 July 1963, 1 female (E. M. Fisher); 39 mi. N Guaymas, 1 Aug. 1971, 2 males (E. M. Fisher); Guaymas, Estero Soldado, 8 Aug. 1969, 1 male (L. T. Findley) (CIS); 9 mi. SE Vicam, 22 July 1979, 1 male, 1 female (E. M. Fisher). Sinaloa: Rio Piaxtla, 1 mi. W Mex. 15, 29–30 June 1962 (at blacklight), 2 males (E. Sleeper, R. Anderson, A. Hardy, R. Somerby) (CIS).

Holotype and allotype are deposited in the California Academy of Sciences. The remaining paratypes are returned to Eric M. Fisher and the California Insect Survey.

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New and Little Known Tenebrionidae from Central America and Mexico, with Remarks on their Classification (Coleoptera)

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Abstract.—The tribe Misolampini is restricted to the Old World. New World species are transferred to Coelometopini. Details are presented of morphological similarities between *Hegemona* and *Saziches* (Neotropical) and *Promorphostenophanes* (Oriental). New genera described: *Cnephalura*, *Bothynocephalus*; new species: *Cnephalura umbrata*; *Bothynocephalus cristatus*; *Isaminas breedlovei*, *I. reticuloides*, *I. sullivanii*; *Saziches giesberti*. New synonymy: *Pteroglymmius erotyloides* Gebien = *Isaminas erotyloides* (Gebien).

The taxa treated here comprise a group of flightless, arboreal Tenebrionidae restricted to Central and South America. The genera *Saziches* and *Isaminas* were described by Champion (1886), who placed them, along with *Oxidates* and *Hegemona*, in Misolampini. As discussed by Doyen et al (in press), Misolampini presently construed consists of various geographically restricted groups of flightless Coelometopini. The South and Central American taxa may form a valid clade, but with few exceptions do not show close relationships to the Misolampini of Africa or tropical Asia. For this reason, Misolampini should properly be applied only to *Misolampus* and its relatives, if at all. The new world genera are more conveniently considered as members of Coelometopini. Reconstitution of New World Coelometopini will be considered at greater length by Doyen (in prep.). The purpose of the present contribution is to describe several new genera and species which significantly broaden the range of variation of the New World fauna of these beetles.

Isaminas Champion

Isaminas Champion 1886: 266.

Pteroglymmius Gebien 1928: 223.

Type species: *Isaminas gibbipennis* Champion, Gebien (1942–44) designation.

Champion (1886) described the salient external features of this genus. It may be added that the antennae bear compound sensoriae on the apical five antennal segments and that the internal female reproductive tract and glands are typical of Coelometopini. The female tract consists of the vagina, without a bursa copulatrix, and a single, long diverticulum, glandular except on the abruptly enlarged, apical spermatheca. The first lobe of the coxite of the ovipositor is very elongate, comprising about $\frac{3}{4}$ of the length of the ovipositor tube. The gland reservoirs are

large and annulate, with the secretory tissue draining through a pair of enlarged ampullae at the exit ducts. All of these features show that *Isaminas* is derived from a relatively apotypic group of Coelometopini. In the New World, this group includes most of the tribe, with the exception of the genera *Camaria* and its relatives, *Taphrosoma*, *Mylaris* (= *Nyctobates*; Spilman, 1973), and *Hapsida* which are plesiomorphic in one or more features (Tschinkel and Doyen, 1980). *Isaminas* is very similar to *Oxidates* Champion, differing in the configuration of the metasternum. In *Isaminas* the mesocoxal and metacoxal cavities are nearly contiguous, with the intervening strip of metasternum narrower than the metepipleuron. In *Oxidates* the strip of intervening metasternum is much wider than the metepipleuron. *Isaminas* is superficially similar to *Saziches* Champion, but in the latter the elytral punctures of each series are connected by a fine, longitudinal furrow. In *Isaminas* the punctures are isolated. There are major internal differences between these two as well, discussed under *Saziches*.

I have not examined the type of *Pteroglymmius* Gebien (1928), but his detailed description of the peculiar elytral sculpturing clearly identifies his species *erotyloides* as synonymous with specimens at hand. Gebien separated *Pteroglymmius* from *Isaminas* on the basis of the scutellum (punctiform in *Pteroglymmius*; distinct in *Isaminas*). In the material examined, including cotypes of *I. gibbipennis* Champion and *brevicollis* Champion, the scutellum is punctiform, scarcely entering the elytral disk. In all other features *erotyloides* is extremely similar to other species of *Isaminas*.

Key to the Species of *Isaminas*

- 1. Elytron with distinct epipleural carina; epipleuron continuing to apex of elytra or nearly so 2
- Elytron with epipleural carina visible only from humerus to metacoxa, obsolete posteriorly *brevicollis* Champion
- 2(1). Elytra with more or less uniform series of punctures; sequential punctures in series sometimes contiguous or coalesced, but punctures in adjacent series never coalesced 3
- Elytra with punctures in adjacent series coalesced to form transverse furrows behind humeri and sometimes centrally or on declivity 5
- 3(2). Pronotum broadest before middle; lateral margins shallowly crenulate, nearly straight in posterior half *gibbipennis* Champion
- Pronotum broadest behind middle; lateral margins evenly arcuate 4
- 4(3). Elytra with punctures relatively small, separated by much more than puncture diameter both longitudinally and transversely, except on declivity *breedlovei*, new species
- Elytra with punctures relatively large, subcontiguous; adjacent punctures in series sometimes coalesced, forming elongate foveae *reticuloides*, new species
- 5(2). Each elytron with punctures in series four through eight coalesced just behind humerus and four through seven on declivity, forming depressed areas covered with bright yellow secretion in life; punctation otherwise uniform *sullivani*, new species
- Each elytron with irregular transverse depressed bands about one third and two thirds posterad, uniting punctures in rows two or three to eight;

pairs or triplets of adjacent punctures irregularly coalesced over remainder of surface, especially on declivity *erotyloides* Gebien

Isaminas breedlovei, NEW SPECIES

(Fig. 1)

Frons and vertex with exceedingly shallow punctures about half eye facet in diameter, separated by one to several puncture diameters; punctures slightly coarser, deeper, and denser on genae and epistomum, finer and denser along rim. Pronotal disk sculptured like frons centrally, becoming more shallowly and finely punctate laterally; with very shallow, median longitudinal depression and distinct fovea slightly behind middle at medial third on each side. Anterior angles obtuse, angulate but rounded at apex; lateral margins more strongly arcuate in anterior third, weakly so to base, sometimes very weakly undulate in basal third. Prosternal process with longitudinal, parallel depressions along lateral quarters, becoming deeper posteriorly, producing trilobed apex. Elytra with stria punctures four to eight times eye facet in diameter, separated longitudinally by one to three puncture diameters; striae separated by two to four puncture diameters; sutural stria with finest punctures, becoming gradually coarser laterally and elongate in striae seven through nine, with punctures three to four times longer than wide in epipleural stria; epipleural carina complete to anterior margin of sternite five, continuing as rounded prominence to apex.

Measurements: median pronotal length (PL), 2.5–2.7 mm; greatest pronotal width (PW), 3.9–4.4 mm; elytral length (EL), 6.7–7.6 mm; greatest elytral width (EW), 6.2–7.1 mm.

Isaminas breedlovei is similar to *reticuloides*, new species, in thoracic shape, configuration of prosternal process and in the extremely gibbous elytra, which are abruptly elevated behind the prothorax as steeply as on the declivity. In *breedlovei* the elytral punctures are separated by at least twice their diameter. In *reticuloides* the punctures are subcontiguous.

Holotype female (California Academy of Sciences) from Mexico, Chiapas, 32 km N Ocozacoautla, on rd. to Malpaso, 762 m, 6-X-1974, D. E. and J. A. Breedlove. Two paratypes, Mexico, Chiapas, 13 km N Berriozabel, 975 m, 29-V-1973, D. E. Breedlove.

The holotype is larger than the paratypes and has more finely punctate elytra, but is similar in all other features.

Isaminas reticuloides, NEW SPECIES

Frons and vertex impunctate; genae and epistomum with exceedingly fine, shallow punctures along rim. Pronotal disk with sparse, exceedingly fine, shallow punctures centrally, impunctate marginally; with extremely shallow, scarcely perceptible median longitudinal depression and distinct fovea just before posterior margin, two-thirds toward lateral margin. Anterior angles slightly obtuse, broadly rounded; lateral margins arcuate in anterior three fourths, then parallel to hind angles. Prosternal process with longitudinal depressions in lateral quarters, diverging posteriorly and declivous, producing trilobed apex. Elytra with stria puncture diameter one-half to one times length of dorsal eye lobe; smaller and subcontiguous in sutural stria, coarser and contiguous or sometimes coalesced in striae two to seven,

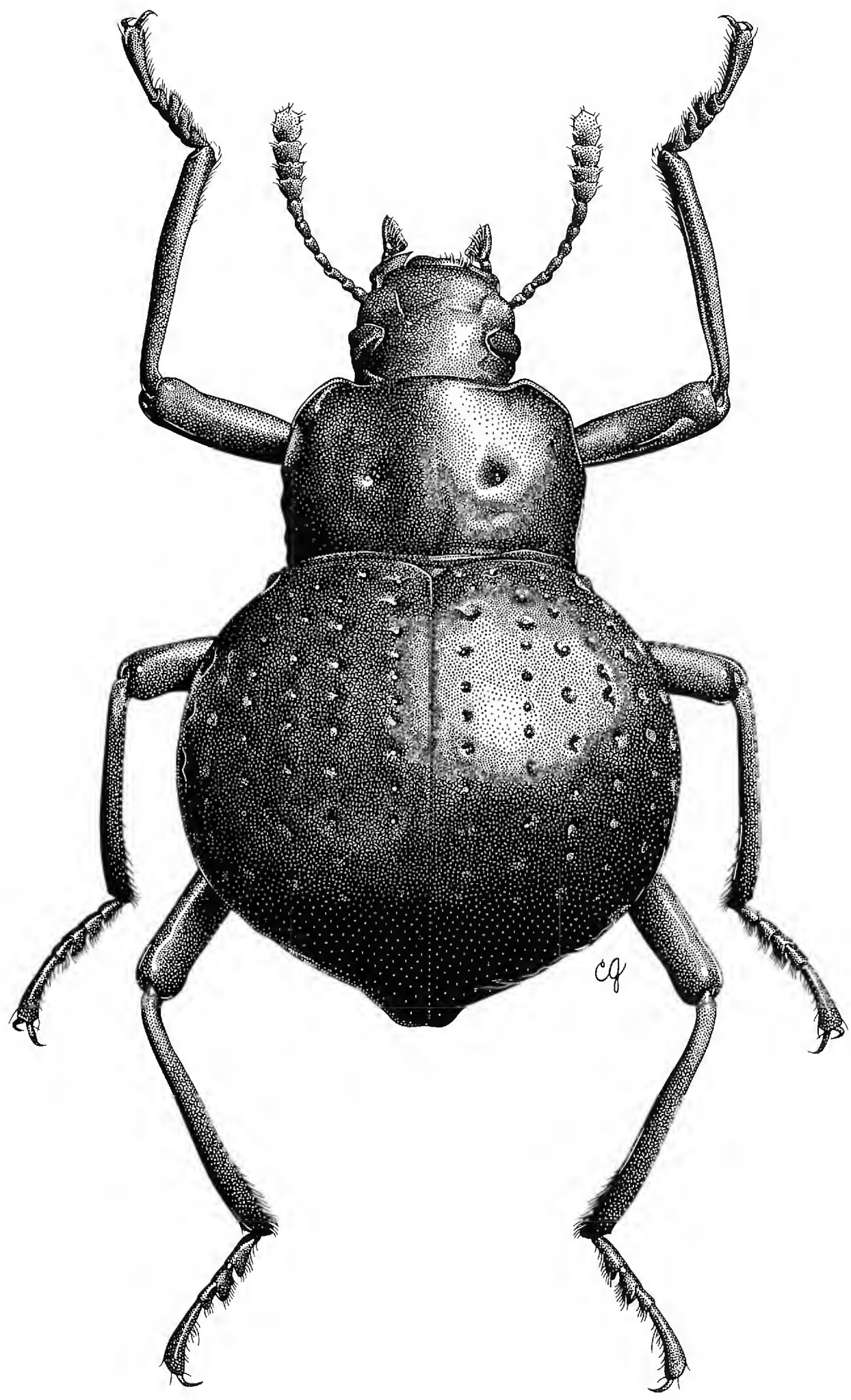


Figure 1. *Isaminas breedlovei*, new species, holotype.

finer in striae eight to nine and seldom coalesced; epipleural carina distinct to sternite five, continuing as rounded prominence to apex.

Measurements: PL, 2.7 mm; PW, 4.1 mm; EL, 7.3 mm; EW, 6.5 mm.

Isaminas reticuloides is similar to *breedlovei*, new species in its extremely inflated body and trilobed posternal process. See remarks under the latter species. The reticulate sculpturing of *reticuloides* is similar to that of *erotyloides* (Gebien), but in the latter punctures from adjacent series are coalesced, forming transverse depressions about one-third and two-thirds posteriad on the disk. In *reticuloides* punctures from adjacent series are never coalesced. In *erotyloides* the lateral pronotal margins are crenulate; in *reticuloides* there is no trace of crenulation.

Holotype (sex undetermined; California Academy of Sciences) from Mexico, Chiapas, north slope Cerro Bola, N. Cerro Tres Picos, 1524–2134 m. 5-V-1972. D. E. Breedlove.

Isaminas gibbipennis Champion

Isaminas gibbipennis Champion, 1886: 267.

Cranium punctate dorsally; punctures exceedingly fine posteriorly, becoming about one-half to one times eye facet in diameter, separated by one to several puncture diameters on epistomum and genae; punctures slightly denser along epistomal rim. Pronotal disk with exceedingly fine, shallow punctures centrally, becoming impunctate marginally; with distinct medial longitudinal depression and distinct fovea just behind middle at medial third on each side. Anterior angles broadly rounded; lateral margins arcuate in anterior half, then nearly straight, weakly crenulate to posterior angles. Prosternal process with longitudinal, shallow depressions along lateral quarters, these slightly divergent posteriorly but not deepened; apex only weakly trilobed, obtusely angulate. Elytral disk with strial punctures one-half to one times length of dorsal eye lobe in diameter, separated by about one-half to one times puncture diameter in each series; smallest anteriorly, on declivity and near epipleuron; distinctly elongated in rows seven to nine, especially anteriorly; epipleural carina complete to elytral apex.

Measurements (of paralectotype): PL, 7.4 mm; PW, 4.3 mm; EL, 6.8 mm; EW, 6.0 mm.

Isaminas gibbipennis is similar to *brevicollis* Champion in sculpturing and body configuration. In *gibbipennis* the epipleural carina is distinct to the elytral apex and the prosternal process has the apex obtusely angulate. In *brevicollis* the epipleural carina is present only as far posterad as the metacoxae and the prosternal process is acutely angulate.

A lectotype is hereby designated from the original series of cotypes in the British Museum (Natural History). Type locality, Nicaragua, Dept. Chontales. Additional paralectotypes are from Costa Rica (no further information). One paralectotype is located in the Essig Museum of Entomology, University of California, Berkeley.

Isaminas brevicollis Champion

Isaminas brevicollis Champion, 1886: 267

Cranium punctate dorsally, punctures about one-half to one times eye facet in diameter, separated by about one to two puncture diameters, becoming finer, denser along epistomal rim. Pronotal disk with punctures about one-fourth to one-half eye

facet in diameter centrally, becoming impunctate near margins; with distinct medial longitudinal depression and distinct fovea at middle at medial third on each side. Anterior angles broadly rounded; lateral margins arcuate except straight just before base. Prosternal process with shallow, longitudinal, parallel depressions along lateral quarters, becoming obsolete behind coxae; apex acutely angulate. Elytral disk with stria punctures about one-third to one times length of dorsal eye lobe in diameter, separated by about one to two puncture diameters in each series; smallest anteriorly, on declivity and near epipleuron; slightly elongate in rows seven to nine; epipleural carina distinct just behind humerus, becoming obsolete posteriorly, and disappearing at about metacoxa.

Measurements (specimen from Chiapas): PL, 2.5 mm; PW, 4.0 mm; EL, 6.7 mm; EW, 6.0 mm.

Isaminas brevicollis is similar in sculpturing and body shape to *I. gibbipennis* Champion, differing as described under the latter.

A lectotype is hereby designated from the original series of cotypes in the British Museum (Natural History). Type locality, Guatemala, Dept. Alta Vera Paz, Senahu. Additional paralectotypes are from Dept. Baja Verapaz, Sinanha. Additional record, Mexico, Chiapas, Tuxtla Gutierrez, 23-VI-1973, G. Ekis.

***Isaminas sullivanii*, NEW SPECIES**

(Fig. 2)

Frons and vertex with punctures about one-fourth to three-fourths times eye facet in diameter, separated by about one puncture diameter, becoming slightly smaller and denser along epistomal rim. Pronotal disk with fine, exceedingly shallow, almost obsolete punctures centrally, impunctate marginally; with distinct median longitudinal depression and distinct fovea at middle at median third on each side. Anterior angles broadly rounded; lateral margins strongly, evenly arcuate in anterior one-third, then nearly straight, slightly convergent and crenulate to posterior angles. Prosternal process with longitudinal depressions along lateral quarters, diverging slightly and becoming deeper posteriorly, producing trilobed apex. Elytra with stria puncture diameter about one-half to one times length of dorsal eye lobe, separated longitudinally by about one-fourth to one-half puncture diameter; punctures slightly smaller in sutural stria, anteriorly and on declivity; punctures in striae four through eight coalesced immediately behind humerus and in striae four through six on declivity, forming irregular transverse depressions, in life filled with bright yellow exudate; epipleural carina complete to elytral apex or nearly so.

Measurements: PL, 1.5–2.4 mm; PW, 2.9–4.5 mm; EL, 4.9–6.4 mm; EW, 4.4–7.2 mm.

Isaminas sullivanii is most similar to *erotyloides* (Gebien). In *sullivanii* the transverse elytral depressions are located immediately behind the humeri and the declivity. The elytral punctation is quite regular aside from the depressions. In *erotyloides* the depressions are located about one-third and two-thirds posteriad, and coalesced pairs or triplets of punctures are scattered irregularly over the elytra, especially laterally.

Holotype (sex undetermined; California Academy of Sciences) from Costa Rica, Cartago Prov. Turrialba, 14/19-V-1974, E. Giesbert. Paratypes: 3, same date as holotype; 1, Cartago Prov., C.A.T.I.E., 3 km SE Turrialba, 13/16-V-1985, J. Doyen; 5, same locality, 29/30-V-1985, J. Doyen; 1, same locality, 28-V-1985, C.

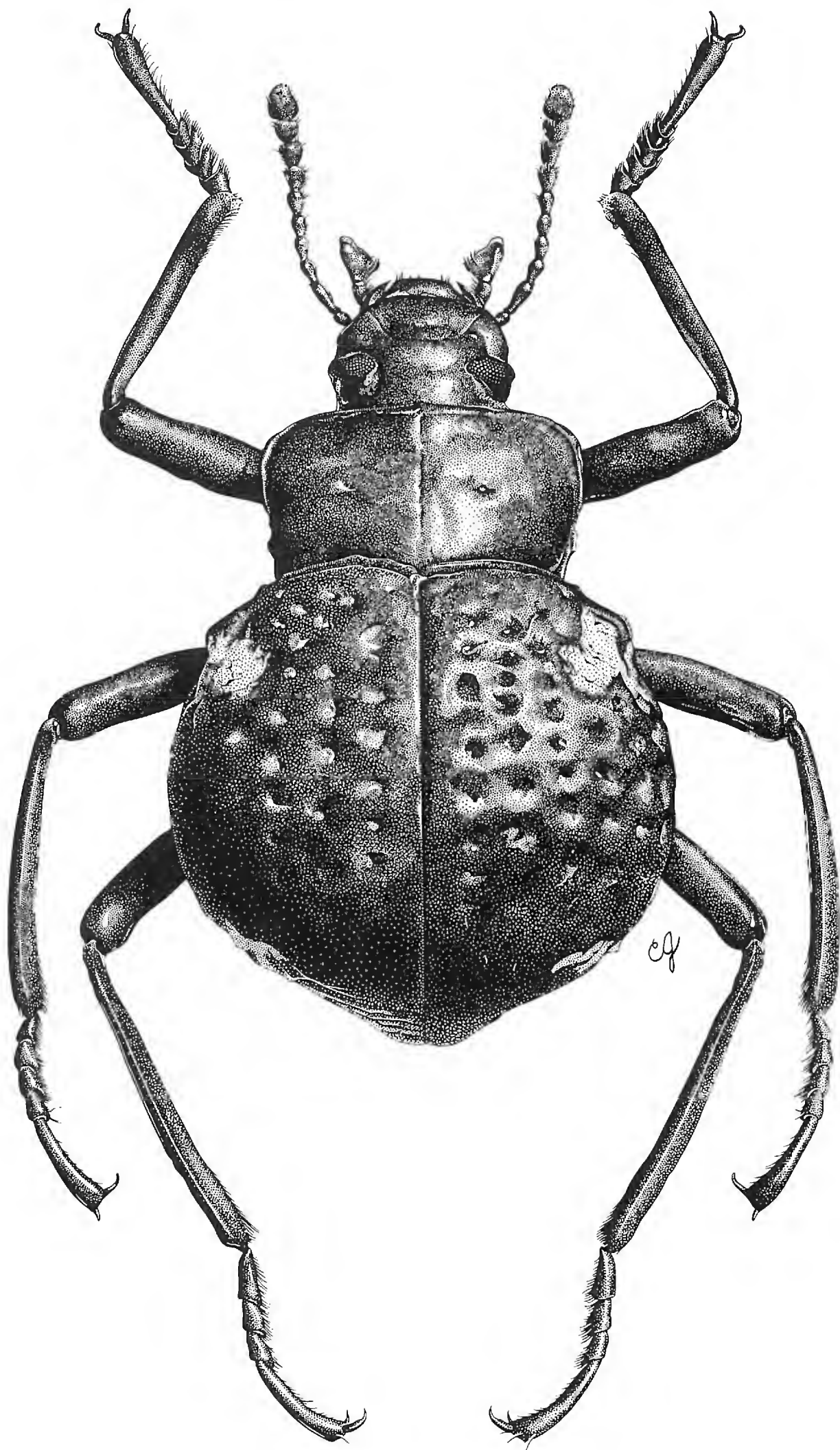


Figure 2. *Isaminas sullivanii*, new species.

Sevilla; 1, same locality, 8-I-1984, R. L. Penrose, F. T. Hovore, P. H. Sullivan; 9, Limon Prov., 22 km S. Siquirres, 9/12-I-1984, R. L. Penrose, F. T. Hovore, P. H. Sullivan.

At the C.A.T.I.E. facility near Turrialba most of the beetles were knocked onto beating sheets from tangles of dead vines in dense forest understory. They are active nocturnally, crawling slowly along vines and twigs.

Isaminas erotyloides (Gebien)

Pteroglymmius erotyloides Gebien, 1928: 224.

Frons and vertex with punctures about as large as eye facets, usually separated by less than one puncture diameter, densest near epistomal suture, becoming finer, sparser along epistomal rim. Pronotal disk with very shallow punctures about twice eye facet diameter medially, becoming impunctate in lateral quarters; with shallow longitudinal median depression, becoming foveate slightly before middle; distinct fovea slightly behind middle at median third on each side. Anterior angles broadly rounded; lateral margins evenly arcuate, crenulate, slightly depressed just inside carina, this depression filled with bright yellow exudate in life. Prosternal process with longitudinal depressions posteriorly convergent, meeting well before acutely angulate apex. Elytra with stria puncture diameter about one-half to slightly larger than length of dorsal eye lobe; punctures most regular in sutural stria, subcontiguous anteriorly, becoming contiguous or occasionally coalesced on declivity; punctures in striae two through nine subcontiguous to contiguous, occasionally coalesced into pairs or triplets; those in three through nine occasionally coalesced with punctures in adjacent striae, especially laterally and posteriorly, producing a coarsely rugose texture; adjacent punctures in striae two or three through eight always coalesced about one-third posterad and two-thirds posterad, forming irregular transverse depressions, in life filled with bright yellow exudate; epipleural carina complete to elytral apex or nearly so.

Measurements: PL, 2.5–2.9 mm; PW, 4.1–4.7 mm; EL, 6.8–7.8 mm; EW, 5.7–6.7 mm.

Isaminas erotyloides is similar to *sullivanii* in bearing transverse, depressed regions on the elytra. It differs as described under the latter.

Holotype (sex undetermined; deposition not stated) from Honduras, Dept. Cortes, San Pedro Sala [sic], no additional data. Additional material examined: Honduras (no additional data) (7); Santa Barbara Departimiento, Lago Yojoa, 7/21-VII-1978, S. Dubon (2); La Paz Departimiento, La Paz, 21-VII-1978, B. Herrera (2); Comayagua Departimiento, Siguatepeque, 22-VI-1978 (1).

Saziches Champion

Saziches Champion, 1886: 261.

Type species: *Saziches subcaudatus* Champion, 1886, by monotypy.

Champion described the important external features of *Saziches*, relating it to *Isaminus*, *Oxidates* and the South American *Sphaerotus*. The last three are derived members of Coelometopini, as discussed above, but *Saziches* has distinctive ovipositor, internal female reproductive tract, and defensive glands which show that it is closely related to *Hegemona* Champion. In both these genera the ovipositor is

strongly modified as a stout, sclerotized, laterally compressed, blade-like structure (Fig. 3). Reduced gonostyles are visible apically, and faint transverse lines may correspond to divisions of the gonocoxite or between coxite and paraproct. In other regards the features of this ovipositor cannot be homologized with those of typical tenebrionids. Presumably the ovipositor is forced into some substrate, but oviposition and larvae are unknown.

The internal female reproductive tract consists of a slender vagina, opening into an enlarged bursa copulatrix, with a single diverticulum (spermathecal accessory gland) attached to the bursa. The gland is of nearly uniform diameter throughout, and glandular except at the extreme base. In *Saziches* the gland attaches dorsolaterally on the body of the bursa (Fig. 4). In *Hegemona* it attaches dorsolaterally on the neck, which is involuted (Fig. 5). The relatively thick walled bursa of *Hegemona* has numerous longitudinal pleats which maintain their shape, while that of *Saziches* is fragile and irregularly saccate when cleared.

The defensive reservoirs in both genera are large elongate sacs with distinct medial lobes basally. Oblique folds are apparent in the reservoir walls, especially in *Hegemona*, but the helical folds of derived Coelometopini are absent. There is considerable common volume between the reservoirs, which receive the secretion from a few basal collecting ducts.

Except for the highly derived ovipositor, most of these features are plesiomorphic. A bursa copulatrix is retained in many of the Old World coelometopines which are included in Cnodalonini in checklists, and also in *Mylaris* and *Taphrosoma* in the New World. In these taxa, however, the apex of the spermathecal accessory gland, though not enlarged, is nonglandular, whereas in *Hegemona* and *Saziches* it is glandular to the apex. Defensive glands similar to those of *Hegemona* and *Saziches* are found in *Camaria*, *Hapsida* and *Talanus* in the new world, and in many old world "Cnodalonini" (see Tschinkel and Doyen, 1980, Fig. 13). In *Catapiestus* and *Strongyliini* the reservoirs are non-annulate, but much smaller.

In external appearance *Hegemona* is extremely similar to *Promorphostenophanes* Kaszab (1960). The holotype of *P. atavus vietnamicus* Kaszab (1980) (BMNH) has the ovipositor visible. Without dissection it is apparent that it is modified in exactly the same manner as in *Hegemona* and *Saziches*. It seems certain that these taxa, and probably *Morphostenophanes* Pic form a natural clade.

In the Gebien catalog (1942–44) *Morphostenophanes* and *Saziches* are included under Misolampini (= Coelometopini, in part), while *Hegemona* appears under Helopini. None of the important features of the defensive glands or female tracts of any of these beetles suggest Helopini. In addition, all these genera have characteristic compound sensoriae on the apical antennal segments, while Helopini have only simple, hair-like sensilla. While cladistic placement is somewhat problematic, this clade appears to contain the most primitive members of the Coelometopine lineage, lacking defensive reservoir annulation, retaining a primary bursa copulatrix, and lacking the spermathecal specialization of the distal accessory gland. The ovipositor also lacks the reflexed paraprocts of nearly all members of the coelometopine lineage (oblique in *Menephilus*), but this may represent a secondary specialization, related to the blade-like structure of the coxites. *Talanus* has a superficially similar blade-like ovipositor, but the coxite structure differs in detail, and the reflexed paraproct is retained, indicating separate derivation. Subdivision of Coelometopini would be premature until a much greater proportion of the world

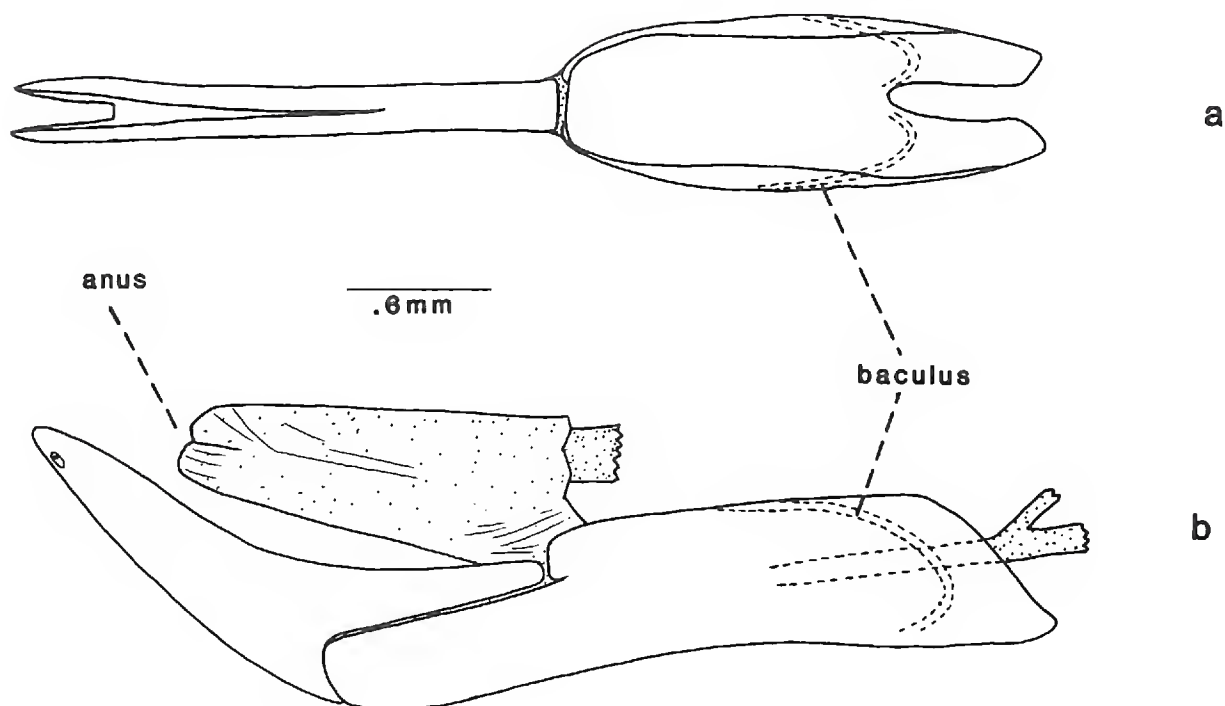


Figure 3. Ovipositor, *Saziches giesberti*.

fauna is examined in detail. At present it is prudent to recognize these genera as a distinctive clade within Coelometopini.

***Saziches subcaudatus* Champion**

Saziches subcaudatus Champion, 1886: 262.

Cranium with extremely shallow, almost obsolete punctures about one-fourth to one-half eye facet in diameter, separated by one to several puncture diameters, becoming slightly finer, denser on epistomal rim. Pronotal disk with sparse punctures much finer than eye facets. Elytra with stria punctures about one-fourth to one-half dorsal eye lobe in diameter, finer anteriorly, in sutural stria and on declivity, coarsest on humped part of disk; stria indicated by very fine line in sutural series, lines becoming gradually coarser laterally and obsolescent near apex; punctures in eighth stria connected by depressed furrow with incised line in bottom; interstriae two through nine subequal, flat; epipleural stria disappearing about halfway posteriad along sternite five; elytral apices forming small, rounded prominences.

Measurements (of paralectotype): PL, 2.4 mm; PW, 3.6 mm; EL, 8.0 mm; EW, 5.9 mm.

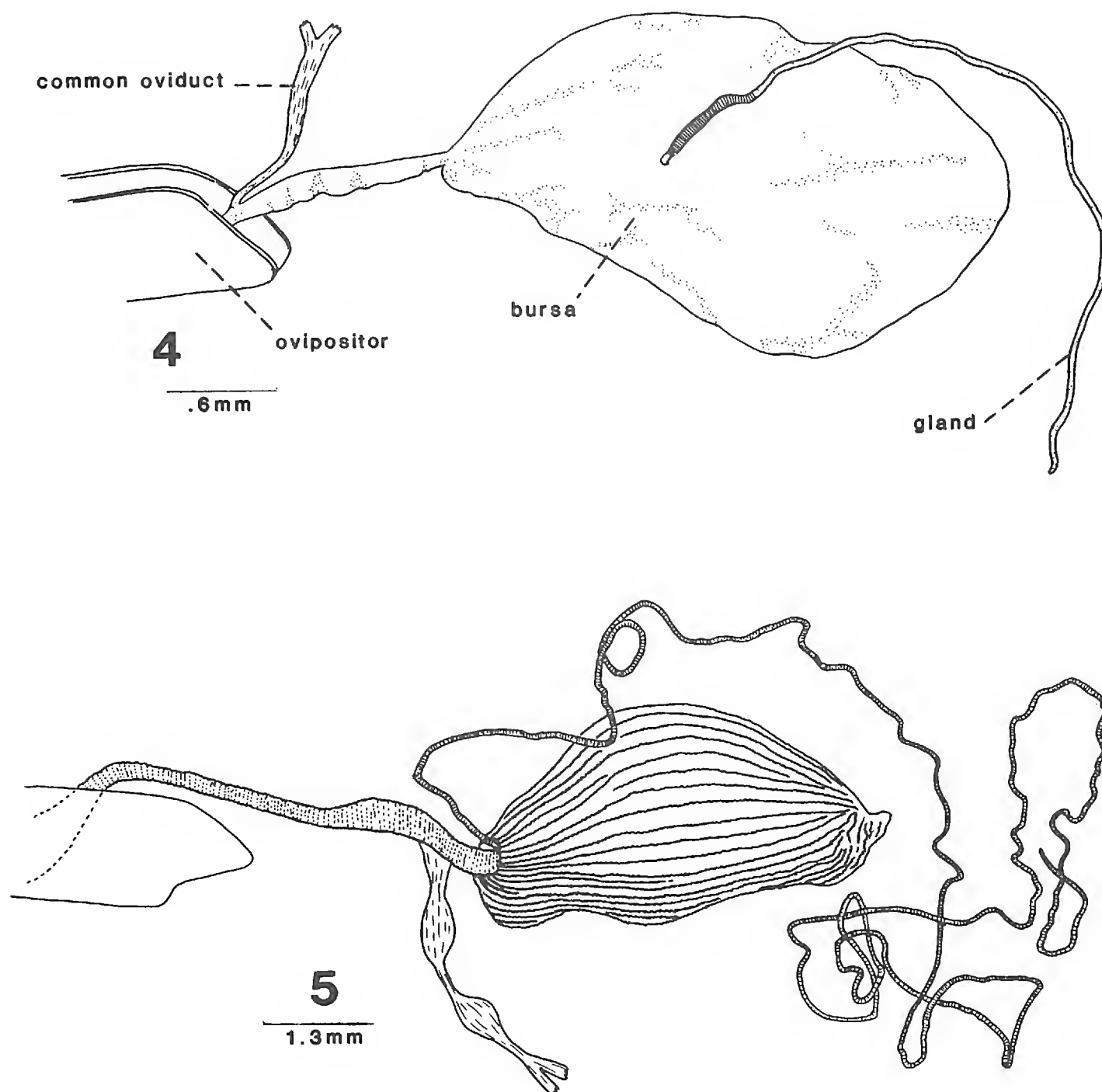
Saziches subcaudatus differs from *S. giesberti* as described under the latter.

A lectotype is hereby designated from the original series of cotypes in the British Museum (Natural History). Type locality: Guatemala, Dept. Alta Vera Paz, San Juan. Additional paralectotypes are from Dept. Alta Vera Paz, Senahu. One paralectotype is located in the Essig Museum of Entomology, University of California, Berkeley.

***Saziches giesberti*, NEW SPECIES**

(Fig. 6)

Cranium with shallow, setigerous punctures about one-fourth to one-half eye facet in diameter, separated by one to several puncture diameters, becoming coarser,



Figures 4–5. Internal female reproductive tracts. 4. *Saziches giesberti*. 5. *Hegemona filibuster* Champion.

denser on epistomum, then finer on epistomal rim. Pronotal disk with very shallow setigerous punctures about one to two times eye facet in diameter, separated by one to several puncture diameters. Elytra with striae indicated by finely incised lines; punctures minute, scarcely demarked from striae lines; striae one and two meeting anteriorly; striae one and nine, three and four fusing posteriorly; remainder fusing irregularly; interstriae convex, shining; first interstria narrowest, subparallel, with scattered, irregular depressions; second interstria widest, about 2.5 times as broad in middle as on declivity, and bearing scattered, irregular punctures and depressions; interstriae three through nine subequal, slightly broader in middle and traversed by five or six transverse depressions, producing undulating surface; irregular depressions just behind humeri and on declivity with dull surface, in life containing yellow-orange exudate; epipleural stria continuing almost to elytral apex; elytral apices not produced.

Measurements: PL, 1.8–2.1 mm; PW, 2.7–3.5 mm; EL, 5.9–7.3 mm; EW, 4.4–5.9 mm.

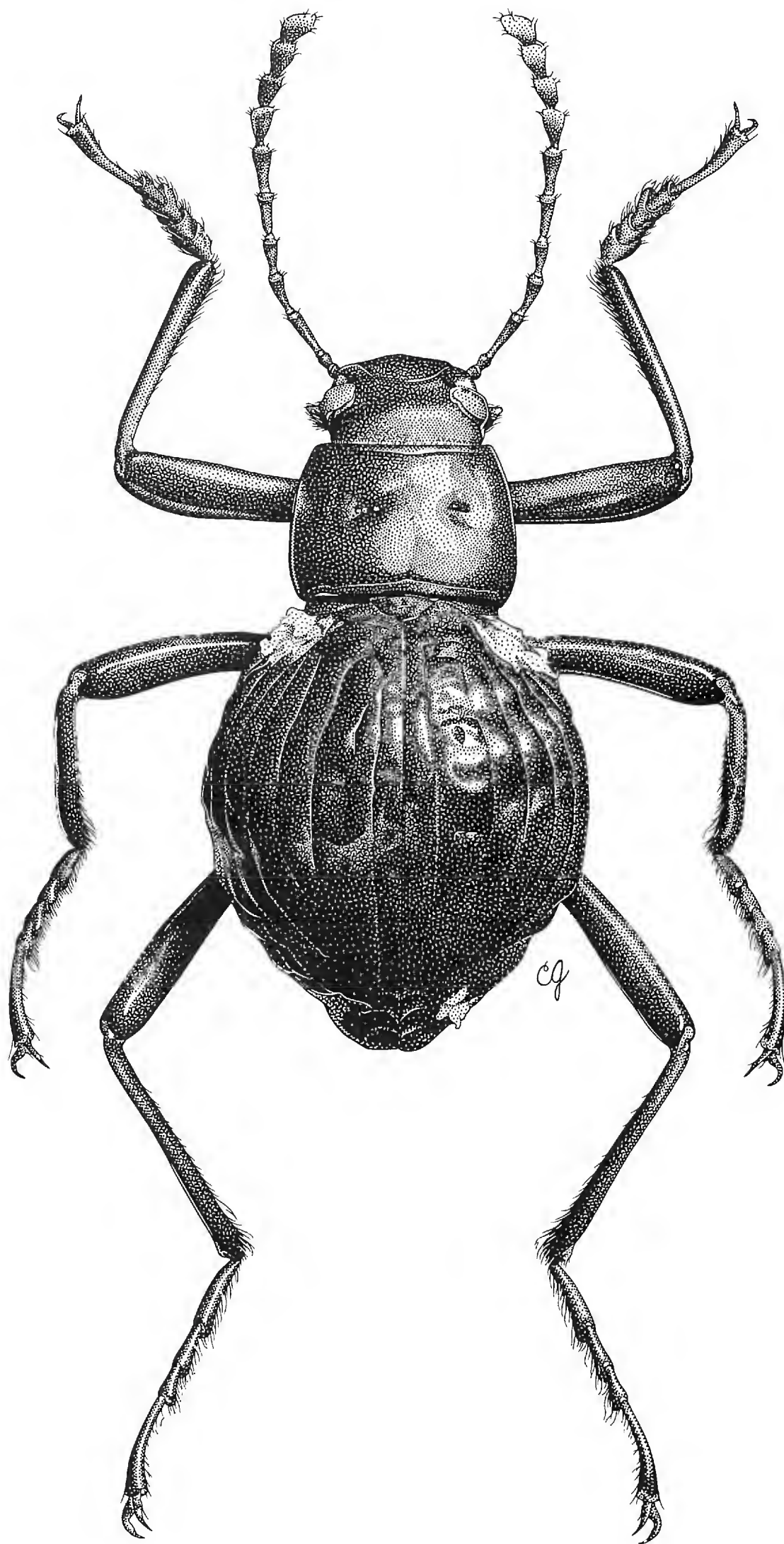


Figure 6. *Saziches giesberti*, new species, holotype.

Saziches giesberti differs from *subcaudatus* Champion in its extremely fine elytral punctures, the impressed striae lines, and the subhumeral and declival depressions. In *subcaudatus* the striae punctures are very coarse, the striae lines barely defined except laterally, and the subhumeral and declival depressions absent.

Holotype (California Academy of Sciences) from Costa Rica, Cartago Prov. Turrialba, 14/17-V-1974. E. Giesbert. Paratypes, Turrialba, 31-V-1951, O. L. Cartwright (2); CATIE, 3 km SE Turrialba, 600 m, 13/16-V-1985, J. T. Doyen (3).

At the C.A.T.I.E. facility *Saziches giesberti* was collected onto beating sheets from tangles of dead vines in dense forest understory. The beetles were taken in company with *Isaminas sullivani*, which they resemble in bearing patches of yellow exudate subhumeral and on the elytral declivity. Adults are probably active nocturnally.

Cnephalura, NEW GENUS

Epistomum nearly straight medially, shallowly emarginate at lateral epistomal sutures; epistomal suture obsolete medially, faint laterally; epistomal membrane concealed. Eyes shallowly emarginated by epistomal canthus; dorsal lobe slightly larger than ventral, bordered medially by shallow groove, deepening and extending posteroventrally to mid-lateral postgena, delimiting distinct postocular lobe; eye bounded posteriorly by shallow groove. Antenna with third segment about twice length of fourth; segments four through eight becoming gradually shorter, broader; segments nine through 11 forming weak club and bearing compound sensoriae apically. Mentum trapezoidal, anterior central portion forming elevated tuberosity.

Pronotum subquadrate, moderately convex; lateral carina complete, very narrowly upturned; prosternal process about as wide as procoxa, declivous behind coxae, apex broadly rounded. Elytra moderately convex, evenly ovate; epipleuron narrowing very little from humerus to elytral apex; scutellum about twice as broad as long. Mesosternal fossa obtusely concave, lateral margins scarcely elevated; metasternum between coxae almost as long as mesocoxal diameter; intercoxal process three-fourths as wide as metacoxa, truncate. Femora and tibiae nearly cylindrical; femora reaching slightly beyond head and approximately to abdominal apex; tibiae with apices pilose; tarsi with plantar surfaces of all but apical segment pilose. Abdominal defensive reservoirs large, saccate, with annular foldings and considerable common volume; aedeagus inverted, simple, fusiform; median lobe sessile. Female reproductive tract unknown.

Cnephalura is similar to *Oxidates* in body form. In *Cnephalura* the epistomal suture is obsolete to absent, at least medially, whereas in *Oxidates* it is distinct. In *Cnephalura* the supraocular groove extends posteroventrally behind the eye, delimiting a distinct postocular lobe. In *Oxidates* the supraocular groove is restricted to the dorsolateral margin of the eye. In addition, the male of *Cnephalura umbrata* has a sharp tooth three-fourths of the distance toward the apex of the femur (see below). This secondary sexual feature is unknown in *Oxidates*.

Type species: *Cnephalura umbrata*, new species, here designated.

Cnephalura umbrata, NEW SPECIES

(Fig. 7)

Male.—Cranium with deep, setigerous punctures about one to two times eye facet in diameter, separated by about one puncture diameter, becoming shallower and

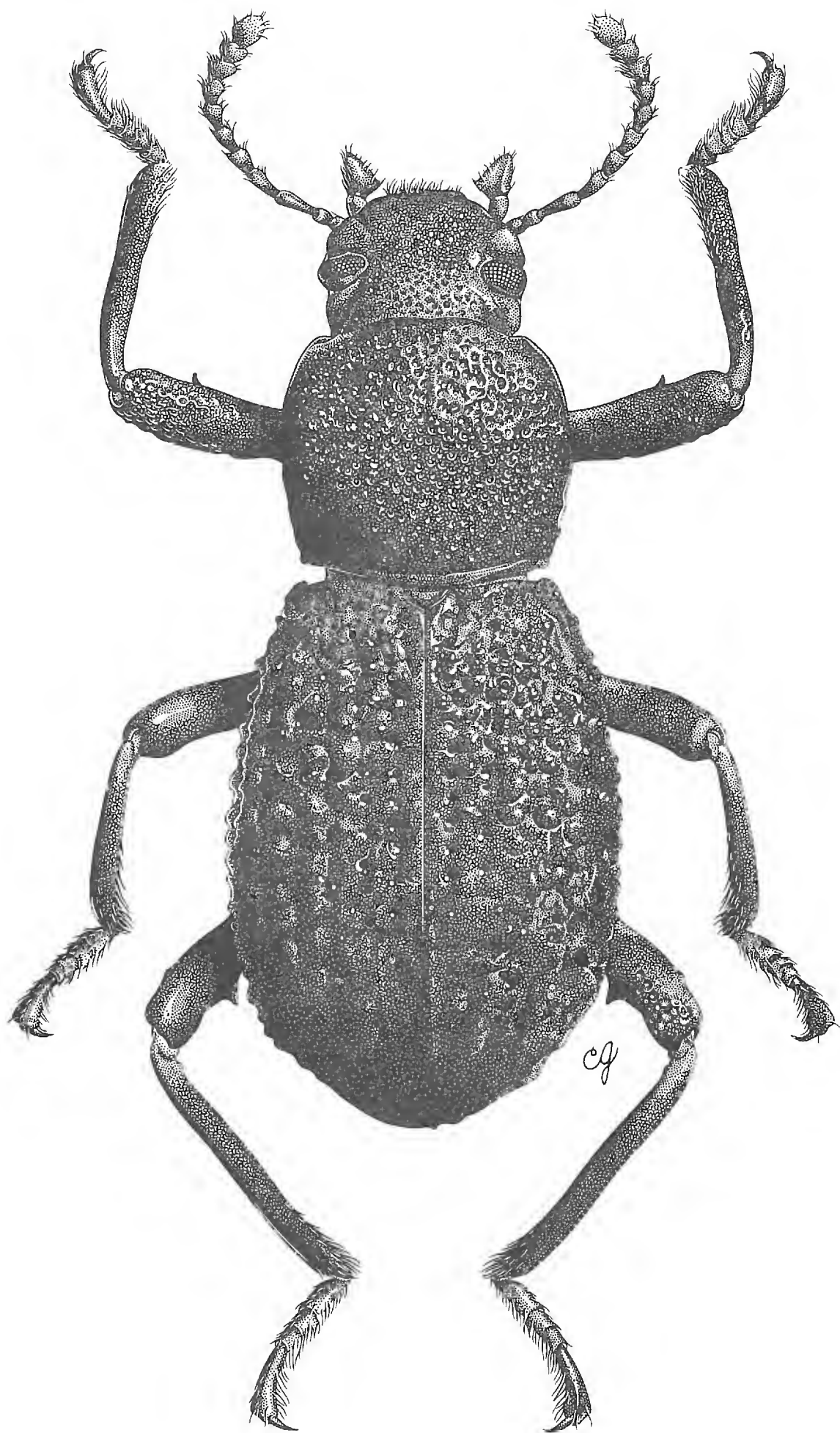


Figure 7. *Cnephalura umbrata*, new species, holotype.

finer on epistomal margin; setae pale, procumbent. Pronotal disk with deep, setigerous punctures about twice eye facet in diameter, contiguous to separated by about one puncture diameter, forming irregularly rugosopunctate surface; setae recumbent. Anterior angles obtusely rounded; lateral margins nearly evenly

arcuate; posterior angles right angled; posterior border weakly bisinuous; hypomeron sculpted as disk; prosternum scabrous; prosternal process with marginal groove along lateral borders. Elytra with regular series of stria punctures about 1.5 times diameter of eye facet, separated by about two puncture diameters on disk, decreasing to one diameter on declivity; interstriae irregularly set with rounded shining tuberosities one to three times punctures in diameter, each bearing several minute setae and one to several very fine punctures. Abdominal sternites with punctures a little larger than eye facets, separated by about one to two puncture diameters, becoming denser, finer on apex of sternite five. Legs rugosely punctate; femora bearing sharp, short tooth at about distal three-fourths.

Measurements: PL, 2.5–2.7 mm; PW, 2.8–3.0 mm; EL, 5.7–5.8 mm; EW, 3.9–4.0 mm.

Female.—Unknown.

Holotype male (California Academy of Sciences) from Mexico, Chiapas, Municipio la Trinitaria, Dos Lagos, 14 km E paved road at Lagos de Colores, 1219M, 29-XI-1976. D. E. and J. A. Breedlove. Paratype, Chiapas, Municipio de Cintalapa, 4–6 km NW La Cienega, 40 km NW Las Cruces, 1400 m, XII-1-1980. D. E. and J. A. Breedlove.

The combination of coarsely punctate pronotum and head with coarsely, densely tuberculate elytra distinguishes *Cnephalaria umbrata* from all other Central American Coelometopini.

Bothynocephalus, NEW GENUS

Epistomum straight just before eyes, then evenly arcuate between antennal sockets; lateral epistomal sutures faint, median suture absent; epistomal membrane concealed. Eye with dorsal and ventral lobes subequal, shallowly emarginated by epistomal canthus; dorsal lobe bordered anteriorly and medially by a shallow groove terminating posteriorly in a deep cavity adjacent to the posterodorsal corner of the eye (Fig. 8); eye bordered posteriorly by shallow groove. Frons forming prominent, abruptly declivous, curving brow between postocular cavities. Antenna with third segment about 1.7 times longer than fourth; segments five through 10 becoming gradually shorter, broader; 11 almost twice as long as broad, asymmetrically rounded apically; compound sensoriae distributed on mesal and lateral angles of segments eight through 10, on apical half of 11. Mentum trapezoidal; central third forming prominent, elevated tuberosity.

Pronotum globular, lateral carina obsolescent in posterior third, anterior border not margined; posterior border broadly margined, deeply grooved just before margin; prosternal process slightly wider than coxa, abruptly declivous immediately behind coxae. Elytra strongly convex, evenly ovate; epipleural margin ventrolateral in aspect; scutellum triangular, moderate in size, about twice as broad as long. Mesosternal fossa very shallow, lateral margins scarcely elevated; metasternum between coxae about as long as mesocoxa; intercoxal process nearly as broad as coxa, truncate with broadly rounded corners. Femora and tibiae subcylindrical; femora reaching slightly beyond head and to fourth abdominal sternite; tibiae with apex pilose; tarsi with plantar surfaces of all but apical segment pilose, apical segment more sparsely setose. Abdominal defensive reservoirs large, saccate, with annular foldings and considerable common volume; collecting ducts emptying through single large ampulla on each reservoir. Ovipositor coelometopoid, with

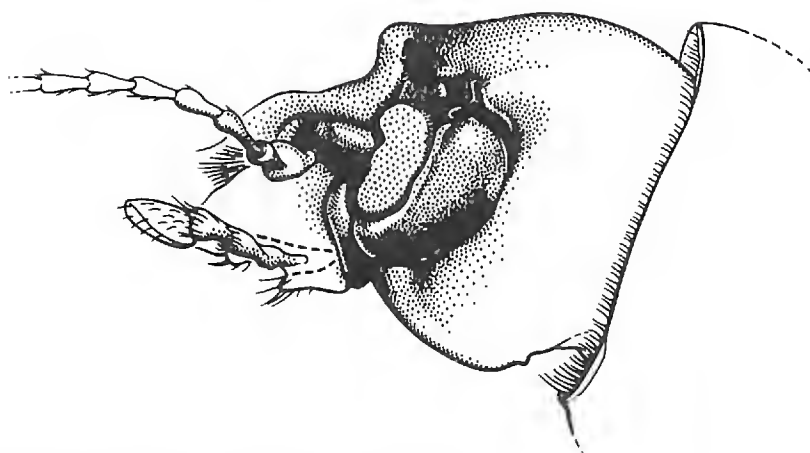


Figure 8. *Bothynocephalus*, cranium, lateral aspect.

paraprocts rotated, basal lobe of coxite extremely elongate; internal tract without bursa copulatrix; spermathecal accessory gland about as long as ovipositor, terminating in large, saccate spermatheca. Male reproductive tract unknown.

Bothynocephalus is similar to *Oxidates* and *Cnephalura* in body form, but has a relatively smaller, more globular pronotum, and a greater constriction between the prothorax and the hindbody, which superficially gives it the appearance of members of the tenebrionid tribe Triorophini. In the characteristics of its defensive glands, ovipositor and internal female reproductive tract, *Bothynocephalus* is a typical, highly derived member of the Coelometopini.

Type species: *Bothynocephalus cristatus*, new species, here designated.

***Bothynocephalus cristatus*, NEW SPECIES**
(Fig. 9)

Female.—Cranium with very fine, minutely setigerous punctures, very much smaller than eye facet diameter, separated by about two to five puncture diameters; cranial surface very finely shagreened, except for polished declivity below brow ridge. Pronotal disk with anteromedial punctation as on cranium; punctures becoming slightly coarser, shallower in anterolateral corners, gradually coarser posteriorly to slightly larger than eye facets along posterior margin; large punctures more or less coalesced along lateral carina, forming irregular marginal groove; carina rounded anteriorly, weakly explanate and upturned near middle, becoming obsolescent posteriorly; anterior corners broadly rounded, without definite angles; lateral margins strongly arcuate; posterior angles obtuse; posterior margin evenly arcuate. Hypomeron with shallow punctures about 1.5 times eye facet in diameter, separated by about one to three puncture diameters. Prosternal process with deep marginal groove along lateral and posterior borders. Elytra with regular series of deep stria punctures about 1.5 to two times eye facet in diameter, separated by about one to three puncture diameters; sutural stria of one or two punctures; striae one and nine, two and seven, three and six, four and five joining posteriorly; one and two, five and six joining anteriorly. Interstriae weakly sulcate, finely shagreened. Epipleuron obsolete anteriorly, becoming visible as fine ridge at about anterior margin of fifth sternite and extending almost to elytral apex. Abdominal sternites finely shagreened, with fine, obsolescent punctures barely visible on last three sternites.

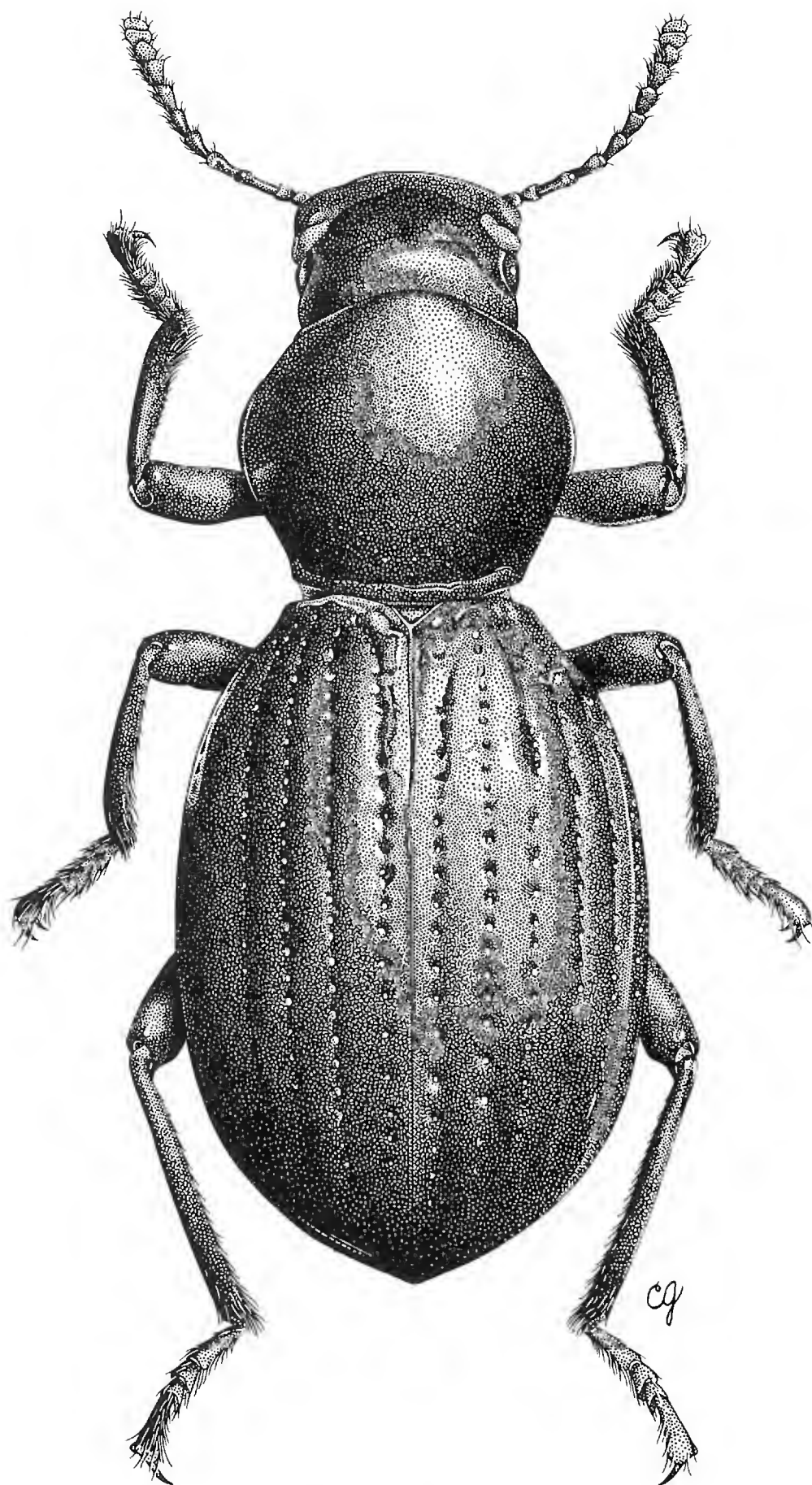


Figure 9. *Bothynocephalus cristatus*, new species, holotype.

Femora with punctures about one-half to one times as large as eye facets, separated by about one puncture diameter to subcontiguous. Tibiae more finely punctate.

Measurements: PL, 2.6–3.3 mm; PW, 3.0–3.6 mm; EW, 4.2–5.2 mm; EL, 6.5–8.2 mm.

Male.—Unknown.

Holotype female (California Academy of Sciences) from Honduras, Comayagua Departimiento, Siguatepeque, 8-VI-1976. J. V. Mankins. Paratype (abdomen missing, probably female), same locality 26-X-1975. J. V. Mankins.

Bothynocephalus cristatus differs from all other new world Tenebrionidae in its prominently browed frons and deep postocular cavities.

ACKNOWLEDGMENTS

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**The Exotic Aphids (Homoptera: Drepanosiphidae)
on Ornamental Birch in Northern California**

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Abstract.—Five introduced species of aphids occur on ornamental birch trees in northern California. A key to these aphids is provided along with species diagnoses and biological notes.

In northern California, five species of aphids of the Family Drepanosiphidae, Tribe Phyllaphidina (sensu Heie 1980) feed on introduced trees of the genus *Betula*, the birches. The most common birch in northern California is the ornamental European white birch, *Betula pendula* Roth. The downy birch, *Betula pubescens* Ehrhart, has also been planted but much less frequently (Hajek 1986). These host trees and their aphid fauna are endemic to Europe where a guild of eleven birch aphid species occur sympatrically (Heie 1972). These introduced species of birch aphids have only recently been studied in California (Grushkowitz 1976; Hajek 1984), although they frequently create an urban pest problem due to production of copious amounts of honeydew. Dates of introduction for these species are not known although one species, *Callipterinella minutissima* (Stroyan), was only recently recorded from North America (Hajek 1985).

Apterous and alate viviparae of all five species can often be distinguished with the naked eye. The only English language keys presently available for identification of these birch aphid species include the entire European fauna of the aphid family including these species (Stroyan 1977; Heie 1982). For ease in future studies of this birch aphid fauna in California, a key to apterous and alate viviparae of these five aphid species is presented.

KEY TO BIRCH APHIDS IN NORTHERN CALIFORNIA

- | | | |
|------|--|---|
| 1 | Apterous (wingless) viviparous females. | 2 |
| | Alate (winged) viviparous females. | 5 |
| 2(1) | Dorsum with blackish banding. | 3 |
| | Dorsum not conspicuously blackish banded. If bands present, they are pale and indistinct. | 4 |
| 3(2) | Dark banding only on abdominal tergite VIII. Very small, plump, oval, greenish aphids (body length 0.9–1.4 mm). Short, 5-segmented antennae. | |

Callipterinella minutissima (Stroyan)

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Dorsum with regular blackish banding on all abdominal segments. Color variable from green to red. Body length 1.6–2.5 mm. Antennae 6-jointed.

Callipterinella calliptera (Hartig)

- 4(2) Cauda broadly triangular (Fig. 1). Small (1.5–2.0 mm), rather flat, oval aphids. Frons with six capitate hairs placed on 4 tubercles. Apices of antennae dark.

Betulaphis brevipilosa Börner

Cauda slightly to distinctly constricted (Fig. 2). Delicately built aphids with long, thin legs. Body length 1.9–2.7 mm. Frons lacking capitate hairs on tubercles. Antennae pale with dark apices of segments.

Calaphis flava Mordvilko

- 5(1) Large aphids (body length > 3 mm). Pale green, thorax with brown coloration. Abdomen sometimes with short, dark cross bars on tergite IV and/or V. Sometimes covered with flocculent white or bluish-white wax.

Euceraphis betulae (Koch)

Body length < 3 mm.

6

- 6(5) Cauda broadly triangular (Fig. 1). Dorsum with very short, almost invisible hairs; margins of posterior segments glabrous. Abdomen usually with dark spot on tergites III–V (–VI) and dark marginal markings.

Betulaphis brevipilosa Börner

Cauda slightly constricted or knobbed (Fig. 2). Dorsum with distinct, visible hairs.

7

- 7(6) Frons concave (Fig. 3). Siphunculi with a thickened flared apex (Fig. 5).

Calaphis flava Mordvilko

Frons almost straight (Fig. 4). Siphunculi without flared apex (Fig. 6).

8

- 8(7) Processus terminalis about 1.75 or more times as long as basal part of antennal segment VI (Fig. 7). Abdomen sometimes with dark, dorsal cross [bars]. Body length 1.5–2.4 mm.

Callipterinella calliptera (Hartig)

Processus terminalis about 1.25–1.50 times as long as basal part of antennal segment VI (Fig. 8). Abdomen without dorsal cross bars. Body length 1.5–1.9 mm.

Callipterinella minutissima (Stroyan)

TREATMENTS OF SPECIES

Betulaphis brevipilosa Börner

Apterous viviparous female.—Small (body length 1.5–2.0 mm), rather flat oval, grass- or lime-green aphids. Abdominal cuticle usually wrinkled. Abdomen with very short hairs except for marginal hairs on segments (IV–) V–VIII. Frons with 6 capitate hairs on four tubercles. Tarsi and apices of antennae dark. Siphunculi low, truncate. Cauda broadly triangular.

Alate viviparous female.—Abdomen usually grass-green or yellowish with dark spot on tergites III–V (–VI) and dark marginal sclerites. Hairs on frons fine and acute. Siphunculi sometimes dark.

Eggs.—Black, ellipsoid and without distinguishing markings. Length: $\bar{x} = 0.516$ mm ($s_{\bar{x}} = 0.007$, $n = 20$); Width: $\bar{x} = 0.258$ mm ($s_{\bar{x}} = 0.005$, $n = 20$).

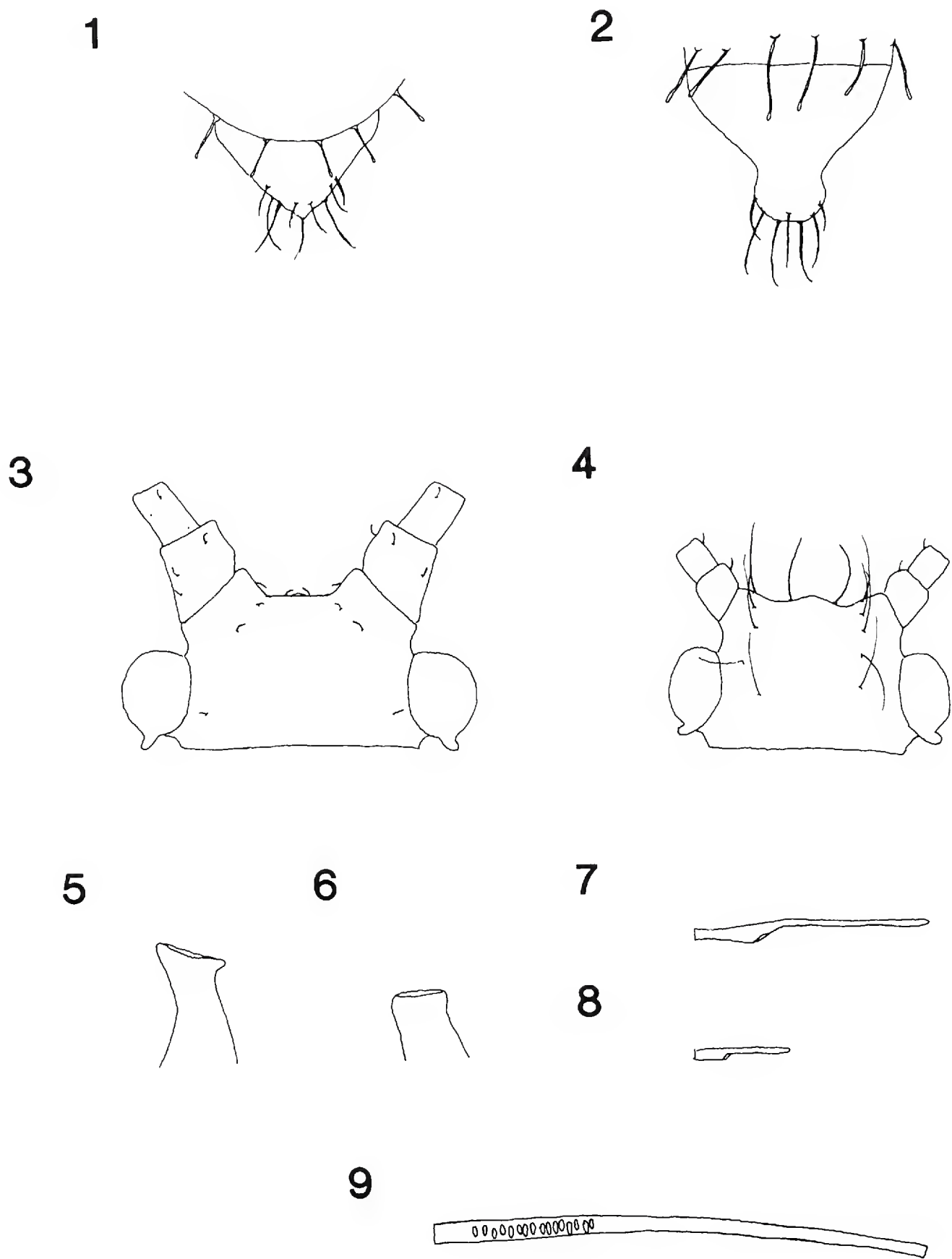


Figure 1. *Betulaphis brevipilosa*. 2, 3, 5. *Calaphis flava*. 4, 6, 7. *Callipterinella calliptera*. 8. *Callipterinella minutissima*. 9. *Euceraphis betulae*. 1, 2. cauda. 3, 4. head. 5, 6. siphunculus. 7, 8. processus terminalis. 9. antennal segment III.

Biology.—Common on *B. pendula*. Avoids new leaves in spring. Dense aggregations are frequent. Extremely sessile aphid. Not ant tended.

Calaphis flava Mordvilko

Apterous viviparous female.—Pale green or yellowish, delicately built aphids with long, thin legs. Body length 1.9–2.7 mm. Hairs on dorsum long and capitate. Frons

concave. Antennae a little longer than body. Apices of antennal segments dark. Legs pale with knees, apices of tibiae and tarsi dark. Pale siphunculi low and truncate with thickened, flared apices. Cauda slightly constricted.

Alate viviparous female.—Pale green or yellowish. Hairs on dorsum short and blunt. Wing veins strong and black bordered.

Biology.—Uncommon. Populations occur predominantly on *B. pubescens*. Developing leaves are preferred in spring. Not ant tended.

Callipterinella calliptera (Hartig)

Apterous viviparous female.—Green to red with blackish dorsal cross bars on all abdominal segments. Body length 1.6–2.5 mm. Eyes red. Antennae pale with apices of segments dark. Siphunculi and legs dark. Cauda slightly constricted, knobbed.

Alate viviparous female.—Abdomen sometimes with dark dorsal cross bars. Processus terminalis 1.75 or more times the length of the basal part of antennal segment VI.

Eggs.—Black, taper toward one end, meso-dorsal suture quite evident. Length: $\bar{x} = 0.524$ mm ($s_{\bar{x}} = 0.006$, $n = 20$); Width: $\bar{x} = 0.243$ mm ($s_{\bar{x}} = 0.005$, $n = 20$).

Biology.—Common, predominantly found on *B. pendula*. In spring, developing leaves preferred. Throughout the year, found in leaves tied together by insects, e.g., spiders or Lepidoptera larvae. Often found in aggregations of many individuals which are ant tended. Fairly mobile aphid, running when disturbed.

Callipterinella minutissima (Stroyan)

Apterous viviparous female.—Very small (body length 0.9–1.4 mm), plump, oval aphids. Greenish with one dark dorsal band on abdominal tergite VIII. Vertex with a large dark sclerite. Short, 5-segmented antennae. Apical antennal segments usually dark. Siphunculi shorter than wide. Cauda slightly constricted, knobbed. White tuft of wax present below cauda.

Alate viviparous female.—Abdomen greenish. Apices of antennae, tibiae and whole tarsi dark. Antennae 6-segmented. Processus terminalis 1.25–1.50 times as long as basal part of antennal segment VI.

Biology.—Localized populations present inside of female catkins throughout the summer. On leaves during early spring and fall, preferring leaves spun together by insects. Usually aggregated when found on leaves. Not ant tended.

Euceraphis betulae (Koch)

Viviparous female.—All viviparous females alate. Large aphids (3.0–3.6 mm long), elongate, pale green. Body sometimes clothed in flocculent white or bluish-white wax. Head with dark dorsal spot or longitudinal stripe. Prothorax with two brown spots, meso- and metathorax brown. Abdomen sometimes with short, dark cross bars on segments IV–V or IV only. Antennae as long as body. Basal parts of antennal segments III and IV dark in some specimens from spring and autumn. Antennal segment III with 14–26 characteristic narrow transverse oval rhinaria almost in a line (Fig. 9). Long legs sometimes with darkened tarsi and distal ends of tibiae. Siphunculi about 0.03 times body length, truncate, sometimes dark. Cauda knobbed.

Eggs.—Black, ellipsoid, and without distinguishing markings. Length: $\bar{x} = 0.802$ mm ($s_{\bar{x}} = 0.008$, $n = 20$); Width: $\bar{x} = 0.394$ mm ($s_{\bar{x}} = 0.007$, $n = 20$).

Biology.—Common on *B. pendula*. Prefers new, developing leaves in spring and senescent leaves in early autumn. Forms loose aggregations usually of few individuals. Highly mobile aphid which runs or drops from leaves readily. Not ant tended.

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Scientific Note

Heimbra opaca (Ashmead) (Hymenoptera: Eurytomidae) Discovered in Idaho: A New State Record for the Subfamily Heimbrinae¹

During the years 1981–1985, four specimens of *Heimbra opaca* (Ashmead) were collected at three widely separated localities in Idaho. All three sites are quite typical northern Great Basin grasslands with scattered shrubs. This is the first report of *H. opaca*, and thus the subfamily Heimbrinae, in Idaho. This species was previously known from California, Arizona, New Mexico, Utah, Colorado, Kansas and Montana (Burks 1979, in Krombein et al., Cat. Hymen. Am. N. of Mex., Vol. 1, p. 846). The specimens of this distinctive species were identified by the authors using key criteria (Burks 1971, Trans. Am. Ent. Soc. 97:1–89).

Specimens of *H. opaca* examined: Idaho: 1 ♀ Nez Perce Co., Hellsgate State Park, 4 mi. S. Lewiston, 8 Sept. 1981, T. D. Miller, collector; 1 ♀ same locality, 20 July to 15 Aug. 1985, Moericke trap, T. D. Miller, collector; 1 ♀ Clark Co., Blue Dome, 6 July 1982, J. B. Johnson, collector; 1 ♀ Elmore Co., 14.7 mi, NE Anderson Ranch Dam, 3 Aug. 1982, sweeping grass, J. B. Johnson, collector. Specimens were deposited in the William F. Barr Entomological Museum, University of Idaho.

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A New Species of *Andrena* at the *Micrandrena-Scaphandrena* Boundary (Hymenoptera: Apoidea)

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Abstract.—A new species of *Andrena*, *A. (Micrandrena) robinsoni* is described from Colorado. Two related species, *trapezoidea* Viereck and *primulifrons* Casad are transferred from the subgenus *Scaphandrena* where they were placed by Ribble to the subgenus *Micrandrena*.

The two subgenera *Micrandrena* and *Scaphandrena* are closely related, and both have been monographed by Ribble (1968, 1974). *Scaphandrena* has been given special attention on account of the extensive introgressive hybridization by two or three of its species in the Rocky Mountain region, the trihybrid complex "*scurra* Viereck x *capricornis* Casad and Cockerell x *arabis* Robertson" of Ribble (1973, 1974) and further described by me (1981, 1984).

In my experience in Pennsylvania and the Rocky Mountain region, *Scaphandrena* is an oligolege of small-flowered crucifers. Species of *Micrandrena* are frequently collected on the same hosts as pollen-gathering females of *Scaphandrena*, but *Micrandrena* as a group has a wide range of pollen sources. Ribble thought that the *primulifrons* group, originally assigned to *Micrandrena* was a crucifer oligolege, and finally suggested that on the basis of morphology and nomenclatorial convenience it should be transferred to *Scaphandrena*, as it now appears in the *Catalogue of Hymenoptera in America North of Mexico* (Krombein et al, 1979). Ribble states that within *Scaphandrena* the closest relative of the sibling species *primulifrons* Casad and *trapezoidea* Viereck (the *primulifrons* group) is *capricornis*.

In collecting specimens of the hybrid complex for the University of Colorado Museum there accumulated a small lot of a species of the *primulifrons* group which I provisionally considered to be *trapezoidea* Viereck. Recently Frank Parker and Terry Griswold of the USDA Bee Systematics and Biology Laboratory at Logan, Utah, lent me specimens of *trapezoidea* from Texas determined by Ribble. The Colorado specimens turned out to be a third species of the *primulifrons* group, which is described below.

Andrena (Micrandrena) robinsoni, NEW SPECIES

This Colorado species has the strongly punctate abdominal terga characteristic of the *primulifrons* group, but can be distinguished at a glance from the females of the other two species, the rare *trapezoidea* and common *primulifrons* Casad, whose distribution lies to the south and southwest, by a shiny, very sparsely punctate median area of about one third the length of the 2nd abdominal tergite, with both anterior and posterior margins becoming closely and strongly punctate. The general

appearance of the bee is dominated by the three white abdominal hair bands and the contrasting bare, shiny anterior third of the abdomen. *Robinsoni* is also more robust, 8 mm in length instead of 7.

Female.—Length 8 mm. Integument black to brown black with obscure metallic reflections of blue and green, except for the obscure amber apices of the tergites and the bright reddish brown flagellum of the antennae.

Head with brownish white hairs, labral fringe golden-amber; measurements of the facial quadrangle (distance between middle of eyes and vertex and bottom of clypeus) with w:1 ratio of 3.6:4.5; clypeus with upper half markedly flattened, dull and strongly reticulate, strongly contrasting with the shiny and polished lower half which is coarsely and irregularly punctate; facial fovea seen from front dark, golden-tomentose seen obliquely, upper end occupying less than half space between it and ocellus, widening centrally then narrowing below to about $\frac{1}{2}$ width of space between it and antennal insertion, ending just below level of insertion; upper ocelli $\frac{1}{2}$ ocellus width from vertex; antenna with segment 3 not quite as long as 4 + 5; process of labrum 2–3 times as wide at base as at tip, which is truncate, sometimes slightly emarginate; labrum shallowly concave, ending with a narrow raised rim; galea reaching as far as apex of 4th segment of maxillary palpus.

Thorax covered with long, slender grayish-white hairs dorsally, so sparse that the moderately reticulate, semi-shining, closely (2–3 p–w apart) and strongly punctate integument of notum is not obscured; hair on pleura thickened, whiter; scutum with integument like that of notum, scutellum and triangle of propodeum strong-reticulate, triangle with weak longitudinal wrinkles above, rest of propodeum strongly reticulate but semi-shining and obscurely punctate; pronotum with lateral lines extending from pit at base of pronotal lobe diagonally across side of pronotum, fading out at about $\frac{1}{3}$ distance to midline; corbiculum without anterior fringe, posterior half with sparse long simple hairs; legs with integument black to brown-black, tibial spurs white-translucent, middle basitarsis broadened, lateral margins curved outward, hind leg with tibia strongly widened apically, the basitarsis about half its width at point of attachment, face of tibial scopa of short and simple hair, the profile (not hair-length) of posterior fringe of scopa at midpoint of tibia a little less than half width of tibia at apex, trochanteral floccus imperfect, with basal hairs short and not recurved; tooth of hind tarsal claw with length about $\frac{1}{4}$ distance from inner base of tooth to tip of claw; forewing 6 mm, veins amber, membrane clear, wingtips slightly infused with amber, pterostigma rather slender, less than $1\frac{1}{2}$ times width of prestigma, first transverse cubital vein ending 3–4 vein-widths distant from pterostigma, basal nervure meeting or falling slightly short of nervulus.

Abdomen with three strong, appressed hair bands on apices of tergites 2–4, that of second complete or interrupted medially by about $\frac{1}{4}$ th the width of the tergite, hairs white, as are the sparse fine decumbent hairs between the bands, caudal fimbria brownish orange; integument of 1st three tergites non-reticulate, polished, 4th weakly reticulate, 1st with wide-scattered weak punctures, the 2nd with anterior and posterior margins closely and coarsely punctate, with punctures 1–3 p–w apart, becoming increasingly sparse toward mid-third of third of tergite, where the punctures are coarse but very widely scattered, 3rd and 4th tergites entirely closely strong-punctate.

Holotype female.—COLORADO, 10 mi SW Loveland, 5500', 26 May 1980, fls. *Physaria belli*, P. Robinson.

Paratypes female.—2, same data as holotype; 2 with same data except U. Lanham; 1, COLORADO Weld Co., 6 mi ENE Nunn, 8 June 1981, fls. *Rorippa sinuata*, U. Lanham; 1, COLORADO, Weld Co., Briggsdale, 19 May 1979, fls. *Descurainia*, U. Lanham.

An additional female, COLORADO, Baca Co., 31 mi SSW Springfield, 4 May 1977, U. Lanham and P. Byron.

A byproduct of this study was the discovery of a character which distinguishes females of the *primulifrons* group from *capricornis* and from the females of the several other species of *Scaphandrena* available to me. The visible labrum in the *primulifrons* group is shallowly concave in profile, while that of *capricornis* and the sundry species of *Scaphandrena* is evenly convex. It seems to me that the three species of the *primulifrons* group do not pose the danger of sinking *Scaphandrena* in *Micrandrena* as feared by Ribble, and should be returned to *Micrandrena*. Also the females of six species of the *piperi* group of *Micrandrena*, thought by Ribble (1968) to intergrade with *Scaphandrena*, seen by me, have the labrum similarly concave.

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Publication Received

Cladistic Analysis of North American Platynini and Revision of the *Agonum extensicolle* Species Group (Coleoptera: Carabidae). By James Kenneth Liebherr. University of California Publications in Entomology, vol. 106, x + 198 pp., 70 figs., 36 tables, 7 appendixes. Issue date on review card given as "August 1986." Received by PCES at CAS 11 August 1986. Published and distributed by University of California Press, 2120 Berkeley Way, Berkeley, California 94720, U.S.A., telephone (415) 642-4562. Price \$16.95 paperbound. ISBN 0-520-09958-3.

The introduction states in part:

"John L. LeConte wrote of the *Agonum extensicolle* species group in 1854, saying that it is "a group of extreme complexity, containing winged species of metallic colors, bluish or greenish, with the base of the antennae, the feet, and occasionally the thorax rufous or pale piceous." LeConte recognized that the species within the *Agonum extensicolle* group are difficult to diagnose. Several of the species are widely distributed geographically, and the accompanying variability in biometric features has caused past authors to describe and name many invalid taxa. Six of the seven species are found in the American Southwest and in adjacent Mexico, one of the last areas in North America for which the carabid fauna remains poorly understood. This study circumscribes the species using qualitative morphological characters, electrophoretic data analyzed at the population level, and discriminant function analysis based on biometric measurements.

The *A. extensicolle* group is distinct within the genus, supporting recognition of it as a monophyletic lineage. Relative confidence that a taxon is monophyletic is a prerequisite for certain aspects of systematic study. The study explores the phylogenetic affinities of the species in the *A. extensicolle* group based on genetic data obtained from starch-gel electrophoresis and on internal and external morphological characters. The hypothesis of phylogenetic relationships is then analyzed in light of the present-day distributions of the species. This analysis provides insight into the speciation events and mechanisms that have brought about the present day diversity of the *A. extensicolle* group."

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A New Species of *Paruroctonus* from Coastal California (Scorpiones: Vaejovidae)

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Abstract.—A new species of scorpion from coastal California is described and named *Paruroctonus maritimus* Williams. Its nearest relatives appear to be *Paruroctonus boreus* (Girard) and *Paruroctonus silvestrii* (Borelli).

A few years ago a small series of *Paruroctonus* was collected under cardboard and other surface debris by Roy Johnson, along railroad tracks at Sea Side, Monterey County, California. At the time, this sample posed certain problems of interpretation, although it appeared to be *Paruroctonus boreus* (Girard). Since the collection site was well outside of the known distribution of *P. boreus*, restricted in area, and ecologically disturbed, the identification of this species was tentative. Reinvestigation of these specimens indicates they are not *P. boreus*, but an undescribed new species that appears to inhabit the coastal sand dune community. This new species is here described and named. The measurements cited are as defined by Williams (1980).

Paruroctonus maritimus Williams, NEW SPECIES (Fig. 1, Table 1)

Diagnosis.—Members of subgenus *Paruroctonus*. Total length up to 50 mm. base color of exoskeleton pale yellow with contrasting dusky-black marbling dorsally on carapace and mesosoma, dark marbling not extending to posterior margin of mesosomal terga, metasoma with ventral and ventrolateral keels outlined in dusky pigment; frontal margin of carapace convex; pectine teeth 24–27 in males, 18–20 in females; metasoma with ventral keels smooth to obsolete on I, smooth on II–IV, serrate on V; metasoma with ventrolateral keels smooth to granular on I–II, smooth on III, smooth to crenulate on IV; chela with supernumerary denticles 6 on fixed, 7 on movable finger; chela with primary row denticles divided into 6 subrows on fixed finger, 7 subrows on movable finger.

Related to *Paruroctonus boreus* (Girard) and *Paruroctonus silvestrii* (Borelli). Distinguished from *P. silvestrii* by pigment pattern of mesosomal terga not extending to posterior margin of terga, metasoma with 4 pairs of ventral macrosetae on segment II. Differs from *P. boreus* by less distinct proximal gap between fingers of chela in males; slightly fewer pectine teeth; median ocelli more forward on carapace; ratio of carapace length to frontal margin distance less than 2.0; metasoma of males less elongate, metasomal segment IV length to width ratio less than 1.9.

Holotype.—Male. Coloration: Base color of cuticle pale yellow, carapace with black marbling, frontal margin outlined in dusky-black; mesosomal terga with

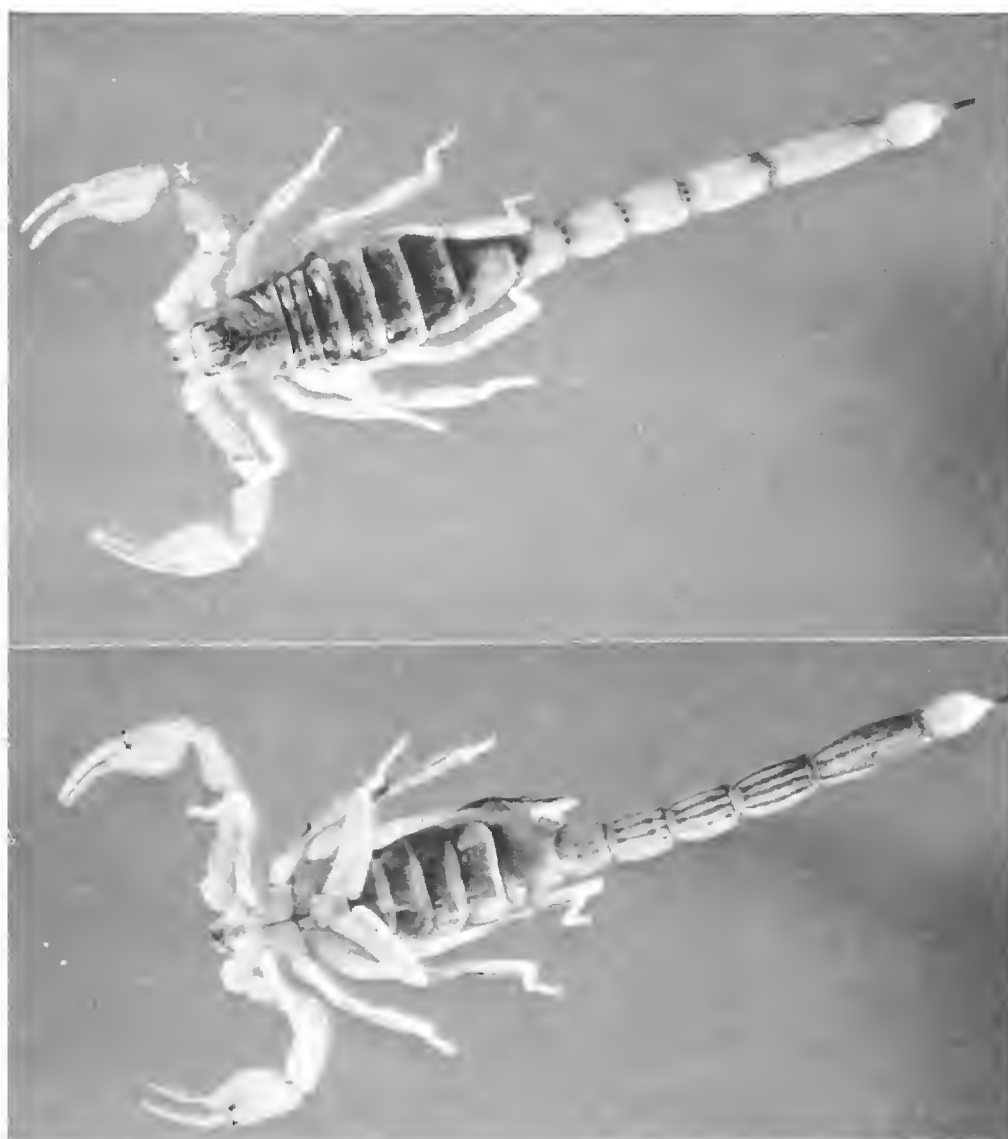


Figure 1. *Paruroctonus maritimus* Williams, holotype, dorsal and ventral views.

underlying dusky black markings, these not extending to posterior margin of terga, dusky markings mostly limited to anterior $\frac{1}{4}$ of tergum 7; walking legs with inconspicuous, localized, dusky-black markings prolaterally; brachium, humerus, and chela with inconspicuous underlying dusky-black markings; fingers of chela similar to palm in color; pectines white, mesosomal sterna lacking dark markings; metasoma with ventral and ventrolateral keels outlined in dusky pigment on segments II–V. Prosoma: Carapace frontal margin slightly convex, with 2–3 pairs of macrosetae; lateral ocelli 3 per group, median ocelli on smooth, raised ocular tubercule; sternum elongate pentagonal, 4 pairs of sternal macrosetae, median posterior depression, deep, broad. Mesosoma: Terga finely granular, terga 5–7 with subtle obsolescent median keel, tergum 7 with 2 pairs of granular lateral keels; genital opercula triangular, 10–11 pairs of genital macrosetae, distinct genital papillae; pectine basal sternum with deep median notch on anterior margin; comb with three marginal lamellae, middle lamellae with angular basal piece and 19 subcircular sclerites, fulcra triangular, 4–6 ventral macrosetae per fulcrum; stigma elongate, 3.5 times longer than wide; sterna 2–6 smooth, agranular, sternum 7 with 1 pair of granular submedian keels over one-half of sternum. Metasoma: Dorsal keels granular on I–V; dorsolateral keels granular on I–V; lateral keels granular on I,

Table 1. Measurements (mm) of *Paruroctonus maritimus* Williams, new species, holotype (male) and allotype. Abbreviations as follows: l=length, w=width, d=depth, fmd=frontal margin distance, ditd=distal internal trichobothrium distance, p-row=primary denticle row of chela, ff=fixed finger, mf=movable finger.

| | holotype (male) | allotype |
|---------------------------------|-------------------|-------------------|
| Total length | 41.0 | 48.0 |
| Carapace, (l/w at median eyes) | 4.6/3.6 | 5.8/4.5 |
| Diad (width/fmd) | 0.95/2.1 | 1.1/2.7 |
| Metasoma, length | 19.0 | 21.3 |
| Segment I (l/w/d) | 2.5/2/7/2.2 | 2.9/3.2/2.5 |
| Segment II (l/w/d) | 3.0/2.6/2.1 | 3.3/3.1/2.5 |
| Segment III (l/w/d) | 3.3/2.5/2.1 | 3.6/3.0/2.4 |
| Segment IV (l/w/d) | 4.2/2.4/2.0 | 4.5/2.8/2.4 |
| Segment V (l/w/d) | 6.0/2.1/1.8 | 7.0/2.6/2.3 |
| Telson, length | 5.4 | 6.5 |
| Vesicle (l/w/d) | 3.3/2.0/1.6 | 7.0/2.6/2.3 |
| Aculeus (1) | 2.1 | 2.5 |
| Pedipalp, Humerus (l/w) | 3.8/1.3 | 4.8/1.7 |
| Brachium (l/w) | 4.2/1.8 | 5.1/2.3 |
| Chela (1) | 7.2 | 8.6 |
| Palm (l/w/d) | 4.1/2.2/2.9 | 4.8/2.4/3.2 |
| Movable finger (l/base) | 4.2/1.05 | 5.7/1.4 |
| Fixed finger (l/ditd) | 3.1/2.7 | 3.8/3.2 |
| Supernumerary denticles (ff/mf) | 6/7 | 6/7 |
| Fixed finger p-row denticles | 5-7-7-9-13-9 | 6-8-8-10-11-17 |
| Movable finger p-row denticles | 1-6-10-10-12-15-7 | 1-6-9-10-13-15-11 |
| Pectine teeth (left/right) | 24/26 | 18/18 |
| Stigma 3 (l/w) | 0.35/0.1 | 0.4/0.1 |

granular on posterior 1/4 of II, obsolescent except for 3 posterior granules on III, absent on IV, granular on anterior half of V; ventral lateral keels smooth to granular on I–II, smooth on III, smooth to crenulate on IV, serrate on V; ventral keels smooth to obsolete on I, smooth on II–IV, serrate on V. Telson: Vesicle smooth and lustrous, subtle subaculear tubercule flanked laterally by 1 pair of long reddish macrosetae. Pedipalps: Chela with swollen palms, keels of palm roughly granular; subtle scallop between fingers proximally when fingers closed; supernumerary denticles 6 on fixed finger, 7 on movable finger; primary row denticles divided into 6 subrows on fixed finger, 7 on movable finger by distinctly enlarged denticles; palm with well-developed ventral prolateral and ventral retrolateral granular keels. Chelicerae: Ventral margin of movable finger with 2–3 subtle crenulations, fixed finger lacking apparent denticles or crenulations; ventral surface of movable finger not conspicuously hirsute, with about 6 long ventral macrosetae.

Allotype.—Female. Similar to holotype in color and structure except as follows: Longer in total length; pectines much smaller, shorter, with fewer teeth; no genital papillae; median ocelli slightly smaller; metasomal segments slightly less elongate

(ratio of metasomal length to width 6.7); chela slightly more elongate (ratio of chela length to width 3.6).

Topoparatype variation.—Similar to holotype and allotype except: Total length 21.3–50.0 mm; pectine tooth counts (per comb) 24–27 in juvenile males (mode 26), 18–20 in females (mode 19); juveniles with base color of cuticle whitish, dusky-black marbling more contrasting, more extensive; cheliceral denticles on ventral margins of movable finger more developed, 4–5 crenular denticles; ventral margin of fixed finger with 2 small granular denticles; adults with cheliceral denticles more worn and subtle on movable finger, not apparent on fixed finger.

Type data.—Holotype (male), allotype, California: Monterey County, Seaside, 7 Apr. 1985, Coll. Roy Johnson. Depository: California Academy of Sciences, Entomology Type No. 15791. Named *Paruroctonus maritimus* in reference to its coastal habitat.

Topoparatypes studied.—California: Monterey County, Seaside, 3, 5, 7 Apr., 1985, Coll. Roy Johnson, 21 females, 3 juvenile males.

Remarks.—This species is known only from coastal habitats of central California. In the type locality it was found under surface debris on dry, fine coastal dune sand. Field collections suggest that its preferred habitats may be coastal sand dune communities in this region. It was curious that of the 26 specimens collected all were mature females except one mature male and 3 juvenile males.

ACKNOWLEDGMENTS

I am particularly indebted to Roy Johnson for collecting the specimens used in this study. I also gratefully acknowledge the following colleagues for materially assisting this study: Vincent F. Lee and Jack T. Tomlinson critically read this manuscript; Jett S. Chinn assisted with the illustrations; Paul H. Arnaud, Jr. provided research facilities at the California Academy of Sciences. The West Point Academy of Arts and Sciences partially supported this project.

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The Southern Green Stink Bug, *Nezara viridula* Linnaeus (Heteroptera: Pentatomidae); New Location

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The southern green stink bug, *Nezara viridula* Linnaeus was collected from a 30.6 hectare commercial field of processing tomatoes located five kilometers north of Davis, Yolo Co., California on 12 September 1986. *N. viridula* occurs across much of the southeastern United States and as far west as Texas. Menezes, Herzog, Teare and Sprenkel (1985. Phenological events affecting southern green stink bug on soybean, Proc. Crop Sci. Soc. Florida, 44:227–231). This species has not previously been reported in California.

The abundance of *N. viridula* in this tomato field was determined by recording the number of nymphs and adults found in 60 plots each 2m in length. In each plot the tomato plants were cut off at ground level and shaken onto a drop cloth. The number of *N. viridula* found on the drop cloth and upper 2.5–5.0 cm of soil was recorded. The mean number of *N. viridula* per meter of tomato bed was 5.97. Approximately 32, 28 and 40 percent of the population were small-medium nymphs (1st to 3rd instar), large nymphs (4th and 5th instars) and adults, respectively. One hatched *N. viridula* egg mass was found near a group of first and second instars. None of the eggs appeared to have been parasitized. On September 29 we collected 50 adult *N. viridula* and caged them in our laboratory. As of October 30 no parasites had emerged from these individuals.

The southern green stink bug has a very wide host range including: fruit and ornamental trees, field crops, vegetables, and weeds. Todd and Herzog (1980, Sampling phytophagous Pentatomidae on soybean, pp. 438–478 in Kogan and Herzog ed. Sampling methods in soybean entomology, Springer-Verlag, N.Y. 587 pp.). If successfully established and in the absence of satisfactory natural enemies this stink bug could have a significant economic impact on numerous crops in California.

Personnel from the California Department of Food and Agriculture and personnel from surrounding County Agricultural Commissioners offices are conducting a survey to determine the distribution of *N. viridula* in California.

We thank Ray Gill, George Buxton and Alan Hardy (CDFA) for confirming our identification of *N. viridula*.

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Publication Received

The Butterflies of North America. A Natural History and Field Guide. By James A. Scott. Stanford University Press, Stanford, California 94305. xiii + 583 pp., 71 figs., 64 col. pls., distribution maps. ISBN 0-8047-1205-0. Publication date given as "September 26, 1986"; review copy received by PCES at CAS on 12 September 1986. Price \$49.50 hard cover.

The book jacket states:

"The only field guide to cover all North American butterfly species, this monumental work is also a complete natural history, fully describing the biological and ecological world of butterflies in general. It is without question the most important book on butterflies in several decades, and the most complete treatment of a major butterfly fauna ever published.

The book is written at several levels of detail, most of it accessible to anyone, and employs the minimum of technical terms necessary for ensuring scientific accuracy. Extensive introductory material—a book in itself—stresses butterfly biology and ecology: structure, flight, metamorphosis, hibernation, physiology, roosting, migration, mating, egg laying, intelligence, social behavior, larval and adult foods, enemies, mimicry, variation, evolution, habitats, distribution and conservation. The main text is arranged in phylogenetic sequence, and characteristics or behavior common to all members of a family, subfamily, or tribe are discussed at those levels. The skippers, a large group often excluded, are treated in full."

—Paul H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California, 94118.

A New Species and Records of the Genus *Toxorhina*, Subgenus *Eutoxorhina* From the South Pacific (Tipulidae, Diptera)

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Abstract.—Alexander (1934) described *Toxorhina (Eutoxorhina) simplex* from a badly broken specimen which consisted of only the thorax, one wing, and the first two abdominal segments. Two more specimens of the subgenus were found in 1963, in the same geographical location (Fiji). These specimens correspond precisely with the original description given by Alexander and, having studied the holotype, I have little doubt that they represent the same species. I here add further notes on the description of this species. I have examined another specimen from New Caledonia, which is different from the specimens from Fiji, and I describe it here as a new species. All specimens are being returned to the Bishop Museum.

Toxorhina (Eutoxorhina) simplex. Alexander 1934.

Two Females: length excluding rostrum 6.8–6.9 mm; wing 4.9–5.1 mm.; rostrum, 5.7–5.8 mm. The following are details other than those given by Alexander in the original description. Rostrum light yellow-brown, darker at base and near tip. Antennae dark brown, verticils at tip 4–5 times longer than the segments. Frons and vertex light brown, pruinose; back of head and neck region dark brown. Dorsum of the thorax pruinose, paratergites a lighter brown separating dark brown dorsal and pleural areas. Coxae dark brown, femur light brown, grading to darker brown at tip; tibia brown grading to darker brown at tip; tarsi uniformly brown. Abdominal tergites and sternites dark brown; posterior sternites lighter. Ovipositor dark brown at base; tips of valves much lighter brown. The two specimens differ only in the intensity of the coloration.

Female.—Fiji, Viti Levu, Colo-i-suva, 3-6.iii.63 (C. Yoshimoto).

Female.—Fiji, Viti Levu, Nadarivata 850 m, 8-13.iii.63 (C. Yoshimoto).

Toxorhina (Eutoxorhina) parasimplex NEW SPECIES

Male.—Length, excluding rostrum 4.1 mm; wing 4.3 mm; rostrum 3.6 mm; antennae 5.3 mm.

Antennae with scape and pedicel yellow, fusion segment and flagellar segments dark brown. Rostrum brown, shorter than the remainder of the body. Area surrounding eyes and vertex pruinose black. Pronotum and mesonotum dark brown. Propleural plates yellow-brown, remainder of thoracic pleura dark brown. Mesonotal praescutum pruinose gray at lateral edges. Halteres uniformly reddish brown. Legs with coxae dark brown; trochanters and basal portion of femur yellow-brown grading to dark brown for the remainder of the leg; the hind legs slightly darker. Terga of abdomen brown, sterna lighter to reddish brown. Segment

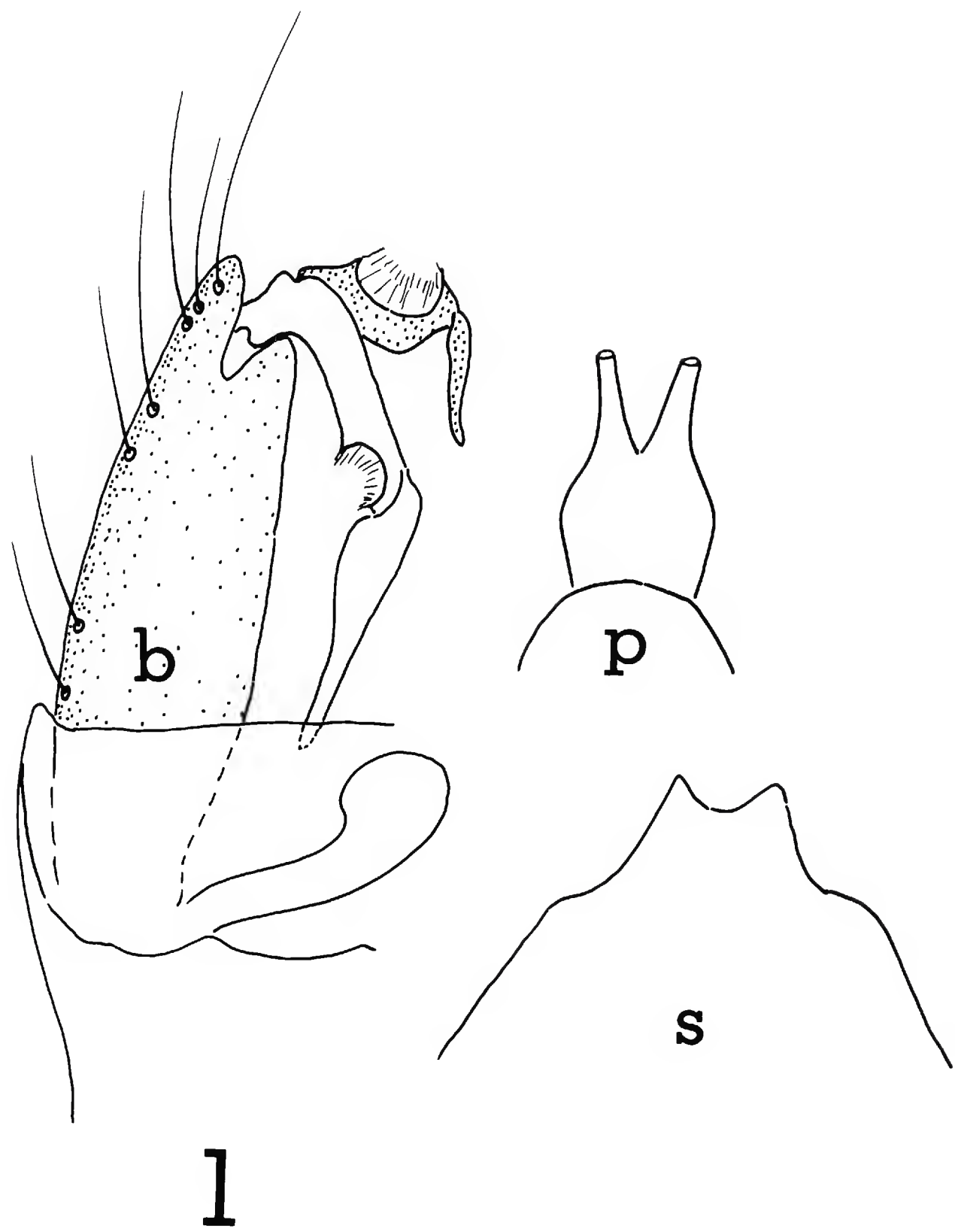


Figure 1. *Toxorhina (Eutoxorhina) parasimplex* n. sp. (b = basistyle; i = interbase; p = phallosome; s = sternite)

just before the hypopygium appears as a dark brown ring. Last sternal segment with an extended process which is furcate, the arms very short and blunt. Ninth tergite with central area bordered by five short points. Wing venation exactly as described in subgenus, tinted with brown, more hyaline between stigmal area and tip of wing; a whitish stripe crossing m-cu; veins uniformly dark brown. Hypopygium with elongate basistyle reddish brown; inner surface concave giving hollowed-out appearance. A distinct line of large setae on interior surface of basistyle extending diagonally from the ventral anterior margin to the dorsal posterior margin.

Interbases sigmoid in shape. Outer dististyle a broad triangular shaped base, which then curves sharply cephalad into a darkened, elongate, triangular blade with one small seta at the tip. Inner dististyle sharply curved, basally broad blade with a clear fimbriated membrane on the outer edge. Phallosome large, stoutly bifurcate at tip, base longer than arms of fork.

Holotype.—(male) New Caledonia, Cole des Roussettes 450–550 m, 4–6.ii.63 (J. L. Gressitt, C. Yoshimoto, N. Krauss),. BPBM slide 2037.

ACKNOWLEDGMENTS

I wish to thank Dr. Neal Evenhuis for his courtesies while at the Bishop Museum and for the privilege of describing these specimens.

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Publication Received

Spiders. Webs, Behavior, and Evolution. Edited by William A. Shear. Stanford University Press, Stanford, California 94305. xiv + 492 pp., illus. ISBN 0-8047-1203-4 (alk. paper). Publication date given as "September 12, 1986," with review copy received by PCES at CAS on 22 August 1986. Price \$55.00 hard cover.

Collection of papers presented at the 1981 meeting of the American Arachnological Society at the University of Tennessee. Contributors—James Edwin Carico (Web removal patterns in orb-weaving spiders, pp. 306–318), Jonathan Coddington (The monophyletic origin of the orb web, pp. 319–363), Frederick A. Coyle (The role of silk in prey capture by nonaraneomorph spiders, pp. 269–305), William G. Eberhard (Effects of orb-web geometry on prey interception and retention, pp. 70–100), Robert R. Jackson (Web building, predatory versatility, and the evolution of the Salticidae, pp. 232–268), Anthony C. Janetos (Web-site selection: Are we asking the right questions?, pp. 9–22), Yael D. Lubin (Web building and prey capture in the Uloboridae, pp. 132–171), W. Mitch Masters, Hubert S. Markl, and Anne J. M. Moffat (Transmission of vibration in a spider's web, pp. 49–69), Susan E. Riechert and Rosemary G. Gillespie (Habitat choice and utilization in web-building spiders, pp. 23–48), William A. Shear (Introduction, pp. 1–7; The evolution of web-building behavior in spiders: A third generation of hypotheses, pp. 364–400), Mark K. Stowe (Prey specialization in the Araneidae, pp. 101–131), William James Tietjen (Social spider webs, with special reference to the web of *Mallos gregalis*, pp. 172–206), and George W. Uetz (Web building and prey capture in communal orb weavers, pp. 207–231). Taxonomic Glossary, pp. 403–432. Bibliography, pp. 433–472. Index, pp. 474–492.

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Geographical Inexactitude

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In reading over recent issues of the Pan-Pacific Entomologist, I was, once more, reminded of a persistent error which many entomologists in this country consistently commit. For example, in his paper describing new tenebrionids from western North America, John Doyen (1983) cited specimens from "Baja California del Norte" (p. 83) and from "Baja California Norte" (p. 90). Another such paper is that of Allen and Murvosh (1963). The authors uniformly cited mayfly distribution records under "Baja California Norte" and from "Baja California Sur." Their map (Fig. 12) has the two States properly identified.

These designations in both papers are incorrect and point to a problem to which I have alluded in the past (Snelling, 1970), one that emphasizes the general ignorance of historical events south of our border.

Prior to 1952, the peninsula of Lower California was divided into two territories: Baja California del Norte and Baja California del Sur. In 1952 the northern territory became the State of Baja California (*Estado de Baja California: note that the designation "del Norte" was dropped*). At the same time, the southern portion became the Territorio del Sur de Baja California. This Territory became Estado de Baja California Sur in 1974 (Anonymous, 1984).

Obviously, it is convenient to designate "del Norte" or "del Sur," as is commonly done, but the fact remains that it is also geopolitically incorrect. Within their own country, Mexicans have no problem. The peninsula, as a whole, is "Baja California," or simply "Baja"; the northern State is "Estado de Baja California," and the southern State is "Baja Sur." Authors north of the border tend to be less precise.

Thus, in looking at Doyen's paper, I wonder how I am to interpret the statement: "*Adelonia filiformis* Laporte from southern Baja California . . .," etc.? Is the reference to the southern part of the State of Baja California or is it to the southern part of the peninsula (in other words, to the State of Baja California Sur)? Such imprecision in geographic citations is common, as a quick perusal of recent literature on insects of western North America will make clear.

There exists confusion of still another sort: the failure to recognize that the entire peninsula is not a single state. For example, Evans (1966) consistently cites records from the entire peninsula under "Baja California" as though it were a state equivalent to Sonora or Michoacan.

All of this confusion is certainly not limited to published papers. Most entomologists who collect there seem not to know the situation. This is attested by the many specimens from recent collections that I have seen labelled "Baja California del Norte" and "Baja California del Sur." Then, there are the specimens

from La Paz, Todos Santos, and other southern peninsular localities that are labelled "Baja California."

There is a solution, a way out of this confusion, and it is based on historical precedent. It is a solution which, perhaps, might appeal to systematists, since it is merely an extension of the principle of nomenclatural priority.

The entire peninsular region (Estado de Baja California plus Estado de Baja California Sur) can be referred to as Lower California; this, of course, is a straightforward translation of Baja California. The use of this term in entomological literature is more than 100 years old (e.g., LeConte, 1861; Saussure, 1875). It has also been used much more recently (Bohart, 1948). The two States may then be properly designated Baja California and Baja California Sur with little or no confusion.

There certainly should be no reason to suppose that this is linguistic "chauvinism" on my part. It seems to me that it should be just as acceptable to use the English, viz. Lower California, as to use Mexico, Panama, Peru, Spain, or Germany (rather than the indigenous languages: México, Panamá, Perú, España, or Deutschland, etc.).

Then, there is "Sierra Nevada Mountains" (Gilbert, 1982). This is not an uncommon error of redundancy. So, we see "Sierra Ancha Mountains," "Sierra Madre Mountains," etc. Since the Spanish word "sierra" = "mountains," there truly is no excuse for this sort of error, other than simple carelessness.

Authors, of course, must assume initial responsibility and should make every effort to avoid such errors. Reviewers, too, are not doing their job very well when they allow such lapsi to pass. Finally, editors must assume their share of guilt.

In short, I suggest that we devote the same attention to detail and accuracy in dealing with geography as we give to taxonomy in our work.

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Marking Technique for Larvae

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Keywords: larval marking, marking technique, field marking, insect larvae.

Abstract.—A technique for marking insect larvae as individuals is described and the kinds of data derivable from studies of individually coded larvae are discussed. The relative importance of larval stages is discussed.

INTRODUCTION

Biological explorations of plants and of insects still suffer from defects of omission. In the case of plants, the roots have been too often ignored (Cody 1986). In the case of insects, the immature stages have in general been much less studied than the mature stage (adult). This understandable but unfortunate bias in scientific effort limits the ultimate value of many population dynamic studies. If key factors controlling population dynamics act during the life stages not studied, then analyses of dynamic data remain either inconclusive or misleading. Hypotheses depending on population dynamic data, such as those involving population genetics, suffer accordingly. Control programs designed without accurate knowledge of the factors affecting immature stages may have minimal effects on target population sizes.

Not only do population numbers often depend on phenomena occurring during the immature stages, but the larval stage is frequently where the physical size achieved by an adult insect is determined. For holometabolous insects that are short lived as adults (the vast majority of Lepidoptera, for example), the mature larval size (at least of females) relates directly to reproductive capacity and therefore to potential for population increase. The last larval stadium is where most of an insect's weight is gained. In the case of *Euphydryas editha* (Boisduval) (Lepidoptera: Nymphalidae), for instance, 60 to 80% of the mature larva's weight is gained then (Weiss, White, & Murphy unpublished). Therefore study of this single stadium may contribute disproportionately more to knowledge of the biology of this and similar insects than would the study of other stadia or stages.

For field study of phenomena such as mortality, growth, and dispersal it is necessary to reliably identify individuals. For adult Lepidoptera this is commonly done by means of some variation of the magic marker technique (Ehrlich & Davidson 1960, Brussard 1970, Scott 1975, Singer & Wedlake 1981, Gall 1985). A number of workers have used techniques for marking larvae, but such studies remain the exception and techniques such as mutilation are still current (Weseloh

1985). Here we describe a technique for marking individuals that works within a stadium for larvae of insects.

DESCRIPTION OF TECHNIQUE

Larvae of *Euphydryas editha bayensis* Sternitzky were collected at the Morgan Hill (MH) site in Santa Clara County, CA, USA, in February and March 1985 and January through March of 1986. Each larva was given a unique mark with Testors enamel paint (available through such outlets as Long's Drugs and hobby shops). Among the dozens of colors available, several worked well with these dark-colored larvae: 1103 red, 1108 light blue, 1114 yellow, 1145 white, 1127 orange, and 1134 purple. On these larvae, 1111 dark blue and 1124 green were not easily readable. Usable light blues and greens could be produced by mixing the darker colors with white. For lighter colored larvae, colors such as dark blue, green and black might be effective. Metallic colors such as silver and gold cause violent reactions: vomiting and fleeing. Testors 1170 light tan was too runny, producing large, messy marks.

Though there are thirteen body segments in the larvae of Lepidoptera that can, with care, be identified (Howe 1975), we found that we could reliably distinguish dots of paint on the left and right sides of segments A) near the head, B) near the middle, and C) near the end. Very small dots of paint were applied with a sharpened toothpick or with an insect pin (#3) to the subdorsal and/or lateral scoli (bristles) of the appropriate segments. The paint did not wear off, nor did it seem to affect behavior. Marked larvae were picked up 2 to 7 days after marking and release. So far the maximum observed duration of the marks in the field is 21 days, on 2 larvae that had hung up to pupate. Larvae that died of unknown causes and larvae that were stepped on were found to retain their marks identifiably. In this species the final stadium lasts just long enough (7 to 14 days during sunny weather) to be studied. Keeping records of individual morphological traits where they exist, along with painted codes, can help maintain the integrity of the system. Codes, by their nature, are inevitably misread at some frequency.

When the last larval stadium ends and the skin is shed, it usually remains with the pupa. Careful examination of shed skin allows some codes to be distinguished from others (different colors, anal vs. cephalad, left vs. right; potentially also ventral vs. dorsal). Thus individual pupae can be matched to larvae whose traits have been measured.

By assigning numbers (Fig. 1) to the marking positions, each larva could be coded with any of fifty different numbers, without changing colors of paint. It is, however, better for the organism, the experiment, and the investigator to impose as few spots of foreign material as possible. Restriction of the marking scheme to a single dot of paint would allow six unique marks per color of paint used. Restriction to two dots would allow 21 unique marks per color, three dots would allow 40 marks per color, four dots would allow 50. Thus, a three dot system, given six positions and six colors, provides for unique codes to be given to 240 larvae. Obviously the system can be extended by careful use of additional marking locations (eight positions would provide for 444 unique marks). Two colors can be used together on the same individual to, in effect, add another color to the system.

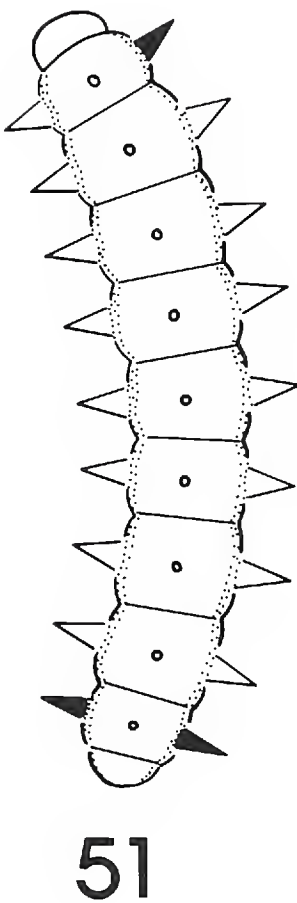
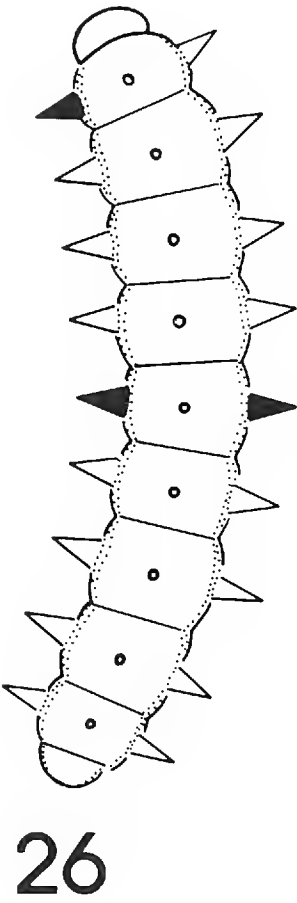
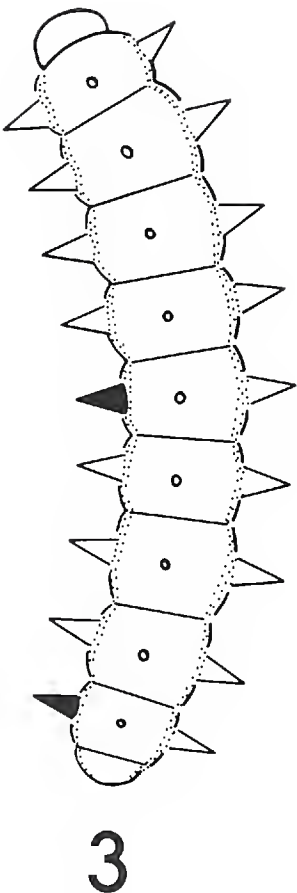
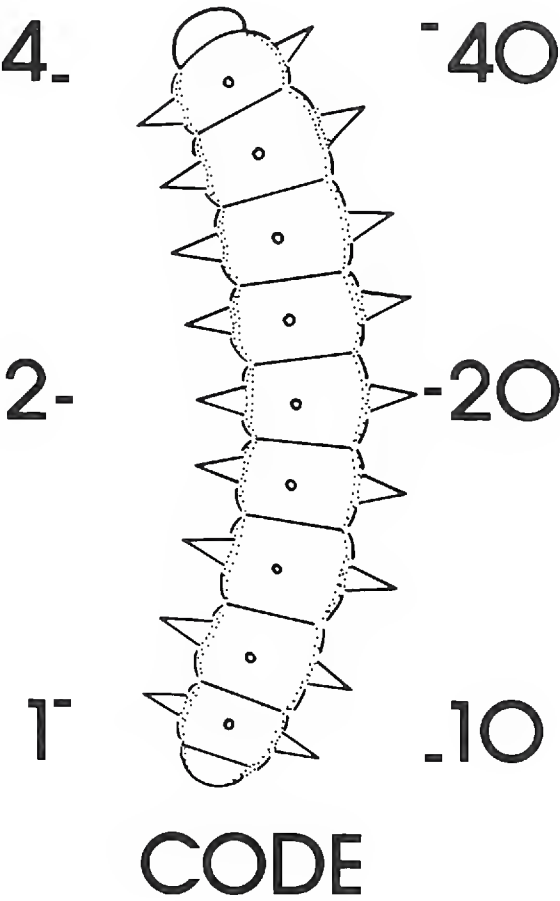


Figure 1. System for coding insect larvae individually. Upper left, key; others, examples.

USES FOR MARKED LARVAE

Marking larvae individually makes it possible to track weight gains of individuals through time under field or laboratory conditions. This is very important because other sampling methods are subject to significant error. For example, we (Weiss, White, & Murphy, unpubl.) have taken field samples of larvae every ten days to assess field growth rates. The resulting data generally show steady growth, but exceptions occur. Even the steady growth curves misrepresent growth to some degree because males lose weight in preparation for pupation while females are still gaining. Preliminary data indicate that in this species the mature larva at its maximum will lose 20% of its weight by the time the pupa is formed (larva, 400 mg: pupa, 320mg). Since males and females of most holometabolous insects differ significantly in size, the problem is a common one. Larvae may be kept individually without marking in the laboratory, but laboratory studies of heliothermic insects are often negatively influenced by the effects of replacing solar heat with ambient heat. Migration of larvae, perhaps surprisingly, can also bias field samples of anonymous (previously unidentified) larvae. Checkerspot butterfly larvae may commonly move ten meters per day when experiencing adverse local conditions. For other experiments, groups of marked larvae can be kept together in the laboratory without the loss of individual identification. The behavior of particular individuals can be tracked over time. Individuals may differ also in other ways (color morphs, for instance) that may affect their growth or survival. Such traits may be recorded if individuals are uniquely identified.

FINDING LARVAE

When larval hosts of phytophagous insects are known they can be searched at the right time of year and larvae can often be found. However, for many species this works poorly at best, and for many other species it does not work at all or the host is still unknown. In the case of *Euphydryas editha bayensis* (the bay checkerspot butterfly), the host is so common and dense that searching the host plants is very similar to searching the entire habitat. These dark larvae can be found by looking into one's shadow. The spots that remain dark when in shadow may be larvae. These animals are essentially thermal collectors and spend a lot of time basking in areas of the sparsest vegetative cover. It is thought that speed of digestion is a limiting factor, requiring time spent in the sun (Porter 1982). In the case of *E. editha rubicunda* (the large collinsia checkerspot), the postdiapause larvae seem to be crepuscular, feeding at dusk and dawn (Singer, pers. comm.). My own recent experience with isopods, earwigs, and weevils on my garden *Passiflora* reminds me to emphasize the potential value of night searches. The serious investigator may have to be active at midnight with a powerful flashlight. He may also have to lie prone on a muddy substrate (as one of us did this January) in order to see larvae that weigh under 20mg, but that have already doubled in weight since breaking diapause.

SUMMARY

All too often the more difficult life stages of experimental organisms are ignored in terms of literature discussion as well as experiment. Marking individuals of such stages is an invaluable tool for extending knowledge of the biology of insects. The

technique described here is usable on the later instars of many species of insects. So far we have found differential dispersal of larvae on slopes of different exposure and have determined growth rates under some field conditions (Weiss, White, & Murphy, unpubl.). We expect to use the technique described here for further growth, microhabitat, and dispersal studies and to estimate larval survival to pupation.

ACKNOWLEDGMENTS

We owe Dennis Murphy and Waste Management, Inc. thanks for use of the Morgan Hill field site. Helpful comments on the manuscript were made by Gordon Pratt.

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Publication Received

California Butterflies. By John S. Garth and J. W. Tilden. Illustrations by David Mooney and Gene M. Christman. University of California Press. xvi + 246 pp., 33 text figs., 24 colored pls. (first 20 colored). ISBN 0-520-05249-8. Price \$19.95 hard cover. \$10.95 paperback. Publication date given as November 13, 1986. Review copy received at CAS by PCES on October 27, 1986. California Natural History Guides: 51 (Arthur C. Smith, general editor). The book jacket states:

“With the help of this field guide, users can learn where to find butterflies and skippers ranging in size from the tiny Pygmy Blue, with a wing span sometimes as small as half an inch, to the Two-tailed Swallowtail which may have a wing span of half a foot. The volume is filled with the fascinating lore of butterflies: their migrations (some marked individual Monarchs have flown more than 2,000 miles), their congregating on hilltops, their intriguing caterpillar and chrysalis stages.

This guide is small enough to be carried in the field, yet complete enough to enable users to identify the more than 230 kinds of butterflies they may encounter anywhere in California or nearby areas. This comprehensive coverage is achieved through generous color or black-and-white illustrations of all but a very few species, together with a text that provides compact descriptions followed by information on size, habitat, distribution, abundance, and larval food plant preferences.

Detailed tips are provided for observing, rearing, collecting, and preserving butterflies. An introductory section treats their intriguing anatomy and behavior. A checklist of scientific and common names is included, along with a key to the eleven families of California butterflies, plus a glossary of terms. A special section recounts the history of butterfly collecting in California, and others deal with variation and hybridization, classification, and name changes.

For all butterfly enthusiasts, this volume will provide the key to new enjoyment and understanding.”

—Paul H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

**A Key to *Trichrysis* and New Species From Sri Lanka and Africa
(Hymenoptera: Chrysididae)**

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Abstract.—A key is given to 20 species of the genus *Trichrysis*. New species described are *eardeleyi* from South Africa, Nigeria and Tanzania; *hexapholis* from Sri Lanka; and *lomholdti* from South West Africa.

In connection with a generic revision of Chrysididae by Lynn Kimsey and me, 3 species of *Trichrysis* appear to be undescribed. Some 22 other species of the genus occur in the Ethiopian, Palearctic and Oriental Regions. Except for a few, rarely collected forms of other Old World genera, *Trichrysis* can be recognized by the tridentate form of tergum III. Abbreviations used in the descriptions are: F-1 etc., flagellomeres; TFC, transverse frontal carina; MOD, median ocellus diameter; T-I etc., terga; S-I etc., sterna.

The following key includes 20 species known to me. Others, not now available, are *coreana* (Uchida), *longispina* (Mocsáry), *purpuripyga* Edney, *seducta* Smith, and *sudai* Tsuneki.

Key to *Trichrysis* (based on females)

- | | |
|--|------------------------------|
| 1. Pronotum with a complete sublateral, longitudinal carina | 2 |
| Pronotum without a complete sublateral, longitudinal carina, such carina obsolete medially or absent | 11 |
| 2. F-I bright green in front, pronotal median groove well developed (Palearctic Region). | 3 |
| F-I all dark or somewhat greenish toward base, pronotal median groove various | 4 |
| 3. Hindbasitarsus bright green on outer side; T-III lateral tooth sharp; pit row weakly indented | <i>excisifrons</i> (Mocsáry) |
| Hindbasitarsus weakly colored; T-III lateral tooth obtuse, pit row strongly indented | <i>secernenda</i> (Mocsáry) |
| 4. Pronotal median groove sharp and extending more than half of dorsal surface, T-III lateral tooth merely an angle (Palearctic Region) | 5 |
| Pronotal groove weakly indicated at most; T-III lateral tooth sharp | 6 |
| 5. Moderate-sized (4–6 mm long) | <i>cyanea</i> (Linnaeus) |
| Medium large (8–11 mm long) | <i>buyssoni</i> (Mocsáry) |
| 6. F-I less than 2.5 × as long as broad, tarsi dark | 7 |
| F-I more than 2.5 × as long as broad, tarsi various. | 8 |

- 7. T-III mid tooth strong, larger than lateral teeth; forewing discoidal cell well pigmented throughout (N. Africa) *scioensis* (Gribodo)
- T-III mid tooth sharp but smaller than lateral teeth; forewing discoidal cell weakly pigmented distally (Philippines) *aspera* Brullé
- 8. Median bridge of pit row sharply depressed, leaving apical tooth hooklike (view laterally) (Philippines, Taiwan). *luzonica* (Mocsáry)
- Median bridge of pit row at most slightly depressed. 9
- 9. T-III tooth intervals markedly convex (fig. 6) (Oriental Region)
- *vestigator* (Smith)
- T-III tooth intervals at most faintly convex 10
- 10. T-III mid tooth stronger than lateral teeth (fig. 5); highly colored green, purple, gold, and red; tarsi yellowish (S. India). *lanka* (Bingham)
- T-III mid tooth not stronger than lateral teeth, not highly colored, tarsi dark (Oriental Region) *triacantha* (Mocsáry)
- 11. Pronotum with a longitudinal sublateral carina which is obsolescent medially 12
- Pronotum without a longitudinal sublateral carina. 15
- 12. TFC strong, straight, nearly reaching eyes (fig. 4); scapal basin partly polished mediad (Ethiopian Region). *eardeleyi* Bohart
- TFC developed toward middle where it forms an inverse V (fig. 3); scapal basin various 13
- 13. Scapal basin completely sculptured with punctures and microridging, tarsi reddish yellow (Palearctic Region) *lacerta* (Semenov)
- Scapal basin punctate but polished between punctures mediad, tarsi various 14
- 14. T-III tooth intervals unusually deep and evenly incurved (fig. 3); terga highly colored, green, blue, purple, and gold; tarsi light red (Sri Lanka). *hexapholis* Bohart
- T-III tooth intervals shallow; terga green and purple; tarsi dark (Oriental Region). *trigona* Mocsáry
- 15. Malar space 3 or more MOD (fig. 7), T-III middle tooth long and curved downward toward tip (lateral view), S-II spots joined medially to form a large shieldlike spot (fig. 7); dorsum of body microsculptured between punctures (fig. 8) 16
- Malar space 2 MOD or less, T-III middle tooth short; S-II spots rather small, rounded, slightly separated; body dorsum without conspicuous microsculpture between punctures 17
- 16. Body dorsum mostly with coarse punctures, microsculpture imparting a frosted look (fig. 8), middle half of scapal basin microsculptured (S. Africa) *impressifrons* (Mocsáry)
- Body dorsum moderately to finely punctate, microsculpture quite fine, middle half of scapal basin extensively polished (fig. 7) (S. W. Africa) *lomholdti* Bohart
- 17. T-III tooth intervals strongly convex (as in fig. 6) 18
- T-III intervals evenly concave to almost straight (fig. 9) 19
- 18. Brow with a definable TFC as a downcurved crescent (Palearctic Region) *mendicalis* (Cameron)
- Brow with at most slight traces of a TFC among coarse punctures (Ethiopian Region). *heliophila* (Mocsáry)

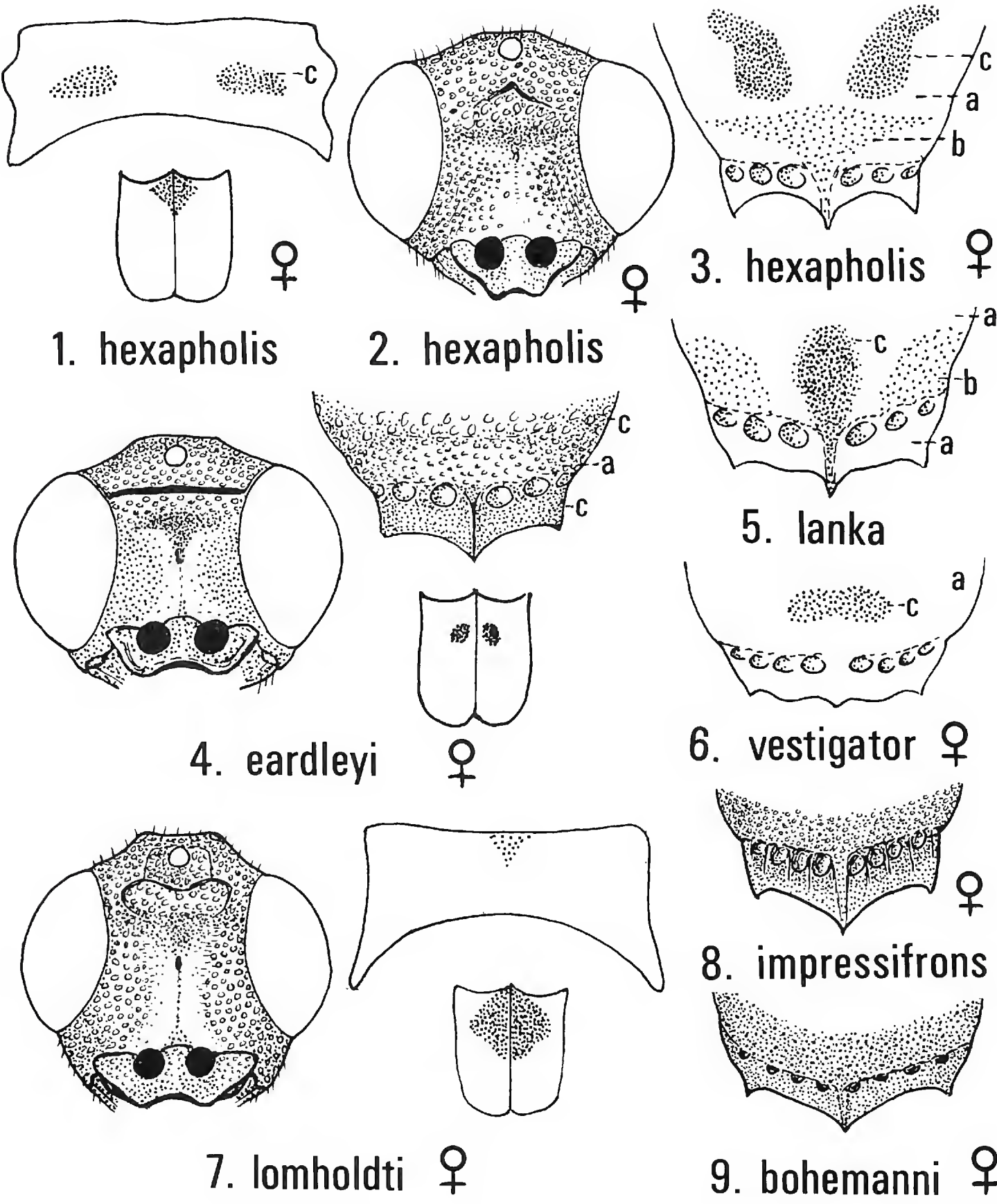


Figure 1, pronotum, S-II. Figure 2, face. Figures 3, 5, 6, 8, 9, T-III apex. Figure 4, face, T-III apex, S-II. Figure 7, face, pronotum, S-II. Small case letters, a, blue-green; b, golden; c, purple.

- 19. Forewing discoidal cell obsolescent toward wing apex; pit row not much impressed and pits tiny (fig. 9), T-III punctation unusually fine and close (fig. 9), F-I a little less than $2\times$ as long as broad (Ethiopian Region) *bohemanii* Dahlbom
- Forewing discoidal cell complete; pit row well developed; T-III punctation moderate; F-I nearly $3\times$ as long as broad (Ethiopian Region). *polinierii* Guérin

***Trichrysis eardleyi* Bohart, NEW SPECIES**

Male holotype: Length 5.5 mm. Green, grading to blue, and dark blue to black toward base of T-II and III, F-I and following dark, tarsi off-white, wings weakly stained, darkest in marginal cell. Vertex, notum and terga with moderate close punctation; scapal basin finely punctate and silvery pubescent. F-I twice as long as broad, $1.6\times$ as long as II; scapal basin concave, moderately deep; TFC strong, nearly straight, almost reaching eyes (as in fig. 4); malar space and subantennal space each about 1 MOD; pronotum with a weak dorsomedian groove, lateral margin sharply incurved in dorsal view, and with a carina broken toward middle; discoidal cell of forewing complete and with upper outer vein strong toward base; propodeal projection sharp; T-III lateral margins sinuous, pit row deep, preceded by a low transverse swelling, apical 3 teeth small but sharp, S-II spots small and oval (as in fig. 4).

Female: About as in male except: length 6.5 mm, tarsi light brown, face narrowly polished medially (fig. 4), T-III somewhat saddled, apical teeth stronger, intervals evenly concave (fig. 4).

Holotype male, South Africa: Pafuri, Kruger National Park, Transvaal, Jan. 1984 (C. D. Eardley, National Insect Collection, Pretoria). Paratype male, Nigeria: Umuahia, IV-9-75 (J. T. Medler, U. C. Davis); paratype female, Tanzania: East Usambara, Amani, II-2-77 (O. Lomholdt and O. Martin, Zoological Museum, Copenhagen).

Discussion. In many respects *eardleyi* is similar to *scioensis* (Gribodo) but there are important differences. TFC in *scioensis* is developed mediad as an inverted V (as in fig. 2) rather than nearly straight and well developed all across, the sublateral pronotal carina is complete, and intervals between T-III teeth are slightly convex rather than evenly concave as in *eardleyi* (fig. 4).

***Trichrysis hexapholis* Bohart, NEW SPECIES**

Female holotype: Length 5.5 mm. Green with bright purple and gold markings as follows: purple are ocellar area, neck, transverse pronotal spots, broad median notal stripe, rim above tegula, large semimedial spots on T-I-II-III, basal band on T-II-III; gold are apicolateral spots on T-I, apical band enlarged sublaterally on T-II, prepit band on T-III extended onto middle tooth; flagellum dark, wings faintly stained, tarsi light reddish. F-I $2.5\times$ as long as broad, $1.5\times$ as long as II; scapal basin shallow, coarsely punctate laterally, becoming mostly polished in median one-third; brow prominent but short, topped by an inverted broad V-like TFC in middle one-third (fig. 2); malar space 1.6 MOD, subantennal space 1.2 MOD; pronotum with a weak dorsomedian groove, lateral margin sharply incurved (fig. 1), and with a carina which is broken toward middle; discoidal cell of forewing complete; propodeal projection sharp; T-III lateral margin weakly convex, pit row with distinct pits preceded by a low transverse swelling and moderate saddle; apical 3 teeth long and sharp, intervals deeply concave (fig. 3); S-II spots joining to form a sharp median triangle (fig. 1).

Male: Unknown.

Holotype female, Sri Lanka: Colombo, IV-10-68 (T. F. Halstead, California Academy of Sciences).

Discussion. The striking dorsal pattern is similar to that of other Sri Lankan chrysidids, particularly *Trichrysis lanka* (Bingham). However, that species has a

complete sublateral pronotal carina; T-III stouter, the teeth shorter, and the intervals nearly straight rather than deeply concave (compare figs. 3, 5).

***Trichrysis lomholdti* Bohart, NEW SPECIES**

Female holotype: Length 3.8 mm. Blue becoming purple toward base of T-II and T-III; flagellum dark; wings water clear; tarsi dark. F-I $3.5\times$ as long as broad, $1.5\times$ as long as II; scapal basin moderately concave, coarsely punctate in outer one-quarter, polished in middle half; brow rounded, TFC faint, laterally recurved, malar space 4 MOD (fig. ?); subantennal space 1.5 MOD; midocellar area outlined by a fine carina; punctation of vertex and notum moderate, punctures of terga finer and separated by weak microsculpture, those of T-III saddle 1–3 puncture diameters apart; pronotum without a dorsomedian groove, weakly incurved laterally (fig. 7) and ecarinate; discoidal cell veins of forewing weak but pigmented; propodeal projection short and acute; T-III lateral margin slightly convex, pit row consisting of 14 moderately impressed pits preceded by a low transverse swelling and moderate saddle; apical 3 teeth sharp, lateral ones receding, intervals evenly but shallowly concave; S-II spots joining to form a large, shieldlike mark (fig. 7).

Male. Unknown.

Holotype female, S. W. Africa: 110 km e. Windhoek, X-25-72, (C. L. Hogue, National Insect Collection, Pretoria).

Discussion. The only other species of *Trichrysis* with a long malar space is *impressifrons* (Mocsáry), also from the Ethiopian Region. However, that species has the scapal basin microridged mediad, punctures of vertex and notum more coarse and with obvious intervening micropunctuation, T-III strongly convex on the lateral margin, prepit swelling rather sharp, pit row deeply impressed, and postpit area longer (fig. 8). This species is named for Ole Lomholdt of the Zoological Museum in Copenhagen for his special interest in African Hymenoptera and his overall cooperation in our chrysidid study.

Scientific Note

Parasitism of Salticid Spiders in Oregon by Two Species of Acroceridae (Diptera)

Arboreal jumping spiders (Salticidae) were collected during June 1985 from Union County, Oregon, by beating lower branches of Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco, and grand fir, *Abies grandis* (Dougl. ex D. Don) Lindl., over dropcloths (Paul and Mason 1984, USDA For. Serv. Res. Note PNW-421:1). About 165 specimens of *Metaphidippus* spp. were collected and individually reared in covered petri dishes; the spiders were fed *Drosophila* fruit flies until needed in field experiments on the western spruce budworm, *Choristoneura occidentalis* Freeman. Nine of the spiders (about 5%) produced dipterous parasitoids belonging to the family Acroceridae. The host spiders spun thick protective webbing in dishes before emergence of parasitoid larvae; larval emergence was similar to that described by Schlinger (1952, Pan-Pac. Entomol., 28:7). The adult parasitoids were later identified by Dr. Evert Schlinger, University of California, Berkeley, as eight specimens of *Acrocera bulla* Westwood and one specimen of *Ogcodes boharti* Schlinger. The spiders were identified by Wayne Maddison, Museum of Comparative Zoology, Harvard University, Cambridge, MA, as *M. aeneolus* (Curtis) (or probably *M. aeneolus*). The immature spiders were difficult to identify, especially because they were damaged by parasitoid emergence. This collection extends the known range of *O. boharti* into Oregon; it has previously been recovered from Arizona and New Mexico (Schlinger, personal communication). Related species of *Ogcodes* have been reared from numerous spider-host species (Eason et al. 1967, J. Kansas, Entomol. Soc., 40:422).

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Electrophoretic Comparison of European *Dendroctonus micans* and Ten North American *Dendroctonus* Species (Coleoptera: Scolytidae)

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Abstract.—Electrophoretic techniques were used to estimate genetic relationships among the great European spruce bark beetle, *Dendroctonus micans* (Kugelann), and 10 North American *Dendroctonus* species. Average heterozygosity for *D. micans* was .053; the North American species ranged from .114 to .226. Cluster analysis suggests that *D. micans* is more closely related to *D. terebrans* and *D. valens* than to other species in the genus.

The great European spruce bark beetle, *Dendroctonus micans* (Kugelann), occurs in spruce forests of Eurasia from the United Kingdom to Siberia. It is believed to have originated in Siberia from a North American spruce-feeding ancestor (Wood 1963) and subsequently spread across Europe. It was discovered in England in 1982 (Bevan and King 1984, Evans et al. 1984).

Relationships among adult *Dendroctonus* species have been studied by Hopkins (1909), Wood (1963, 1982), and Lanier (1981). Immatures were compared by Thomas (1965). Except for its greater size, *D. micans* appears virtually identical to the North American *D. punctatus* LeConte, and may be conspecific (Bright 1976). *D. micans* (Bevan and King 1984), and probably *D. punctatus*, are similar to *D. valens* LeConte, *D. terebrans* (Olivier), and *D. rhizophagus* Thomas and Bright in that adults construct egg galleries in the lower bole and large roots and the larvae mine communally rather than make discrete individual tunnels. However, morphologically (Hopkins, 1909, Wood 1982) and cytogenetically (Lanier 1981) *D. micans* and *D. punctatus* have been allied with *D. rufipennis* Kirby and *D. murrayanae* LeConte. Some aspects of the biology and behavior of *D. micans* are unusual. For example, successful attacks by solitary females are common and inbreeding is the rule. Voulant et al. (1984) report that usually more than 90% of the females are fertilized before they emerge.

Electrophoretic studies of 10 representative North American *Dendroctonus* species revealed species clusters very similar to those developed using cytogenetic and anatomic evidence (Bentz and Stock 1986). *D. micans* and *D. punctatus*, however, were not available for inclusion in those studies. Preliminary electrophoretic comparisons of *D. micans* from France and Great Britain have revealed consistent differences within this species (Evans et al. 1984). More recently,

acquisition of live *D. micans* from Belgium permitted electrophoretic comparison with the 10 *Dendroctonus* species studied earlier. Results of this comparison are reported here.

METHODS

Larvae were grown in the laboratory in Belgium from females introduced into fresh *Picea excelsa* (*P. abies*) logs. Fifth instar larvae were shipped from Belgium and received at the University of Idaho, on May 25, 1985, in a layer of fresh phloem taped tightly between two 15 × 15 cm pieces of plate glass. Pupae were noted beginning June 4 and all had transformed to adults by June 25. On June 27 and July 5, two lots of 50 females each were frozen at -30° C.

Electrophoretic analysis of these beetles followed methods described by Higby and Stock (1982) and Bentz and Stock (1986) for other *Dendroctonus* species. Genetic diversity was estimated and compared among groups using percent polymorphism and Nei's (1975) average heterozygosity. A locus was considered polymorphic when the frequency of the common allele was less than or equal to .99. Relationships between *D. micans* and other *Dendroctonus* species were assessed, using BIOSYS-1 (Swofford and Selander 1981), by hierarchical cluster analysis of Nei's (1978) genetic distance values.

RESULTS AND DISCUSSION

Data from 15 gene loci were obtained (Table 1). Of these, four (AAT, IDH-1, ME, and PEP-gl) were polymorphic, and 11 (CK, EST-1, EST-2, EST-4, IDH-2, MDH-1, MDH-2, MPI, PEP-la, PGI, and SOD) were monomorphic. These beetles were thus much less genetically diverse (27% polymorphism) than any other *Dendroctonus* species that have been studied electrophoretically: polymorphism over the same 15 loci in 10 other species ranged from 40% to 67%. Average heterozygosity for the species was .053, compared to a range of .114 to .226 in the other 10 *Dendroctonus* species at these 15 loci. Cluster analysis suggests that *D. micans* is more closely related to *D. terebrans* and *D. valens* than to other species in the genus (Figure 1).

Specimens of *D. micans* used in this study were from broods of only two females but may still represent the species' diversity. Because the species is isolated from others of the genus and inhabits a unique niche in European forests, with little or no

Table 1. Allele frequencies at 15 gene loci¹ in *Dendroctonus micans* and *D. ponderosae*. Data for *D. ponderosae* are taken from Bentz and Stock (1986). Percent polymorphism (P) and average heterozygosity (H) are also given.

| Enzyme | Locus | <i>D. micans</i> | <i>D. ponderosae</i> |
|--------|-------|------------------|----------------------|
| AAT | A | .606 | — |
| | B | .387 | .662 |
| | C | .007 | .338 |
| | (N) | (91) | (334) |
| CK | B | 1.0 | .989 |
| | C | — | .011 |
| | (N) | (60) | (323) |

Table 1. continued

| Enzyme | Locus | <i>D. micans</i> | <i>D. ponderosae</i> |
|--------|-------|------------------|----------------------|
| EST-1 | A | 1.0 | 1.0 |
| | (N) | (64) | (421) |
| EST-2 | A | — | .019 |
| | B | — | .277 |
| | C | — | .278 |
| | D | — | .137 |
| | E | — | .234 |
| | F | — | .055 |
| | G | .991 | — |
| | H | .009 | — |
| | (N) | (73) | (399) |
| EST-4 | A | — | .993 |
| | B | — | .007 |
| | C | 1.0 | — |
| | (N) | (54) | (291) |
| IDH-1 | B | .995 | — |
| | C | .045 | 1.0 |
| | (N) | (44) | (361) |
| IDH-2 | A | — | 1.0 |
| | B | 1.0 | — |
| | (N) | (64) | (297) |
| MDH-1 | B | 1.0 | 1.0 |
| | (N) | (58) | (377) |
| MDH-2 | A | — | 1.0 |
| | B | — | — |
| | C | 1.0 | — |
| | (N) | (58) | (348) |
| ME | A | .905 | 1.0 |
| | B | .095 | — |
| | (N) | (67) | (478) |
| MPI | B | 1.0 | 1.0 |
| | (N) | (56) | (300) |
| PEP-gl | A | .989 | — |
| | B | .011 | .932 |
| | C | — | .068 |
| | (N) | (44) | (420) |
| PEP-la | A | 1.0 | .017 |
| | B | — | .832 |
| | C | — | .151 |
| | (N) | (58) | (235) |
| PGI | C | — | .009 |
| | D | .009 | .978 |
| | E | .991 | .014 |
| | (N) | (74) | (404) |
| SOD | B | 1.0 | 1.0 |
| | (N) | (53) | (421) |
| P | | 27 | 40 |
| H | | .053 | .114 |

¹AAT = aspartate aminotransferase, CK = creatine kinase, EST = esterase (three loci), IDH = isocitrate dehydrogenase (two loci), MDH = malate dehydrogenase (two loci), ME = malic enzyme, MPI = mannose phosphate isomerase, PEP-gl = peptidase glycyl-leucine, PEP-la = peptidase leucyl-alanine, PGI = phosphoglucose isomerase, SOD = superoxide dismutase (sometimes called TO or tetrazolium oxidase in other reports).

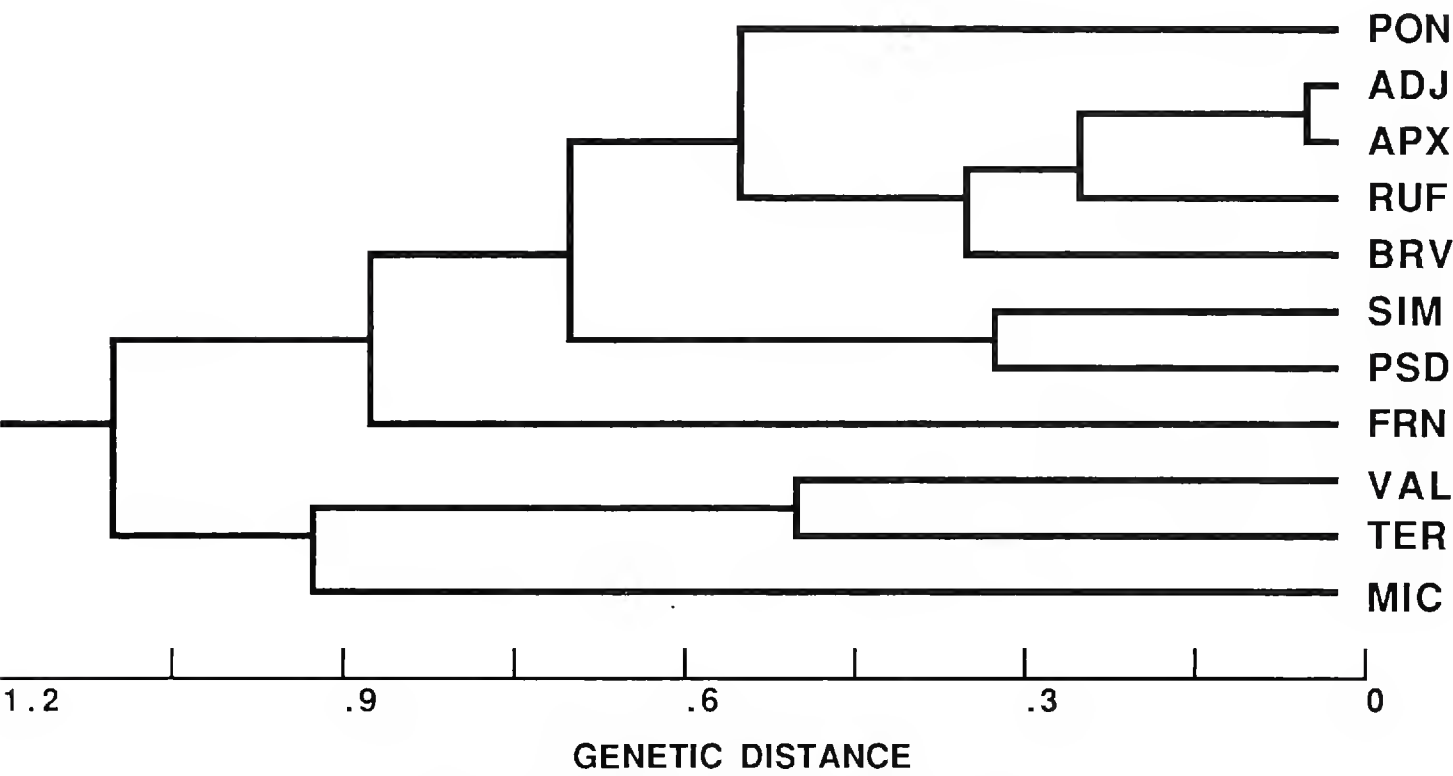


Figure 1. Phenogram derived from electrophoretic data illustrating relationships among 11 *Dendroctonus* species. (PON = *ponderosae*, ADJ = *adjunctus*, APX = *approximatus*, RUF = *rufipennis*, BRV = *brevicomis*, SIM = *simplex*, PSD = *pseudotsugae*, FRN = *frontalis*, VAL = *valens*, TER = *terebrans*, MIC = *micans*)

competition from other insect species, and because the species is highly inbred, it is possible that the low level of genetic diversity observed here may be typical.

Based on the hosts and earlier anatomic and cytogenetic studies, we expected that our electrophoretic data on *D. micans* would correspond most closely to *D. rufipennis*. We observed, however, a closer relationship to the pine-infesting *D. terebrans* and *D. valens* with which *D. micans* shares gregarious larval feeding in the phloem of living hosts.

In order to further clarify *D. micans*' genetic relationship within the genus, we hope to obtain additional broods of *D. micans*, as well as samples of *D. punctatus* and *D. murrayanae* for electrophoretic comparison. Such work has been hindered to date by the relative scarcity of *D. punctatus* and the difficulty of obtaining live specimens of *D. micans* from distant locations.

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Scientific Note

First Records of the German Yellowjacket *Paravespula germanica* (L.) from the East San Francisco Bay (California, U.S.A.) Area

The German yellowjacket, *Paravespula germanica* (L.), is native to Europe, northern Africa, and western Asia (Spradbery, 1973, Wasps, University of Washington Press). Its geographical range has increased largely due to the activities of man, and it is now established in Australia, New Zealand, South Africa, North America, and South America (MacDonald *et al.*, 1980, Bull. Entomol. Soc. Amer., 26(4):436–442). The North American population was introduced on the east coast and gradually spread west. The first California record was from South Lake Tahoe in 1983 (anonymous, 1985, Calif. Dept. Health Services Vector Update, 2–85:1–2). The present report extends the confirmed range to coastal California.

On 1 August 1986, in response to a call from a homeowner, I discovered an active colony of *P. germanica* in a house in Berkeley, California (elevation = 152 m). The exterior entrance hole led to a hollow space above a false wooden ceiling, but the location of the nest within the structure was not determined. This choice of a man-made structure as a nesting site is common in the “North American strain” of *P. germanica* (MacDonald *et al.*, 1980). Workers made approximately 80 sorties per minute, a rate indicative of a thriving colony. No reproductives were observed.

In addition to workers observed in the immediate vicinity of the colony, individual *P. germanica* foragers were captured at other East Bay locations. On 3 September a worker was captured at a garbage can in Berkeley (elevation = 80 m), approximately 1.3 km south of the colony, a distance within the outer limits of the expected foraging range of *P. germanica* workers. This wasp may have come from the aforementioned colony.

Foraging workers were also captured on 8 October on vegetation in Albany (elevation = 4 m) and on 10 October at a garbage can in Berkeley (elevation = 60 m). The sites are separated by 3.4 km, so it is not likely that these workers came from a single colony. Since the known colony had been eradicated in late September, the evidence suggests that at least three colonies of *P. germanica* were established in 1986, and that an invasion of the San Francisco Bay area is underway.

Because of the tendency to nest in buildings, *P. germanica* presents a greater safety hazard than native *Paravespula* (Bluthgen) species, which more commonly nest in the ground. The mild-wintered climate of coastal California may also enable *P. germanica* colonies to overwinter and requeen, as occasionally occurs locally in both *P. vulgaris* (L.) and *P. pensylvanica* (Saussure). Overwintered *P. germanica* colonies are known from Australia (Spradbery, 1973) and New Zealand (Thomas, 1960, N. Zealand Dept. Scientific and Industrial Res. Information Ser., 27:1–4), but not North America.

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A New Genus and Two New Species of Longhorn Beetles (Coleoptera: Cerambycidae) From Mexico and Central America

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Abstract.—A new neotropical elaphidiine genus, *Tropimerus*, is proposed and characterized. Two new species are described in the genus: *T. cyaneus* from Chiapas, Mexico, which is figured, and *T. hovorei* from El Salvador and Costa Rica.

Tropimerus Giesbert, gen. nov.

Form small, elongate. Head moderately small; eyes finely faceted; palpi subequal, terminal segments broadly triangular; frons with transverse impression with pit at each end giving rise to a long, erect seta; antennal tubercles feebly elevated; antennae slender, finely punctate and pubescent, with scattered flying hairs, length subequal to body in male, shorter in female, third segment carinate, segments 3 to 6 with short apical spine or tooth on inner side, third segment longest, 4th segment shortest, 11th longer than 10th. Pronotum nearly glabrous, subcylindrical or with sides slightly rounded, unarmed. Scutellum small, rounded at apex, finely pubescent. Elytra elongate, parallel sided, narrowed at posterior third, apices narrowly rounded to subacuminate. Underside with anterior coxal cavities rounded externally, open behind, prosternal process arcuate; mesosternum gradually sloping in front, apex notched behind, intermediate coxal cavities closed externally; abdomen of male with six sternites visible, female with five. Legs moderately short, slender; femora subclavate, apices unarmed, mesofemora with ventral and dorsal carinae; tibiae carinate; metatarsi with first segment slightly shorter than 2nd and 3rd combined.

Type Species.—*Tropimerus cyaneus* Giesbert, sp. nov.

Remarks.—*Tropimerus* bears a superficial resemblance to *Stenosphenus* Haldeman, and *Psyrassa* Pascoe, but differs from both by the presence of a sixth sclerotized abdominal sternite in the males, the distinctly carinate mesofemora, and the attenuate form of the elytral apices.

The remarkable sexual dimorphism in the abdominal segmentation presents a taxonomic character which may prove to be significant at a higher category of classification. *Tropimerus* shares this character with members of the Callichromatini, but it would be otherwise quite anomalous in that tribe. For the present, rather than establishing a new tribe for this genus alone, it seems more suitable to place *Tropimerus* in the Elaphidiini near *Stenosphenus* and *Psyrassa*.

Key to the species of *Tropimerus* Giesbert:

1. Head and pronotum black; elytra black with blue reflections. Antennae with 3rd segment $1\frac{1}{2}$ times as long as scape or 4th segment. Chiapas, Mexico.
T. cyaneus sp. nov.
- Head and pronotum orange; elytra black with feeble metallic reflections. Antennae with 3rd segment twice as long as scape or 4th segment. El Salvador, Costa Rica*T. hovorei* sp. nov.

***Tropimerus cyaneus* Giesbert, NEW SPECIES**

(Fig. 1)

Male.—Form moderately small, slender, subcylindrical. Integument piceous black, blue metallic reflections on elytra and ventral surface; head, pronotum, and appendages feebly aeneous; palpi, mandibles, and tarsal claws paler. Head shining, moderately rugulose-punctate, sparsely pubescent; vertex longitudinally impressed; occiput transversely rugulose; antennae slender, nearly as long as body, scape short, 3rd segment $1\frac{1}{2}$ times as long as scape or 4th segment, remaining segments slightly longer than 4th with 11th segment somewhat longer than 10th, 3rd segment carinate, segments 3 to 5 with short apical spine, 6th segment apically dentate. Pronotum slightly longer than broad, sides feebly rounded, transversely impressed behind apex, with impression interrupted at middle, disk shallowly indented on each side at middle, shallowly impressed before base; surface shining, with base and apex micro-rugulose, disk very sparsely, finely punctate, with erect, pale hairs sparse. Scutellum rounded at apex, clothed with fine, recumbent, pale pubescence. Elytra about $3\frac{1}{2}$ times as long as width across humeri, parallel sided, narrowing at apical $\frac{1}{3}$ to acuminate apices; surface shining, moderately coarsely, densely punctate, with pubescence sparse, fine, and erect. Underside with a few coarse deep punctures on each side of prosternum in front of procoxae; abdomen with 5th sternite widely emarginate, 6th sternite rounded at apex; prosternum, episternal pieces, and sides of metasternum and abdominal sternites moderately densely clothed with silky, recumbent, pale golden pubescence; remainder of ventral surface shining, finely, sparsely punctate, with scattered, erect, pale hairs. Legs moderately slender, shining, with femora subclavate, mesofemora carinate; tibiae carinate. Length 7–7.5 mm.

Female.—Form similar to male. Antennae reaching about apical $\frac{1}{4}$ of elytra; prosternum lacking coarse punctures; abdomen with 5th sternite widely rounded at apex, no 6th sternite evident. Length 7–8.5 mm.

Holotype male, *allotype* (California Academy of Sciences), and 16 *paratypes* (10 male, 6 female) from MEXICO, Chiapas, Sumidero Canyon, 4000 ft., on blossoms of *Croton* sp., July 7–8, 1986 (E. Giesbert, J. Wappes). Additional paratypes include: 17 males, 8 females, same locality, June 14–24, 1987 (E. Giesbert); 3 males, same locality, June 14–20, 1987 (J. Wappes).

***Tropimerus hovorei* Giesbert, sp. nov.**

Male.—Form moderately small, slender, subcylindrical. Integument piceous black with metallic reflections on elytra; head and prothorax orange. Head shining, moderately rugose-punctate, sparsely pubescent; vertex longitudinally impressed; occiput transversely rugulose; antennae slender, nearly as long as body, scape short,

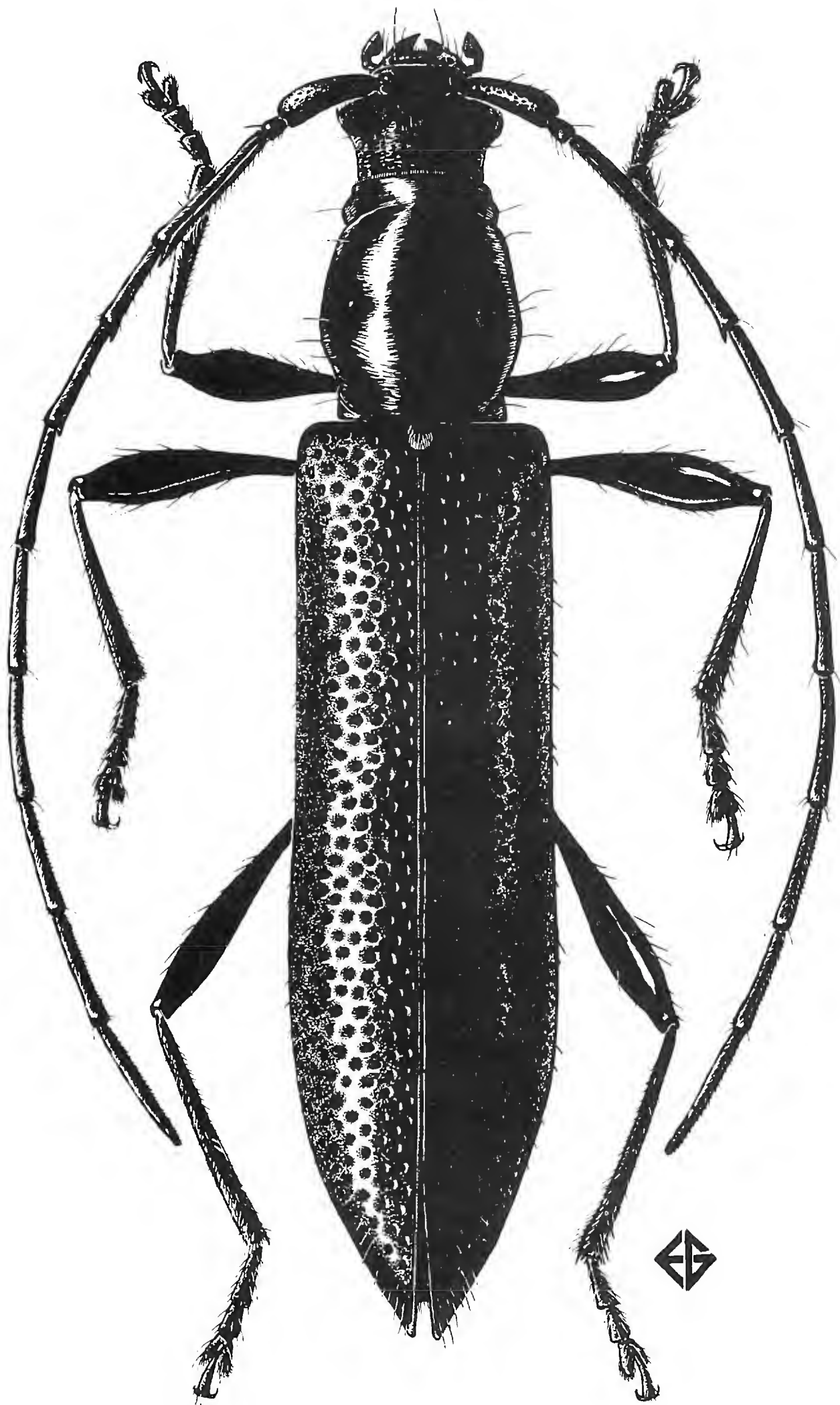


Figure 1. *Tropimerus cyaneus* Giesbert, new species; male.

3rd segment twice as long as scape or 4th segment, remaining segments longer than 4th, with 11th segment slightly longer than 10th, 3rd segment feebly carinate, segments 3 and 4 with short apical spine, segments 5 and 6 apically dentate. Pronotum longer than broad, sides somewhat rounded, transversely impressed at sides behind apex, shallowly impressed near base; surface shining, base and apex micro-rugulose, disk finely, very sparsely punctate, with erect, pale hairs sparse. Scutellum rounded at apex, clothed with fine, recumbent, pale pubescence. Elytra about $3\frac{1}{2}$ times as long as width across humeri, parallel sided, roundly tapering at apical $\frac{1}{3}$ to narrowly rounded apices; surface shining, moderately finely and densely punctate, with somewhat larger punctures scattered on disk and sublineate along suture; pubescence sparse, fine, erect. Underside with prosternum lacking coarse punctures; abdomen with 5th sternite widely emarginate, 6th sternite narrowly rounded at apex; disk of prosternum, episternal pieces, and margins of metasternum and abdominal sternites moderately densely clothed with pale, silky, recumbent pubescence. Legs moderately slender, shining, with femora subclavate, mesofemora and tibiae carinate. Length 7.25–8.5 mm.

Female.—Form similar to male. Antennae slightly shorter, attaining apical $\frac{1}{4}$ of elytra; abdomen with 5th sternite widely rounded at apex, no 6th sternite evident. Length 7.5–10 mm.

Holotype male, *allotype* (California Academy of Sciences), and 8 *paratypes* from EL SALVADOR, Quetzaltepeque, 500m., June 19, July 5, 1963 (D. Q. Cavagnaro, M. E. Erwin). 54 additional *paratypes* (29 males, 25 females) from COSTA RICA, Puntarenas prov., 6 km S. Santa Elena, on blossoms of *Croton* sp., May 23, 1985 (F. Hovore), May 24–28, 1987 (E. Giesbert), June 7–8, 1987 (F. Hovore).

Remarks.—*Tropimerus hovorei* differs from *T. cyaneus* by the orange head and pronotum, relatively longer 3rd antennal segment, the finer elytral punctures, as well as by the more southeastern range.

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Lectotype Designations and Redescription of *Vejovis wupatkiensis* Stahnke (Scorpiones: Vaejovidae)

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Abstract.—The syntypes of *Vejovis wupatkiensis* Stahnke were studied. A lectotype, allolectotype and 6 paralectotypes are designated, and the species is redescribed based on the lectotype. It is concluded that the nearest relatives to *V. wupatkiensis* Stahnke are *Serradigitus gertschi* (Williams) and *Serradigitus torridus* Williams and Berke. The current placement of *V. wupatkiensis* within the genus *Serradigitus* (i.e., *S. wupatkiensis* (Stahnke)) is confirmed.

INTRODUCTION

In 1940, H. L. Stahnke published an abstract of his 1939 doctoral dissertation on the scorpions of Arizona. In it, his characterization of the new species encountered were sufficient to validate and make available 9 new species-group names and one genus-group name. Stahnke named one of these new species *Vejovis wupatkiensis* after its type locality at Wupatki National Monument. This species was distinctive because of its elongate pedipalp fingers, elongate terminal pedipalp denticle, and swollen basal teeth of the female pectines. Subsequently, several related new species have been found and described. The phylogenetic relations among these taxa has remained obscure until recently because the types of *V. wupatkiensis* were not available for study. The purpose of this paper is to designate a lectotype, an allolectotype, and 6 paralectotypes for *V. wupatkiensis*, to redescribe the species based on the lectotype, and to confirm its current placement within the genus *Serradigitus* Stahnke. The measurements given are as described by Williams (1980:2–3).

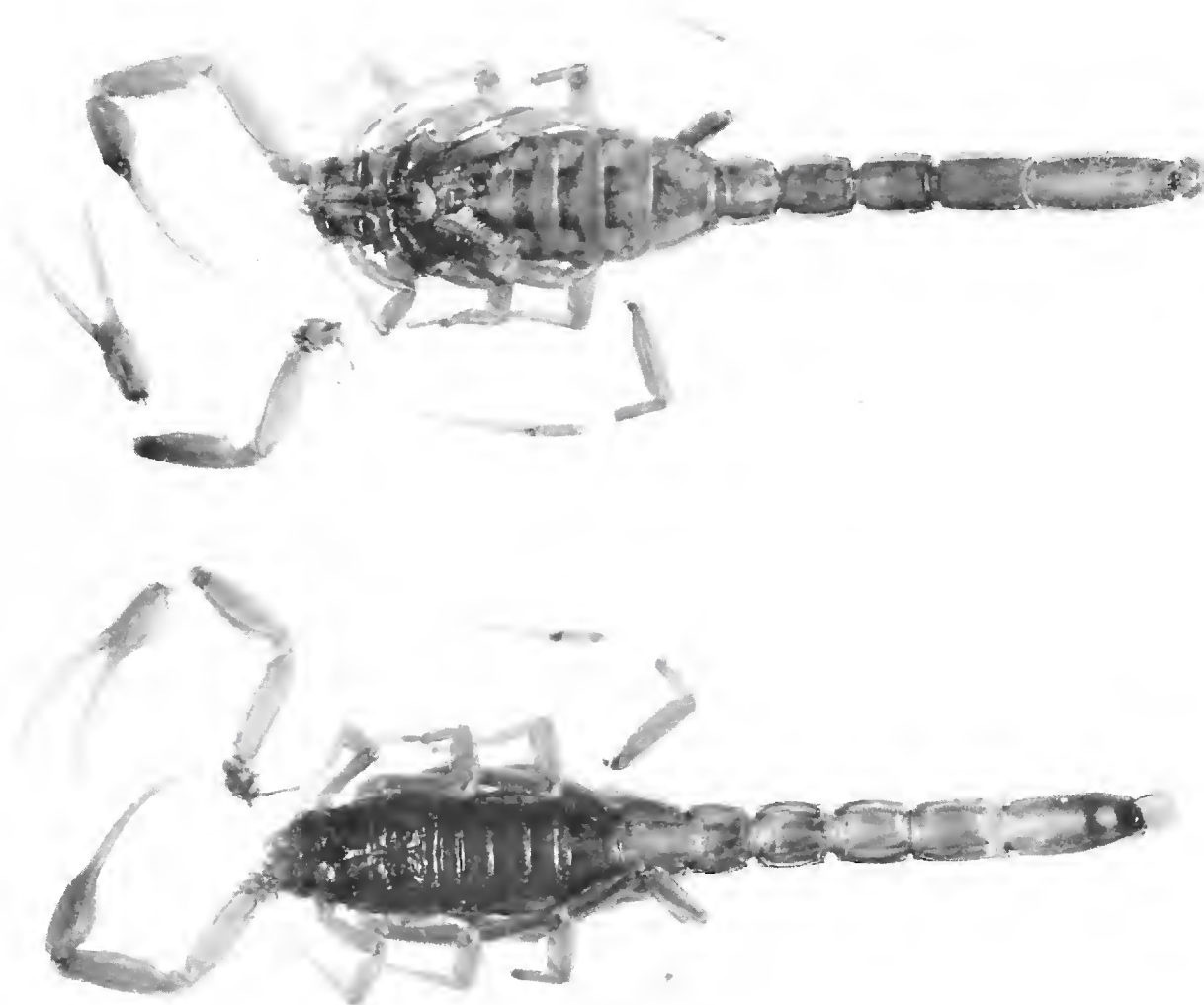
Serradigitus wupatkiensis (Stahnke)

(Figure 1, Table 1)

Vejovis wupatkiensis Stahnke 1940:105. Gertsch and Allred 1965:8. Soleglad 1972:180–181.

Vaejovis wupatkiensis Stahnke. Johnson and Allred 1972:168–169. Williams 1976:2. *Serradigitus wupatkiensis* (Stahnke). Stahnke 1974:130–132. Williams and Berke 1986:(in press).

Diagnosis.—Small, slender species of *Serradigitus*, adults to 35 mm long. Body uniform whitish yellow to amber-brown. Frontal margin of carapace straight to slightly emarginate; chela of pedipalps long and slender, movable finger longer than carapace, ratio of chela length to palm length 5.6 in males, 5.0 in females. Brachium



width approximates palm width; chela with supernumerary denticles 6/7 on fixed and movable fingers respectively; primary row denticles subdivided into 2–3 subrows of sharp serrate denticles by slightly enlarged denticles, chelicerae lacking denticles on ventral margin of fixed finger; stigma short, oval, 2–3 times longer than wide, ratio of carapace length to stigma length 14–15. Telson with small subaculear tubercule.

Similar to *Serradigitus gertschi* (Williams) and *Serradigitus torridus* Williams and Berke. Distinguished from *S. gertschi* by smooth to obsolete inferior median keels of metasomal segment I (not crenulate); differs from *S. torridus* by presence of 4 prolateral macrosetae on pedipalp humerus (not 5).

Redescription based on lectotype.—Female. Coloration: Carapace, mesosoma, metasoma, pedipalps, and walking legs uniform golden brown; pedipalp fingers similar to palm in color; pectines and genital operculum slightly more whitish, no other contrasting markings. Prosoma: Carapace frontal margin slightly concave, with 3 pairs macrosetae; lateral ocelli 3 per group, median ocelli small, similar to most cephalad lateral ocelli in size, interocular space wider than median ocellus diameter; dorsal surface finely granular; sternum broadly pentagonal, wider than long, 3 pairs sternal setae. Mesosoma: Terga 2–6 with subtle obsolescent median keel, tergum 7 with short, obsolescent median keel and 2 pairs well developed serrate

Table 1. Measurements (mm) of *Vejovis wupatkiensis*. Abbreviations are as follows: l = length, w = width, d = depth, fmd = frontal margin distance, ditd = distal internal trichobothrium distance, p-row = primary denticle row of chela.

| | lectotype #67 (female) | lectoallotype (#75.3) (male) |
|--------------------------------|---------------------------|---------------------------------|
| Total length | 33 | 25 |
| Carapace, (l/w at median eyes) | 4.3/3.2 | 3.1/2.4 |
| Diad (width/fmd) | 0.6/1.4 | 0.5/1.2 |
| Metasoma, length | 15.2 | 11.4 |
| Segment I (l/w/d) | 2.1/2.5/2.0 | 1.5/1.8/1.4 |
| Segment II (l/w/d) | 2.4/2.3/2.0 | 1.8/1.8/1.4 |
| Segment III (l/w/d) | 2.6/2.3/2.0 | 2.0/1.7/1.5 |
| Segment IV (l/w/d) | 3.5/2.3/2.0 | 2.6/1.7/1.4 |
| Segment V (l/w/d) | 4.6/2.2/2.0 | 3.5/1.6/1.4 |
| Telson, length | 5.7 | 3.0 |
| Vesicle (l/w/d) | 4.1/1.6/1.2 | 1.8/1.2/0.8 |
| Aculeus (1) | 1.6 | 1.2 |
| Pedipalp, Humerus (l/w) | 4.3/1.2 | 2.9/0.8 |
| Brachium (l/w) | 4.5/1.4 | 3.1/0.9 |
| Chela (1) | 7.8 | 5.0 |
| Palm (l/w/d) | 3.2/1.4/1.4 | 2.1/1.0/1.1 |
| Movable finger (l/base) | 5.3/0.8 | 3.3/0.5 |
| Fixed finger (l/ditd) | 4.6/2.6 | 2.6/1.8 |
| Fixed finger p-row denticles | 47:12,35 | 43:12,31 |
| Movable finger p-row denticles | 43:8,7,28 | 43:9,7,27 |
| Pectine teeth (left/right) | —/16 | 17/17 |
| Stigma 3 (l/w) | 0.3/0.1 | 0.2/0.1 |

lateral keels; genital operculum with 3 pairs setae; pectine with anterior lamella of 4 elongate sclerites, middle lamella of long quadrilateral basal piece plus 9 subcircular sclerites, fulcra triangular, 15 teeth per comb (including missing distal tooth), 2 proximal teeth more swollen, more elongate than others; stigmata small, oval, 3 times longer than wide; sternum 7 with 1 pair lightly developed, smooth to crenular, lateral keels. Metasoma: Dorsal and dorsolateral keels well developed, crenulate, terminating in elongate denticle on each posterior terminus; dorsal keels I–IV with 17-17-18-26 crenulations; ventrolateral keels with 12-17-18-26 crenulations on segments I–IV respectively; ventral keels obsolete on I, smooth to obsolete with a few obsolescent crenulations on II, lowly crenulate on III, crenulate on IV; metasomal segments short, stout, segment IV 1.5 times longer than wide. Telson: Aculeus one-third length of telson, distinct subaculear tubercle flanked with pair macrosetae, similar to aculeus in length, vesicle with about 6 pairs macrosetae approaching aculeus in length. Pedipalps: Chela long, slender, fixed finger longer than carapace, supernumerary denticles 6/7 on fixed and movable fingers respectively; primary row denticles in single, continuous, linear row, these sharp, serrate—numbering 47/43 denticles on fixed and movable fingers respectively, primary row denticles subtly subdivided into 2/3 subrows on fixed and movable fingers respectively by slightly enlarged denticles; fingers each with conspicuously elongate terminal denticle, these greater than 5 times length of first supernumerary;

fixed finger with trichobothrium *di* dorsal to supernumerary 5, trichobothrium *pi* dorsally between supernumeraries 5 and 6; palm with 1 dorsal, 2 dorsal prolateral keels, these lowly developed, crenulate; dorsal retrolateral keels smooth to obsolete. Chelicera: Movable finger ventral margin smooth, with setal comb; dorsal margin with broad basal bicuspid, 2 subterminal denticles and short terminal denticle. Fixed finger with basal bicuspid, 1 subterminal and 1 terminal denticle, no ventral margin denticles.

Variation.—Allolectotype and 6 paralectotypes examined. These similar in structure and coloration to lectotype but varied as follows: six females varied in total length from 29–32 mm, single male 25 mm; pectine teeth 15–16 (mode = 16) in females, 17 in male; females with proximal two pectine teeth swollen (one apparent subadult with proximal first tooth swollen); male pectine teeth all similar in size; fixed finger tends to be slightly shorter than carapace length (lectotype with fixed finger slightly longer than carapace length).

Types.—Lectotype (designated here), female, Arizona: Coconino Co., Wupatki National Monument, November 10, 1938, D. J. Jones (“#67, Wupatki Nat. Mnt., 11-10-38, D. J. Jones, Stahnke Collection, Type”) [missing left movable pedipalp finger, right chela detached, right tarsi missing on leg 4, many setae missing]. Depository: California Academy of Sciences, Entomology Type Number 15173.

Lectoallotype, male, “#75.3 Wupatki Natl. Mnt., Before 8–38, D. J. Jones, *Vejovis wupatkiensis* Stahnke, Type.” Depository: California Academy of Sciences, Entomology Type Number 15173.

Paralectotypes as follows: “#72 Wupatkia, Flagstaff, Arizona, 11-7-38, syntype-cotype” [female]; “#73.4 Wupatkia, Flagstaff, Ariz, Oct 1938, cotype” [female]; “#73.3, Wupatkia, Flagstaff, Arizona, Oct 1938, syntype-cotype” [small subadult female]; “#75.11, Wupatki, Flagstaff, Arizona, 8-10-38, syntype female,” [female]; “#326, Wupatki, Flagstaff, Arizona, 6-11-39” [female, not labeled as type, but apparently part of syntype series]; “#325, Wupatki, Flagstaff, Arizona, 6-9-39” [female, probably subadult]. Paralectotype Depository: California Academy of Sciences.

Remarks.—According to his doctoral dissertation (1939), Stahnke based the description of this species on 9 specimens. Of these, only eight were received by the California Academy of Sciences [from H. L. Stahnke] in 1983. The missing specimen was numbered 75.2 in the dissertation, and its location is unknown.

This species is known from northern Arizona, southern Utah, southern Nevada, and adjacent eastern California. Little geographic variation is apparent. However, I recognize a distinctive race from the Panamint Mountains of eastern California. It is characterized by having pedipalp fingers more darkly pigmented than palm, pedipalp keels outlined with contrastingly dark pigmentation, and slightly more slender pedipalp palms.

ACKNOWLEDGMENTS

Thanks to Wojciech J. Pulawski and Vincent F. Lee, California Academy of Sciences, for arranging the loan of the types, to Warren E. Savary for assistance with illustrations, and to Paul H. Arnaud, Jr., Alec M. Balmy, Vincent F. Lee, and Warren E. Savary for reading and criticizing this manuscript.

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Scientific Note

A Nematode Parasite of *Erebia occulta* Roos & Kimmich (Nematoda; Lepidoptera: Satyridae)

According to the list published by Poinar (1975, Entomogenous Nematodes, Brill, Leiden), nematode parasites have been recorded for 232 lepidopteran species, of which only 20 are butterflies. Parasitism records for North American species include: *Pieris rapae* (L.) Pieridae; *Polygonia comma* (Harris), *P. interrogationis* (Fabricius), and *Vanessa atalanta* (L.), all Nymphalidae (Puttler and Thewke, 1971, Ann. Entomol. Soc. Am., 64:1177–1178). As of November 1986, Poinar (*in litt.*) had no nematode parasite records for the Satyridae. The nematode group responsible for parasitism in butterflies is the Mermithidae, which are obligate parasites. They have no free-living or nourishment-receiving stages outside of their hosts. Most of the moth nematode parasites are also Mermithidae, but there are 6 records of Steinernematidae, which behave as both facultative and obligate parasites, and one record for Rhabditidae, which are facultative parasites.

In Alaska on the morning of 3 July, 1986 I collected a male specimen of *Erebia occulta* Roos & Kimmich (Satyridae) as it was flying over a low scree slope at mile 41.5 Nome-Council Road (64°39'N, 164°20'W, 30–120 m). The specimen was papered and subsequently relaxed for spreading. When removed from the relaxing chamber, about 5 mm of a mermithid was found protruding from the 7th abdominal segment of the specimen, through which it had apparently bored a hole before dying. Using forceps, the worm was carefully extracted. When measured, it extended 10.1 cm. The butterfly's abdomen measured 9 mm. The nematode was placed in 70% isopropanol and sent for identification to Dr. George O. Poinar, Jr. at the University of California, Berkeley, who determined that it was a "postparasitic juvenile and could not be identified past family level (Mermithidae)."



Figure 1. Specimen of *Erebia occulta* from which 10.1 cm juvenile mermithid was extracted. Scale = cm.

The butterfly from which the mermithid was extracted behaved normally in the field, and from its somewhat damaged condition it must have been on the wing for several days prior to capture. It is shown in Fig. 1, and its parasite in Fig. 2.

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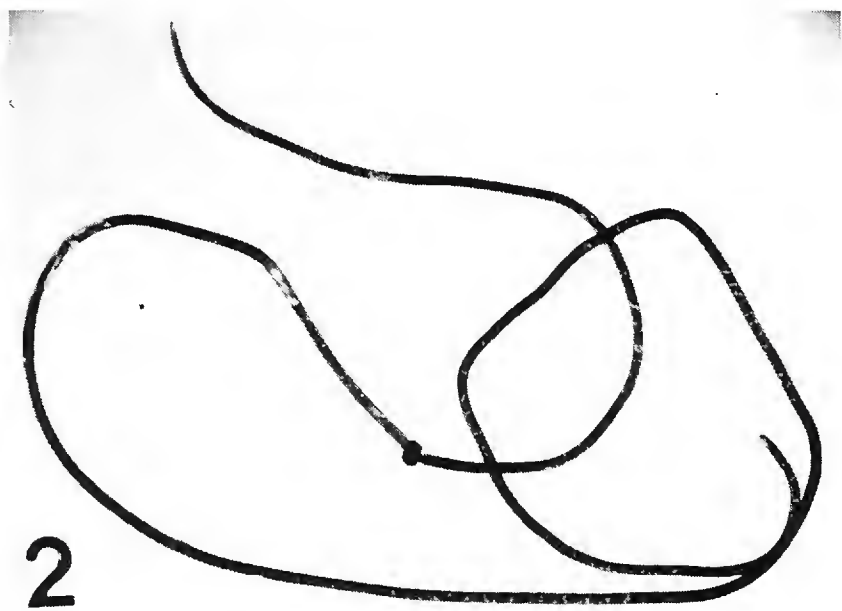


Figure 2. Juvenile mermithid extracted from male specimen of *Erebia occulta*.

Scientific Note

Heleocoris brasiliensis De Carlo is a *Ctenipocoris* (Hemiptera: Naucoridae)

While recently undertaking a character analysis of a large number of naucorid taxa in the subfamily Laccocorinae in an attempt to clarify the generic concepts in this group I examined two specimens of *Heleocoris brasiliensis* De Carlo from the Mato Grosso region of Brazil. It was immediately apparent that this species is not congeneric with the type-species of *Heleocoris*, *H. tabidulus* Stal from Syria, but instead belongs to the genus *Ctenipocoris* Montandon. The following nomenclatural change is thus proposed.

***Ctenipocoris brasiliensis* (De Carlo) New Combination**

Heleocoris brasiliensis De Carlo, 1968. Rev. Soc. Entomol. Arg., 30:101

This species may be assigned to *Ctenipocoris* by the possession of the following characters: eyes triangular when viewed from above, with barely developed lateral flange, converging ventrally below and behind the folded anterior margin of the head; lateral margins of abdominal tergites lacking numerous stout spines, bearing instead scattered short slender pale spines intermixed with long pale setae; fore tibia and tarsi very short and stout; middle and hind tibiae with numerous very long and stout reddish spines, their length exceeding the diameter of the middle tibia; middle tibia lacking a dense pad of short gold setae distally on the ventral face. Based on comments in Usinger (1935, Rev. Entomol., 5:135) I suspect that another South American *Heleocoris* species, *H. spinipes* Montandon, may belong to *Ctenipocoris* as well, but I have not examined any specimens of this taxon. La Rivers (1969, Biol. Soc. Nev. Occ. Pap., 20:5) indicated that none of the Neotropical species held in *Heleocoris* truly belonged there but suggested no alternative generic placements.

The discovery of *Ctenipocoris* in the Western Hemisphere adds yet another naucorid genus to the Neotropical fauna, and provides a link between the tropical Naucoridae of Africa and South America, implying a vicariance pattern resulting from the Cretaceous breakup of Gondwanaland. Based on material I have examined, the range of *Ctenipocoris* now includes Brazil, Zaire, Burma, Thailand, Vietnam, Malaysia, Singapore and Java, giving it a circumtropical distribution.

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**Two New Trichogrammatidae (Hymenoptera) From North America:
Ittysella lagunera Pinto and Viggiani (N. Gen, N. Sp.) and
Epoligosita mexicana Viggiani (N. Sp.)**

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Abstract.—*Ittysella lagunera* Pinto and Viggiani, and *Epoligosita mexicana* Viggiani are described. Both are parasites of leafhopper eggs. *Ittysella* is assigned to the Paracentrobiini and appears closest to *Ittys* Girault. *Epoligosita mexicana* is closest to *E. clara* Hayat and Viggiani, from India.

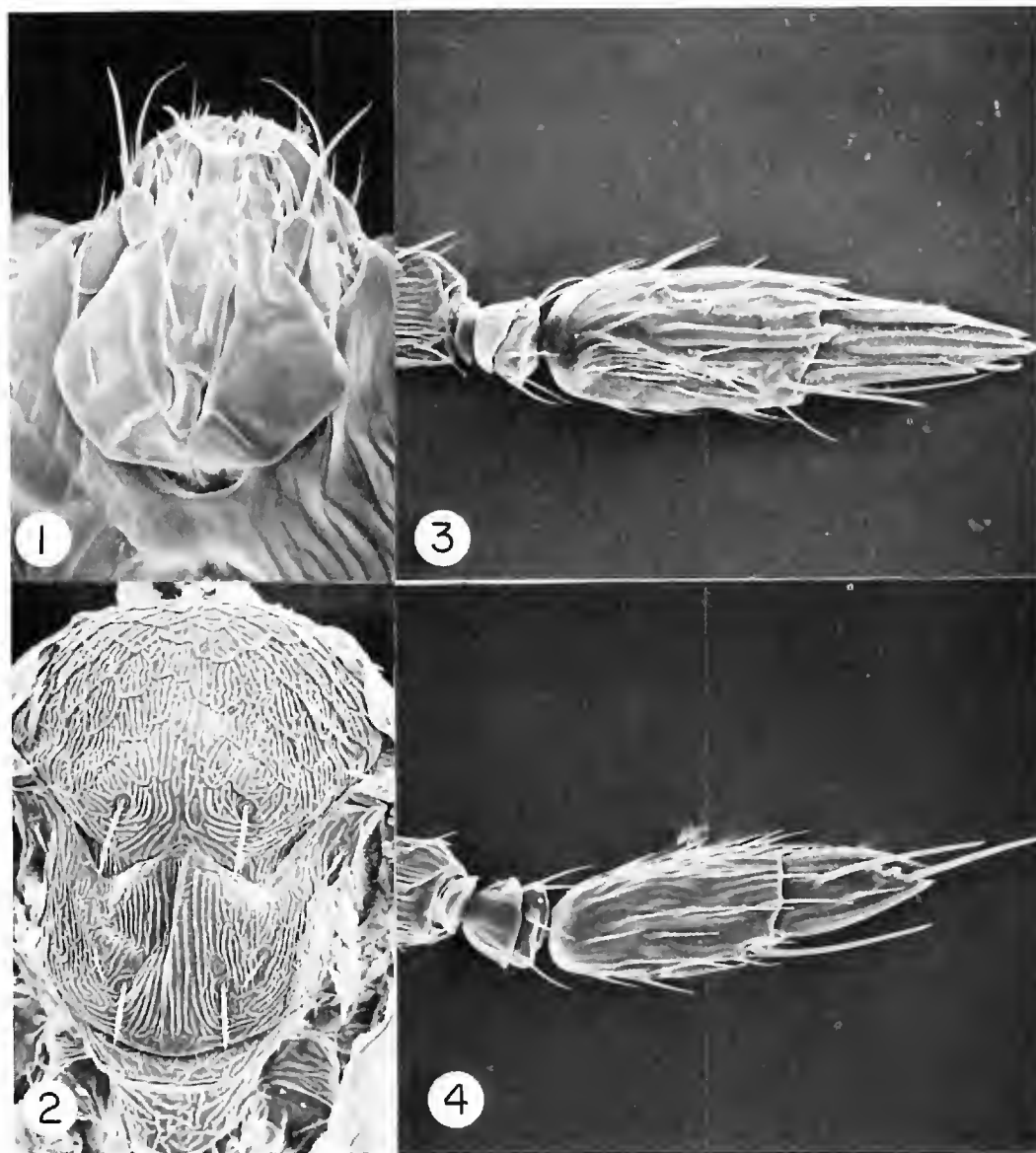
Recent surveys for parasites of leafhoppers on grape have been conducted in northern Mexico and the southwestern United States by D. González, Division of Biological Control, University of California, Riverside. Among the egg parasites collected are two new taxa of Trichogrammatidae, *Ittysella lagunera* Pinto and Viggiani (n. gen, n. sp.) and *Epoligosita mexicana* Viggiani (n. sp.). Both are described below. Collections of *E. mexicana* represent the first records of this genus in the New World.

***Ittysella* Pinto and Viggiani, n. gen.**

Antenna of male and female with a single anellus, two funicle segments and a two-segmented club; funicle II annuliform, distinctly shorter than I. Maxillary palpi one-segmented (Fig. 1). Forewing (Fig. 5) moderately narrow, ca. 0.4 as wide as long; marginal vein contacting anterior border of wing, contiguous with submarginal vein at base, terminating abruptly at apex; stigmal vein well-developed, slightly constricted at base; disc with linear vein tracks; RS₁ track absent. Male genitalia (Fig. 6) with phallobase subconical in shape and a relatively small anterodorsal aperture; parameres distinct, unciform, apices directed laterally; volsellar digiti absent.

Type species.—*Ittysella lagunera* Pinto and Viggiani, n. sp.

Remarks. *Ittysella* belongs to the Paracentrobiini as defined by Viggiani (1971). This tribe also includes *Paracentrobia* Howard, *Ittys* Girault and *Paraittys* Viggiani. Structure of the male genitalia suggests that *Ittysella* is closest to *Ittys*. In both, the parameres are well developed and unciform. Parameres are lacking in *Paracentrobia*, and are present but of an entirely different structure in *Paraittys* (see Viggiani, 1973). *Ittysella* differs from *Ittys* in lacking an RS₁ vein track, and from all genera of the tribe in possessing antennae with a single anellus and a club with two rather than three segments.

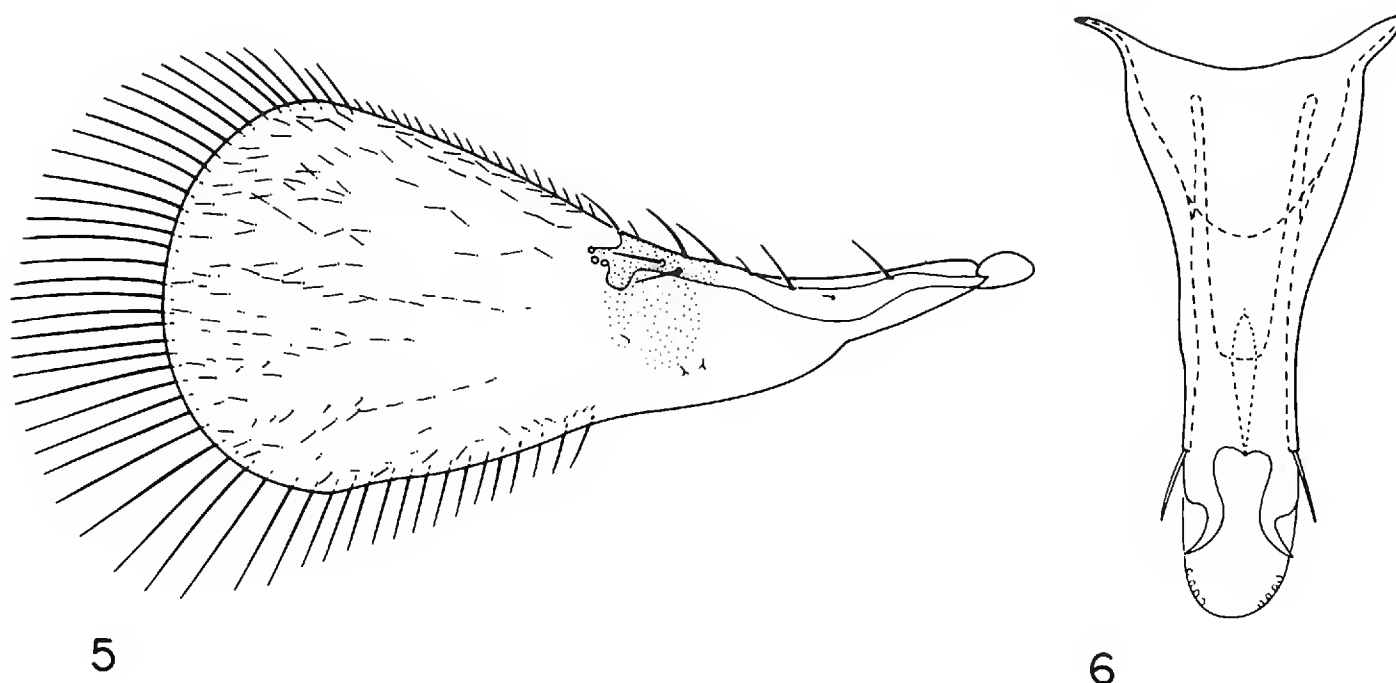


Figures 1–4. *Ittysella lagunera*. 1. Head, ♀, anteroventral view (Torreon, Coah.) (940X). 2. Thorax, ♀ (Torreon, Coah.) (540X). 3. Antenna (right), ♀ (Torreon, Coah.) (780X). 4. Antenna (left), ♂ (Caborca, Son.) (780X).

***Ittysella lagunera* Pinto and Viggiani, n. sp.**

Length 0.40–0.45 mm. Color yellow with limited brown as follows: basal portion of pedicel and antennal club; mandibles; transverse stripe on gena behind eye; ventral and dorsal margins of pronotum; anterior and posterior margins of mesepisternum; metacoxa; marginal and stigmal vein, and area below them on forewing; maculae on dorsolateral margins of visible urotergites, together appearing as a longitudinal stripe; apical half of ovipositor. Legs pallid. Eyes and ocelli reddish.

Head ca. 1.15 as wide as thorax; mandibles tridentate; thorax (Fig. 2) shorter than gaster (ca. 0.6 gaster length), midlobe of mesoscutum subpentagonal, with a pair of setae near apical third at lateral margin and another more medial pair near posterior margin, both pair subequal in length; mesoscutellum ca. 0.67 length of mesoscutum, with two pair of setae, posterior pair closer together and longer than anterior pair. Forewing (Fig. 5) with marginal vein elongate; stigmal vein short, broad, only slightly constricted at base, ca. 0.20 length of marginal vein; marginal vein with six relatively elongate setae dorsally; premarginal vein with one elongate seta; disc relatively sparsely setose, with six poorly developed vein tracks, tracks most distinct



Figures 5–6. *Ittysella lagunera*. 5. Forewing, ♀ (Torreon, Coah.). Male genitalia, ventral view (Hermosillo, Son.).

at apical third of wing; RS_1 absent or indicated by one or two setae at most; fringe setae elongate, longest seta about half the greatest wing width (see below); substigmatal macula obsolescent. Hind wing narrow, elongate, with only one row of setae on disc; hamuli on apex of an acute projection of anterior margin of wing; longest fringe seta ca. 1.7 greatest wing width (at hamuli). Legs unmodified; tarsomeres subequal; hind tibial spur ca. 0.6 length of basitarsis.

Female.—Antenna (Fig. 3) with scape 3.60 as long as wide; pedicle almost twice as long as wide and 0.55 the length of scape; single anellus distinct; funicle segments short, subequal in width, wider than long, distinctly narrower than club; funicle I widening apically, 0.6 as long as wide; funicle II annuliform, only a third as long as wide and ca. half the length of I; club elongate ca. 3.3 as long as wide, widest at basal fourth, with two distinct but appressed segments, first segment 1.5 as long as second, club with 3–4 linear sensilla on each segment and relatively short inconspicuous setae.

Ovipositor moderately elongate, 0.16 mm long, length ca. half that of gaster and 1.4 that of hind tibia, not projecting appreciably beyond apex of gaster.

Male.—Coloration similar to female but with legs more brownish primarily from the coxae to tibiae. Antenna (Fig. 4) as in female except club shorter, ca. 2.9 as long as wide, with 1–2 linear sensilla on each segment and with more elongate setae on apical half. Phallobase (Fig. 6) 0.07 mm long, 0.5–0.6 as wide as long; unciform parameres laterally directed, each with a moderately long ventral seta at base, parameres occupying 0.25 length of entire phallobase; medio-ventral ridge obsolescent; aedeagus subequal in length to phallobase and ca. half the length of hind tibia; apodemes occupying 0.5–0.6 length of aedeagus.

Type information.—Holotype ♀ and allotype from MÉXICO, Coahuila, Torreon; 16 July 1985; D. González, collr.; “ex. grape stem cuttings.”; deposited in the National Museum of Natural History. Twenty paratypes (6 ♂♂, 14 ♀♀) also

from Torreon deposited as follows: British Museum (Natural History) 1 ♂, 1 ♀; Canadian National Collection, Ottawa, 1 ♂, 1 ♀; University of California, Department of Entomology, Berkeley, 1 ♀; University of California, Department of Entomology, Riverside (UCR), 2 ♂♂, 5 ♀♀; University of Naples, Institute of Agricultural Entomology, Portici (UNP), 2 ♂♂, 6 ♀♀.

Holotype, allotype and ten of the paratypes are slide mounted in Canada balsam; the remaining paratypes are point mounted. The type series emerged from grape cuttings harboring eggs of the leafhoppers *Dikrella cockerelli* (Gillette) and *Erythroneura ziczac* Walsh.

Records.—MEXICO. *Baja California Sur*: Las Barracas, ca. 30 km E Santiago, 1 ♂, 2 ♀♀, 19 and 29 April 1984, yellow pan trap, P. DeBach (UCR). *Coahuila*: Parras, 1 ♂, 3 ♀♀, 29 August 1985, D. González (UCR). Torreon, 9 ♂♂, 13 ♀♀, 16 and 28 July 1985, D. González. *Sonora*: Caborca, 2 ♂♂, 2 ♀♀, 19 August 1986, D. González (UCR). Hermosillo, 7 ♂♂, 10 ♀♀, 29 and 30 July 1985 (UCR, UNP). UNITED STATES. *Arizona*: Cochise Co., Chiricahua Mts., Sunny Flats Campground, 1 ♀, 10 July 1983, screen sweeping, A. Mayor (UCR). *New Mexico*: Las Cruces, 5 ♂♂, 10 July 1986, D. González (UCR).

All material from Coahuila, Sonora and New Mexico emerged from collections of grape cuttings. Leafhopper eggs of the following species were deposited in the leaves of these collections: *Dikrella cockerelli* (New Mexico, Coahuila), *Erythroneura ziczac* (Coahuila), and *Erythroneura variabilis* Beamer (Sonora).

Remarks.—All material examined is relatively uniform structurally. Specimens from Arizona and New Mexico have a somewhat longer forewing fringe (0.50–0.56 wing width; $\bar{x} = 0.524 \pm 0.03$ S.D.; $n = 6$) than material from México (0.43–0.50 wing width; $\bar{x} = 0.480 \pm 0.02$; $n = 8$).

The specific epithet is derived from La Laguna, the name commonly applied to the type locality and environs.

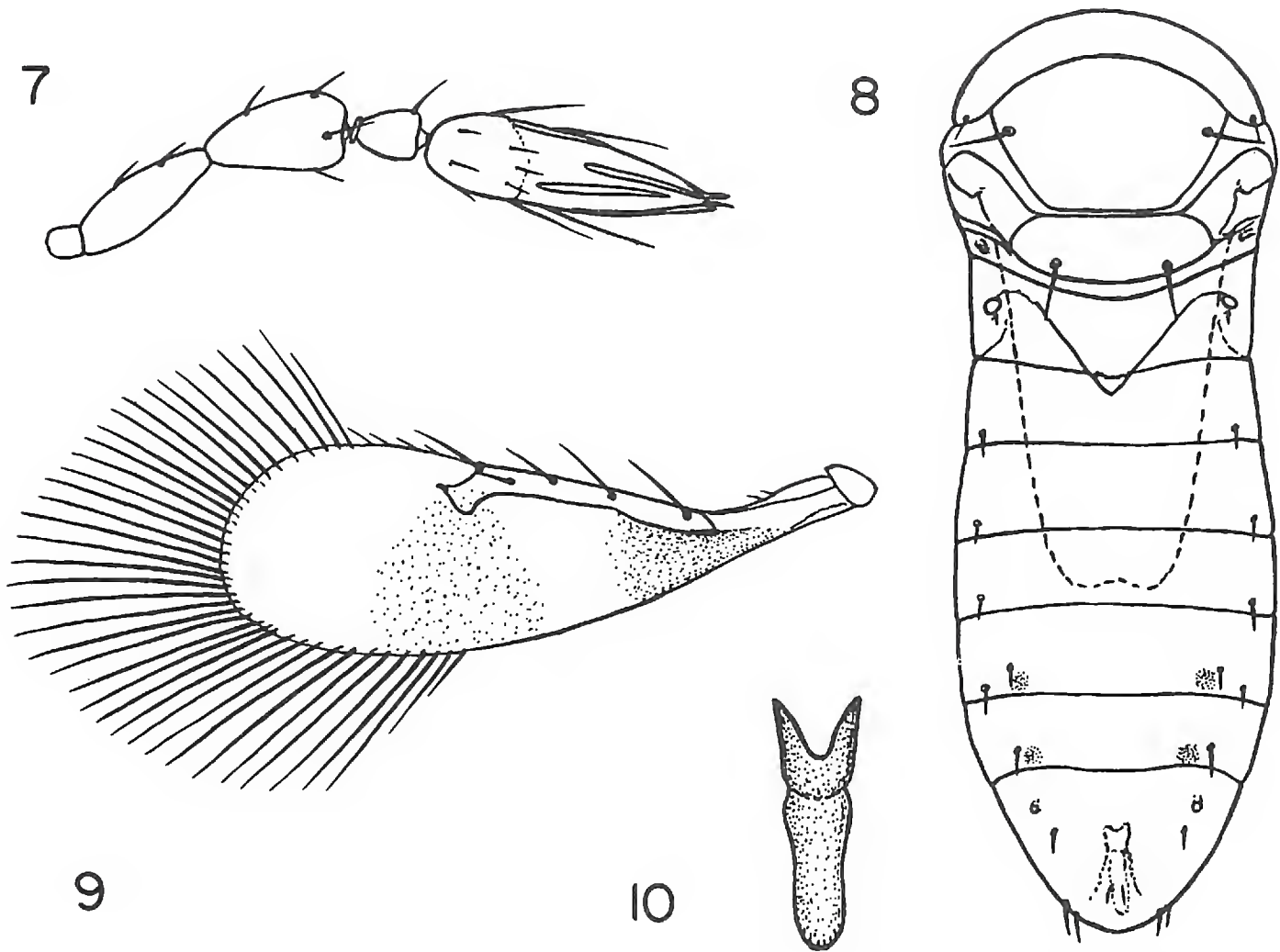
***Epiligosita mexicana* Viggiani, n. sp.**

Female.—Length: 0.47 mm. Body yellow; eyes and ocelli blackish; tips of mandibles yellowish brown; antenna, middle and hind tibiae, meso- and metapleurae, with some brown; forewings with basal third and substigmal area infuscated; ovipositor honey-brownish.

Head normal for the genus, ca. one-fourth wider than high. Mandibles tridentate. Maxillary palpi uniarticulate and labial palpi reduced. Antenna (Fig. 7) with scape 3.0 as long as wide, pedicel slightly shorter but distally ca. one-third wider; single anellus distinct; funicle segment about as long as wide, narrower than pedicel and club; club not clearly divided in two segments, 2.0 as long as pedicel, ca. 5.0 as long as funicle segment and ca. 3.0 as long as wide; first segment with one linear sensillum and distal one with 4.

Thorax ca. one-third shorter than gaster, with main dorsal characters as illustrated for male (Fig. 8). Forewing (Fig. 9) ca. 3.0 as long as wide; disc with only a single minute seta located mid-way between center of marginal vein and posterior margin; longest fringe setae as long as greatest wing width. Hind wing very narrow, without setae on disc. Legs normal; fore, middle, and hind tarsomere ratios respectively as follows: 8:9:10; 18:13:13; 13:12:12 (hind tibial spur = 8).

Gaster conic; ovipositor occupying about half length of gaster, about as long as hind tibia; third valvulae very short, one-sixth of the entire ovipositor.



Figures 7–10. *Epoligosita mexicana*. 7. Antenna, ♀. 8. Thorax, ♂. 9. Forewing. 10. Male genitalia.

Male.—Similar to female, but antenna with longer setae on the club. Male genitalia as in Fig. 10, 0.057 mm in length.

Type information.—Holotype ♀ from MEXICO, Coahuila, Torreon; 28 August 1985; D. González, collr.; allotype, same data as holotype, except 16 July 1985. Both deposited in the National Museum of Natural History. Paratypes from the same locality deposited as follows: University of California, Department of Entomology, Riverside; University of Naples, Institute of Agricultural Entomology, Portici.

Holotype, allotype and 6 paratypes are slide mounted in Canada balsam; 3 additional paratypes are point mounted. All type specimens emerged from leaves of grape cuttings harboring eggs of the leafhoppers *Dikrella cockerelli* and *Erythroneura ziczac*.

One female, UNITED STATES, Arizona, Cochise Co., 25 August 1982, J. LaSalle, collr., screen sweeping, probably belongs to the new species.

Remarks.—The new species *Epoligosita mexicana* runs to the group of *Epoligosita* Girault with the funicle segment quadrate or wider than long (couplet 1 in Hayat and Viggiani, 1981), in which *E. biclavata* (Girault and Dodd), *E. nudipennis* (Kryger) and *E. clara* Hayat and Viggiani are included. Of these species the closest seems to be *E. clara*, from which *E. mexicana* may be separated by having the scape 3.0 as long as wide (in *E. clara* 3.5 as long as wide), the funicle segment as long as wide (in *E. clara* a little wider than long), the club twice as long as length of pedicel (shorter in *E. clara*),

ovipositor as long as half length of gaster (in *E. clara* more than half length of gaster), and the forewings with the basal third and substigmal area infuscated (in *E. clara* only basal third of forewings infuscated).

ACKNOWLEDGMENTS

Figures 5–6 were prepared by Patricia Mote. Robert Velton was responsible for the SEM photographs and specimen curation. Individuals participating in the leafhopper parasite surveys include J. Ellington, D. González, F. González, L. Guerra Sobrevilla, M. Moratorio, A. Tijerina, and W. White.

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Four Species of Scuttle Fly (Diptera: Phoridae) From Dominican Amber

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Abstract.—Four species of Phoridae, *Dohrniphora poinari* n. sp., *Megaselia amberae* n. sp., *M. bernsteinae* n. sp. and *M. dominicana* n. sp. are described from Dominican amber dated 30 m.y. B.P. \pm 10 m.y. (Oligocene, or possibly late Eocene or early Miocene). Morphologically these species resemble living species.

Dr. George O. Poinar, Jr., of the University of California, Berkeley, asked me to examine four specimens of Phoridae preserved in Dominican amber dated 30 m.y. B.P. \pm 10 m.y. They are most probably Oligocene but are possibly late Eocene or early Miocene. All four specimens prove to be undescribed females. In dealing with the present-day fauna one would not describe species on the basis of females alone, unless they were highly distinctive. In the case of fossils more than 10 m.y. B.P. in age this precaution can be safely ignored; although there remains a low probability of a male of one of these species being discovered and, because of sexual dimorphism, treated as a distinct species in error.

The four species are described below:

Dohrniphora poinari sp. nov.

A medium sized species with wing length about 1.2–1.4 mm. Scutum yellowish with contrasting dark, brownish, scutellum which is yellowish at margins. Abdominal tergites dark with median yellowish band, which expands anteriorly on each tergite.

Legs yellowish to brownish yellow. Hind-tibia with a single dorsal hair palisade and no pre-apical bristles. Mid-tibia apparently without dorsal hair palisade but with a pair of bristles in basal quarter and a short anterior pre-apical bristle. Fore-tibia with five near-dorsal bristles, with 2–5 being short.

Wings with costal index about 0.6. Haltere knob yellowish. Third antennal segment pale brownish, the two-segmented palps yellow with short apical bristles. Proboscis not elongated, labella apparent and a little pointed anteriorly. Frons with chaetotaxy much as in the present-day cosmopolitan *Dohrniphora cornuta* (Bigot) but with no apparent anterolaterals, although on the most visible (left) side there is what appears to be a basal scar in the appropriate position.

Thoracic chaetotaxy with a pair of pre-scutellars, intra-alars and pre-alar bristles. A humeral bristles and three notopleurals present. Fine hairs present on mesopleuron. Scutellum with an anterior pair of hairs and a posterior pair of bristles.

Holotype female. D-7-51.

Affinities. While a number of species of fossil *Dohrniphora* have been described from Baltic amber (e.g. Brues, 1939), these have all been subsequently transferred to

the closely related genus *Diplonevra* Lioy (Borgmeier, 1968). The present-day Neotropical species are dealt with by Borgmeier (1960, 1961), Borgmeier & Prado (1975), Prado (1976) and Disney (1983a). These keys and descriptions deal primarily with the males. However the lack of bristles on the hind tibia and short proboscis will distinguish *D. poinari* from the majority of present day species. The long costal index, contrasting colors of the scutum and scutellum and single pair of scutellar bristles will distinguish it from the rest.

Genus *Megaselia* Rondani 1856

Megaselia is the largest genus of Phoridae in the world today, with some 1400 described species. However most species remain undescribed and estimates (Disney, 1983b) suggest that the true total lies between 5,000 and 20,000 species. The present day Neotropical species are covered by Borgmeier (1962, 1969a, 1969b and 1971) and Disney (1982).

The three species described below are evidently closely related and share a number of features. These include a large Costal Index (0.5 or more), short coastal cilia (< 0.1 mm), Vein Sc confluent with R1, Vein 3 forked, Mesopleuron bare, haltere knob mainly yellowish and a posterior pair of bristles and anterior pair of hairs on the scutellum. They thus belong to a sub-section of Borgmeier's (1962) Group VII.

Eight species of *Megaselia* have been described from Baltic amber and two species from Zanzibar copal (Borgmeier, 1968). Whilst all the descriptions are inadequate by present-day standards none agree with the three species from the Dominican amber described below.

Megaselia amberae sp. nov.

A medium to large species (wing length 2.63 mm). Frons black. Scutum and scutellum dusky orange yellow. Antennae orange brown. Abdominal tergites appear to be a bit darker (but considerably obscured in specimen). The Coastal Index is 0.54–0.55. The costal ratios are 4.1:1.8:1. The costal cilia measure 0.07–0.09 mm. There appears to be only two notopleurals, otherwise the chaetotoxy seems to be the standard (ground plan?) for the genus. The palps are orange yellow in color with standard bristles. The last two segments of the fore tarsus are subequal in length. Legs yellowish with a dark apex to hind femur.

Holotype female. D-7-54.

Megaselia bernsteinae sp. nov.

A little smaller than the previous species (wing length 2.08 mm). Frons black, scutum and scutellum yellow. Antennae brown. Abdominal tergites dark greyish brown. Tergites 5 with posterior margin concave. Tergite 6 with anterior margin notched in middle third.

The costal index is 0.552. Costal ratios 3.64:1.56:1. Costal cilia 0.065–0.075 mm long. Only two notopleurals present, otherwise chaetotaxy seems to be standard. Palps not visible in specimen. Legs yellowish except for apex of hind femur.

Holotype female. D-7-52.

Megaselia dominicana sp. nov.

A little smaller than the above species (wing length 1.60 mm). Frons brown, scutum and scutellum yellowish brown. Antennae brown. Abdominal tergites brown



Figure 1. Lateral view of *Dohrniphora poinari* sp. n. in amber from the Dominican Republic. Figure 2. Dorsal view of *Megaselia dominicana* sp. n. in amber from the Dominican Republic.

and somewhat narrow after tergite 2. Tergite 5 with concave notch in middle of hind margin. Tergite 6 with side and rear margins forming a continuous semicircle.

Costal Index 0.497. Costal ratios 3.56:1.48:1. Costal cilia 0.50–0.051 mm long. Three notopleurals present and rest of chaetotaxy appears to be standard. Femora somewhat brownish, otherwise legs yellowish. Tarsal segment 5 of front leg about $1.25 \times$ length of 4. Palps not visible in specimen.

Holotype female. D-7-53.

DISCUSSION

The four species described above belong to the two genera which dominate Neotropical forest Phorid faunas today. Indeed on morphological grounds all appear modern in appearance. However our knowledge of the ground-plan characters of both genera is still extremely slight. In the *Megaselia* species the long costa, short costal cilia and vein Sc confluent with R1 are probably all plesiomorphic features. All, however, are not uncommon in the genus today. The genus *Dohrniphora* is almost certainly closer to the ground-plan of the Phoridae than *Megaselia*, for example in possessing a two segmented palp. *D. poinari* in lacking a hair palisade on the mid-tibia and pre-apical bristles on the hind tibia stands with a minority of the species in the genus today. The relatively short proboscis is almost certainly plesiomorphic for the genus.

The *Megaselia* specimens all have balloon-like distensions of the abdominal pleura. These are evidently post-mortem changes and not structural features.

Specimens are in the collection of G. O. Poinar, Jr., Berkeley, California and will eventually be deposited at the American Museum of Natural History, New York.

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Scientific Note

Pteroloma nebrioides Brown in Idaho (Coleoptera: Agyrtidae)

Pteroloma nebrioides Brown was initially described from southeastern British Columbia, and recorded from a number of sites throughout British Columbia, western Alberta, and one site in northwest Montana. Distribution, taxonomy, and biology, have been reported by R. Anderson and S. Peck (1985, The Insects and Arachnids of Canada, Part 13, The Carrion Beetles of Canada and Alaska, Coleoptera: Silphidae and Agyrtidae, 121 p). Their single United States record is from Glacier National Park, Montana (R. Anderson, pers. comm.).

Here, I report this species from two new localities in the United States, thus representing a significant range extension and a new state record. Distribution of this species is now extended approximately 400 km southwest of Glacier National Park. Specimens have been collected at: IDAHO (NEW STATE RECORD), Clearwater County, Isabella Creek, 43 km NNE of Headquarters, T41N R7E s.31 NESW, 518 m, 21.IX.1984 (1) and 24.VII.1985 (2), P. J. Johnson; and Idaho County, Packer Meadow, 2.4 km E. Lolo Pass, 1585 m, T38N R15E s.15, 25.V.1986 (2) and 30.V.1986 (2), P. J. Johnson and J. R. LaBonte. A single agyrtid larva was collected at Isabella Creek with two adults on 24.VII.1985 and is assumed to be this species. Adult specimens have been deposited in the W. F. Barr Entomological Museum, University of Idaho, and my personal collection. The larva is with A. F. Newton, Jr., Field Museum of Natural History, Chicago.

Isabella Creek is in the Clearwater mountains, a western extension of the Bitterroot Range, at a site dominated by western red cedar (*Thuja plicata* Donn.). Grand fir (*Abies grandis* (Dougl.) Forbes) and western white pine (*Pinus monticola* Dougl.) dominate the steep surrounding slopes. Specimens collected were found under moss coated cobbles on silty-sand in a highwater channel which is lateral and parallel to the main stream channel. The site is densely shaded by red alder (*Alnus rubra* Bong.), thimbleberry (*Rubus parviflorus* Nutt.), devil's club (*Oplopanax horridum* (Smith) Miq.), and ladyfern (*Athyrium filix-femina* (L.) Roth), and is cool and humid on warm summer days. Isabella Creek is a large second order stream with a moderate gradient initiating in subalpine elevations, but largely flowing through dense mesophytic mixed conifer forest on steep mountainous terrain. The water is cold and undoubtedly assists in maintaining a cool temperature regime in the adjacent vegetation which produces heavy, day-long shade.

Packer meadow is a natural, wet, subalpine frost pocket surrounded by subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.), lodgepole pine (*Pinus contorta* Dougl.) and Englemann spruce (*Picea englemannii* Parry) forest, near the crest of the Bitterroot Range. The meadow flora is composed largely of Camas lily (*Camassia quamash* (Pursh) Greene), bistort (*Polygonum bistortoides* Pursh) and sedges (*Carex* spp.); with occasional shrubs of bog birch (*Betula glandulosa* Michx.) and Labrador-tea (*Ledum glandulosum* Nutt.). Winter snow packs are often deep (3–4 m), with final snowmelt usually complete by mid-June, but soil temperatures are cold-to-the-touch until July. A meandering stream and small island-like stands of mature subalpine fir and Englemann spruce characterize the meadow, with these trees providing windfall

logs and limbs under which all specimens were collected on fine to moderately coarse, decomposed organic matter.

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Flume Collecting: A Rediscovered Insect Collecting Method, with Notes on Insect Extracting Techniques

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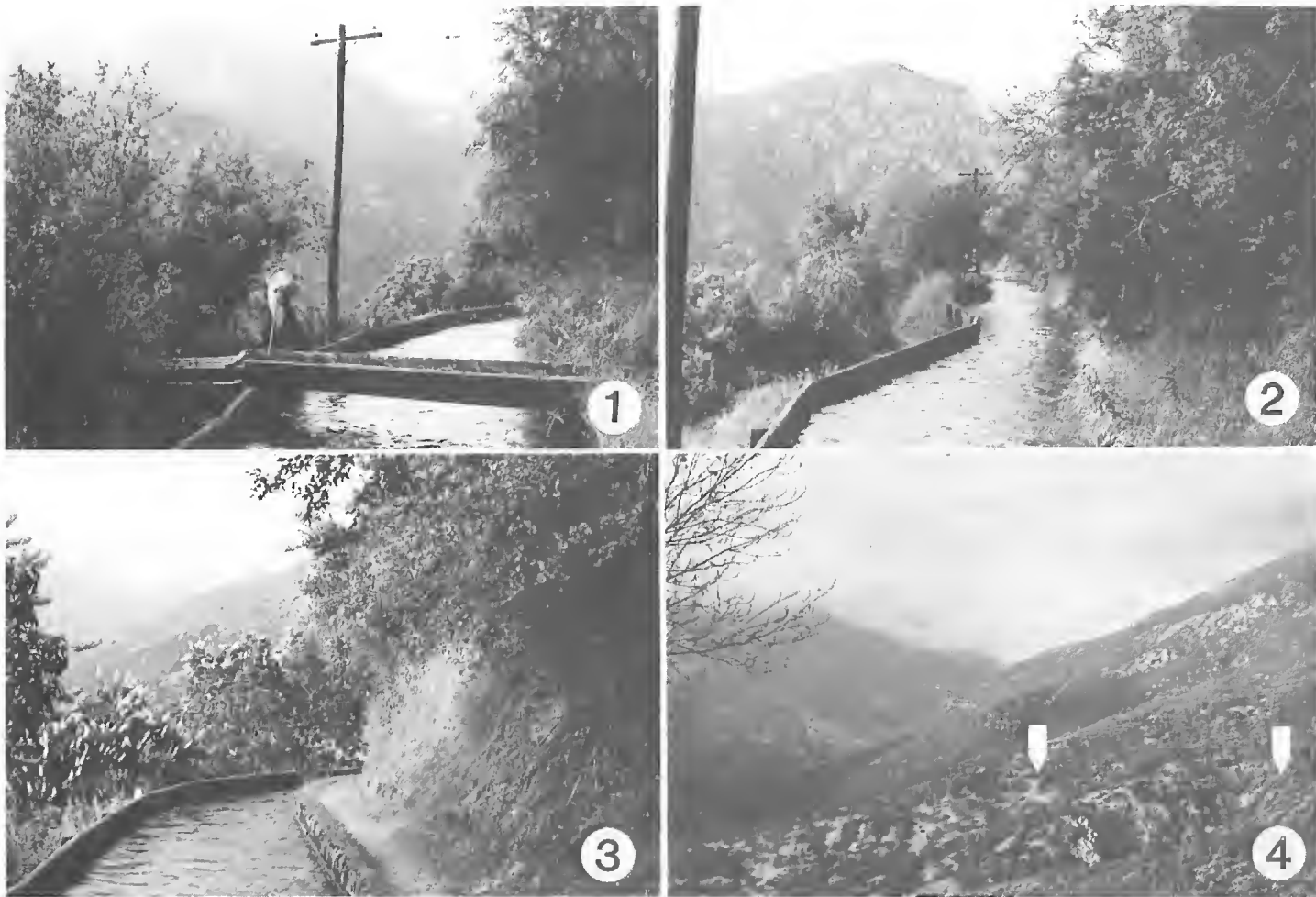
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Abstract.—The use of flumes (i.e., a channel for the transportation of water) as a collecting source is discussed. A five mile long flume near Ash Mountain, Sequoia National Park, Tulare County, California is described, along with techniques used to collect and extract insects from flume debris. This flume, utilizing the various collecting techniques described, has produced an astonishing diversity and abundance of insects. In the 1930's and 1940's, much of the material from this site was cryptically labeled and thus type locations and basic locality data were misleading and difficult to pinpoint. Notes on such labels are presented.

Flumes, as a collecting source, were heavily utilized in the 1930's by such collectors as Dr. E. C. Van Dyke, Mr. F. T. Scott and Mr. R. S. Wagner. Their work greatly added to the knowledge of California species of Coleoptera, many of which were new or rare species collected from flumes. The latter two researchers collected almost exclusively from flumes in the Sierra Nevada foothills. The function of these flumes is water diversion from rivers and streams for the generation of hydroelectric power and public uses. These flumes act as a giant moving pit trap, catching insects that either blunder in or are drawn to a water source.

Two basic techniques were used to collect these insects: (1) watching the water surface as material approached and netting what was seen and (2) pulling out and sorting through debris that had accumulated at the end of the flume prior to the water being run through a powerplant or into a holding pond. The first technique was time consuming, limited to those insects that fell into the flume that day, and yielded mostly larger species. The second technique yielded much better results (i.e., greater diversity and abundance), but required the use of some sort of debris collection device.

All three of the previously mentioned collectors made use of a flume located in Tulare County, California on the Middle Fork of the Kaweah River, initiating at Potwisha Campground in Sequoia National Park and terminating on the hillside south of the Ash Mountain Park Headquarters. This flume (Figures 1-4) flows through approximately five miles of Chamise Chaparral and Foothill Woodland plant communities at an elevation of 660 m (2200 ft.) and empties into a large (20 m × 60 m) forebay (Figure 5) whose teardrop shape and exposure to prevailing breezes promotes clockwise surface currents. A wooden boom (10 cm × 15 cm × 3.5 m) projecting into these currents traps and accumulates the floating debris



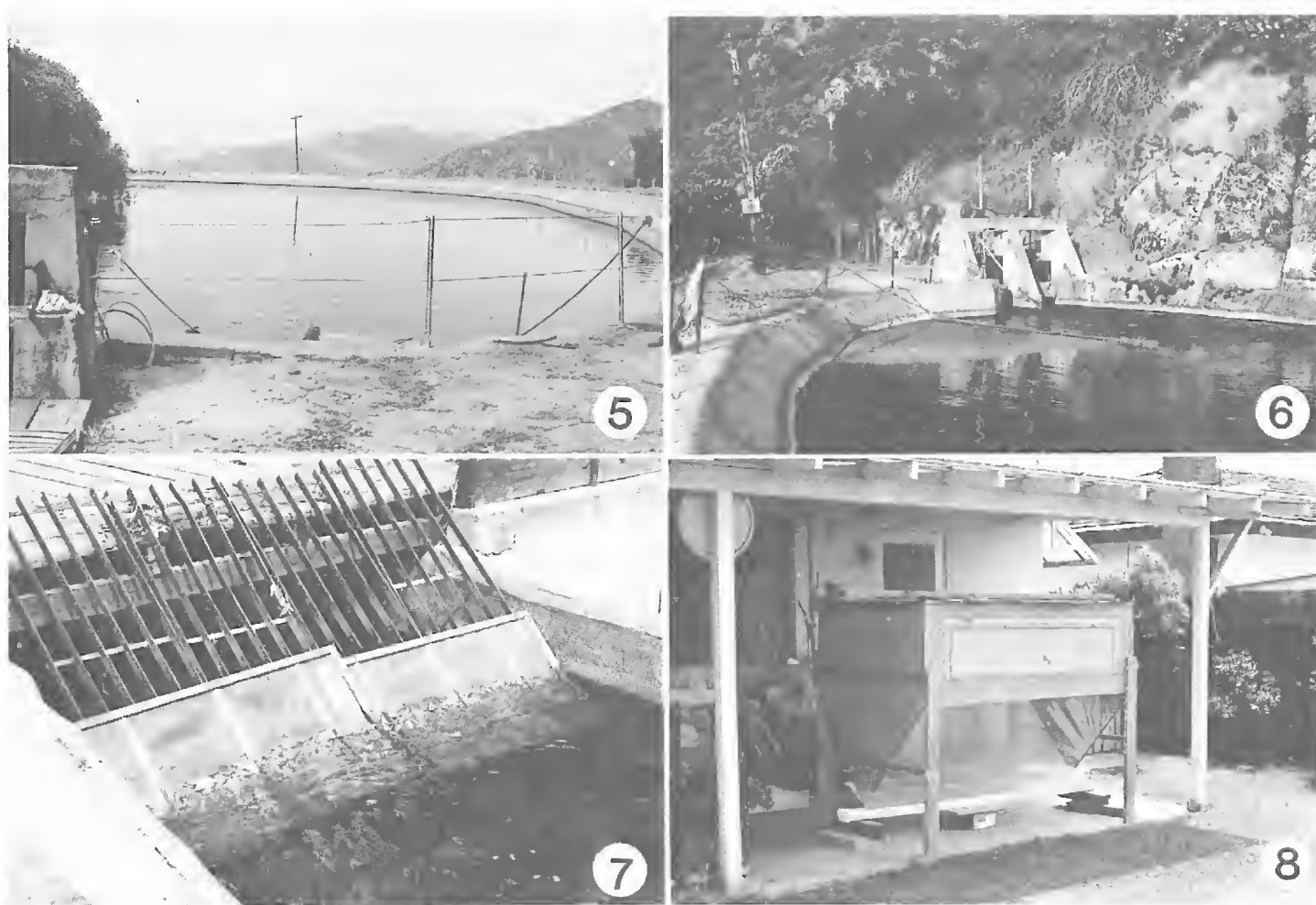
Figures 1–4. Figs. 1–3. Typical sections of the Ash Mountain. Kaweah Powerhouse #3 flume, illustrating adjacent and overhanging vegetation and rugged terrain of Sequoia National Park (June). Fig. 4. The flume, denoted by arrows, curves along hillsides of Chamise Chaparral and Foothill Woodland habitats at 660 m (2200 ft.).

(boom-trap method) (Figure 6). The researchers would scoop out the debris and spread it over the ground for examination.

The Ash Mountain flume is unique in comparison to others in the Kaweah area and throughout California. In addition to having a built-in debris accumulating feature (i.e., the boom); the edge of the flume throughout most of its length is at ground level. This greatly enhances the chance of insects falling into it—in comparison to flumes that are supported by trestlework 1 to 7 m above the ground. The native flora adjacent to and overhanging the flume's edge is another factor contributing to the great diversity and abundance of insects collected.

The early researchers labeled the material collected at the Ash Mountain flume in a variety of ways. Because of this, a number of type localities have been difficult to pinpoint. Examples of such labels are: near Postwisha, Sequoia National Park; Sequoia National Park, 500–2000 ft., Potwisha (Van Dyke); Kaweah; Sequoia National Park, 2000–3000 ft. (Scott); K.P.H.R.; Kaweah Powerhouse Reservoir; Kaweah (Wagner).

Some examples of type material collected from this site include: Coleoptera, Cerambycidae: *Ergates pauper* Linsley, *Paranoplium gracile laticolle* (Linsley), *Aneflomorpha californica* Linsley = *A. parowana* Casey, *Neoclytus resplendens* Linsley, *Leptura sequoiae* (Hopping); Scarabaeidae: *Pleocoma tularensis* Leach,



Figures 5–8. Fig. 5. Overview of forebay from beside the entrance of the flume. Floating debris, having floated down the flume, can be seen on the forebay's surface. Fig. 6. View of forebay towards the entrance of the flume. The wooden boom, floating on the forebay's surface and extending from its edge, traps and accumulates debris which has floated down the five mile flume. Fig. 7. Window screen panels are inserted into the flume to trap and accumulate flume debris before it enters the forebay. Fig. 8. Berlese-photoattractive trap used to extract insects from the flume debris.

Coenonycha fusca McClay; Buprestidae: *Polystoma tularensis* Chamberlin, *Polystoma crypta* Barr, *Acmaeodera simulata* Van Dyke; Elateridae: *Euthysanius cribicollis* Van Dyke; Diptera, Acroceridae: *Ocnaea sequoiae* Sabrosky; Hymenoptera, Pompilidae: *Allaporus amabilis* Evans = *Pompilus (Aporus) smithianus* Cameron. The above information is presented so that researchers will have a clearer understanding of how and where such material was collected.

Beginning in 1982 a renewed effort was made to utilize the Ash Mountain flume facility by the authors, Dr. D. J. Burdick (California State University Fresno) and Mr. W. F. Peregrin (Fresno County Agricultural Commissioner's Office, Fresno, California). Initial efforts using the old technique of retrieving accumulated debris (mostly leaves) at the forebay yielded a great diversity and abundance of species. Insects are easily observed and collected from the drying debris as they dry their wings and/or move among the leaves. Dead insects are also found while sorting through the debris, commonly stuck to wet leaves.

The amount of debris collected by the flume varied with the season. The greatest accumulation of debris correlated with fall leaf drop. Two researchers during a typical 8 to 10 hour period can sort approximately 60 to 75 square meters (200 to 250

square feet) of debris, 2.5 to 5 cm (one to two inches) in depth. Because the flume is continually accumulating debris both throughout the day and the night, the day's collecting was usually terminated only by the lack of visibility (i.e., sunlight). Often, all of the debris which had accumulated behind the boom could not be sorted in a single day. Because this unexamined debris represented material which had floated down the flume that day (thus containing live insects) and was known to contain a good diversity and abundance of late-day and crepuscular species, the debris was sealed in garbage bags and transported to the laboratory for further treatment (see discussion under Insect Extraction Techniques).

While the boom trap method was successful in 1982 and early 1983, a large sandbar, which had accumulated over a number of years, began changing surface currents reducing debris accumulation behind the boom. As a result, the debris was patchily distributed over the forebay, reducing its availability. In order to collect the debris before it entered the forebay, window screen panels were inserted into the flume against an existing metal grating at its entrance into the forebay (Figure 7). The debris was removed from the screens and examined about every 30 minutes. During an 8 to 10 hour period, two researchers could collect and sort approximately 24 square meters (80 square feet) of debris. While some small (<1 mm) insects probably passed through, many were stuck to leaves on the screens. The small amount of debris examined (versus the boom trap method) improved collecting efficiency. Also, the insects collected on the screens were very active and easily detected.

The screens gave excellent results for material-of-the-day (including activity period information), but the accumulated debris behind the boom covered several days and nights, and in general, held a much greater abundance and diversity (including nocturnal species). At times, screening was not practical due to large amounts of leaves and/or algae which blocked flow through the screens. Though the sandbar was removed in 1985, the benefits of using screens for collecting material-of-the-day precluded abandoning this technique to return strictly to the boom trap method.

Another problem was encountered in the late Summer and early Fall of 1985. Due to a lighter than normal winter snowpack in the Sierras and a lack of substantial Spring rains, water levels in the Kaweah River dropped below diversion levels. While there had been temporary shutdowns in prior years for flume maintenance and sand removal, this was the most extensive dry period encountered by the authors, lasting from August through mid November.

INSECT EXTRACTION TECHNIQUES

1) Glass-topped Sleeve Cage.

Approximately 10 to 15 cm (4 to 6 inches) of debris was placed in each of two to three glass topped sleeve cages ($0.6 \times 0.6 \times 1$ m). An oscillating fan was used to move air through the sleeve cage(s) to dry the debris. A white light (60 watt bulb) was positioned on the top of each cage to attract insects. The cages were checked periodically for two days though insect activity rapidly declined after one day. Insects were removed with an aspirator or by hand. Cryptic species were commonly found on the bottom of the cage or among the debris. This technique was productive though limited by the amount of debris that could be placed in the sleeve cage(s). Also, the debris was difficult to dry and immediately started to decay.

2) Enclosed Malaise Trap and Tent trap.

To increase the amount of debris that could be handled at one time, an enclosed Malaise trap and tent trap were utilized. The enclosed Malaise trap ($2 \times 1 \times 1.8$ m) was set up outdoors. The bagged debris and/or debris that was first examined in the sleeve cages was placed inside the sealed trap the morning following the collecting trip. The warmth and drying effect of the sun immediately resulted in insect activity. Insects readily crawled up the sides of the trap, passed through an inverted funnel, and fell into an alcohol solution in the collecting head. The alcohol solution eliminated any damage to specimens. This technique was more productive and less time consuming than the sleeve cages. A major drawback was that insects which did not climb up the Malaise trap were not collected. Also, spiders occasionally spun webs at the entrance to the collecting head, but because of the great numbers of insects very few were eaten or deterred from entering the head.

The tent trap was devised to be used in the laboratory. This trap was a two-man tent ($2 \times 1.2 \times 1$ m) to which an alcohol-collecting head was attached by a fine mesh insect net. The debris was placed inside the tent on a 2.5 cm (one inch) chicken wire screen (1.2×1.8 m (4×6 ft.)) that sat on blocks 10 cm (4 inches) above the floor of the tent. An oscillating fan was run outside the tent's mesh door for about 6 to 12 hours. The screen aided the drying of the debris and also burrowing insects fell from the screen to the floor of the tent where they could be collected. Very little insect activity occurred when the fan was on; though once off, increased immediately. This technique was more profitable than the two previous techniques (especially because non-climbing insects were also collected). Again, minor spider problems occurred with the collecting head.

3) Berlese-photoattractive Trap (Figure 8).

This trap ($2 \times 1.2 \times 1.5$ m ($6 \times 4 \times 5$ ft.)) was the most productive and time efficient insect extracting method, utilizing the collecting principles of both a large Berlese funnel trap and a photoattractive trap. It consisted of a black plastic top, particle board sides with fine mesh windows, two flat internal debris trays (0.9×1.5 m (3×5 ft.)) made of window screening stacked 15 cm (6 inches) apart, and clear plastic lower sides which funnel downward into a plastic rain gutter filled with 5 to 7.5 cm (2 to 3 inches) of super saturated saltwater solution or ethylene glycol.

Upon returning home from the day's collecting trip, about 5 to 10 cm (2 to 4 inches) of debris was placed on each tray. A light and fan were run outside the trap's windows until early morning. Light seeking insects were immediately attracted to the mesh windows and clear plastic funnel. Those which burrowed into or through the debris eventually fell off the screens into the rain gutter. With the coming of daylight, the black plastic top readily heated the inside of the trap, thus forcing insects downward. The windows were occasionally fogged with a quick knockdown pyrethroid. The debris was left in the trap for about one week by which time most insects had fallen into the rain gutter. One last heavy fogging killed any remaining survivors. The debris trays were removed and the inside of the trap was washed with water to remove any clinging insects. The resulting rain gutter full of insects was then screened and the insects preserved for future sorting.

Though much of our material is still unmounted, detailed examination of some groups by authorities have revealed many new species, male/female associations, range extensions, and rarely collected species (not to mention the great diversity and abundance of the more common species). Most of this material has been deposited in

the California Academy of Sciences, San Francisco; California Collection of Arthropods, California Department of Food and Agriculture, Sacramento; and the Canadian National Collection, Ottawa.

Examples of species diversity for some of the families reviewed are (# of genera, # of species): Coleoptera, Buprestidae (11, 40), Cerambycidae (43, 61), Chrysomelidae (47, 57); Hymenoptera, Chalcididae (12, 30), Chrysididae (9, 23), Dryinidae (12, 23), Eumenidae (9, 18), Mutillidae (9, 21), Pompilidae (17, 41), Sapygidae (1, 5), Sphecidae (22, 40); Diptera, Acroceridae (6, 12). Examples of some of the rare families encountered are: Coleoptera, Amphizoidae (1, 1), Cupedidae (1, 1); Hymenoptera, Chalcedectidae (1, 2), Cimbicidae (1, 1), Eucharitidae (1, 1), Evaniidae (1, 1), Leucospididae (1, 1), Orussidae (1, 1), Sierolomorphidae (1, 1), Stephanidae (1, 2); Neuroptera, Mantispidae (3, 3).

As illustrated by this preliminary data, when the appropriate techniques are utilized, flume collecting can be an extremely successful method; giving the collector access to rare species that would be otherwise unavailable. A great deal of seasonality and daily activity information can also be gathered using these techniques. By the publication of this paper we hope to provide an understanding of where and how the Ash Mountain flume specimens have been collected and also to encourage the use of flumes as a collecting source.

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New Distribution Records for Some Nearctic Dryinid Wasps, with a Species List from a Flume in Tulare County, California (Hymenoptera: Dryinidae)

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Abstract.—A species list, collection periods, and distributional notes (including 12 new California-state records) for 23 species of dryinid wasps collected from a hydroelectric flume in Tulare County, California are presented. Additionally, new state records for *Gonatopus mimoides* in California and *G. cyphonotus* in Minnesota are presented. *G. pallidiceps* and *G. portalensis* are each reported from a third locality in California. Twelve genera and 34 species of dryinid wasps are known from California.

Recently, the world fauna of the wasp family Dryinidae was revised and distributional information was updated for each species (Olmi, 1984). Prior to this revision, distribution information for the Dryinidae in America north of Mexico was available in Krombein (1979).

Presented herein are the results of collecting dryinid wasps from a hydroelectric flume located at Kaweah Powerhouse #3, Ash Mountain, Tulare Co, California. Included are a list of 23 species collected from this site, collection periods, the number of specimens collected thus indicating how common or rare each species is, and distributional comments (including 12 new California-state records and many county records) for each species (see Table 1 and text).

The flume winds through approximately five miles of Foothill Woodland and Chamise Chaparral habitats at an elevation of 660 m (2200 ft) (Halstead and Haines, in prep.). A total of 62 flume collecting trips (approximately 1100 man hours of collecting) were conducted from 1982 to 1985. Trips were made throughout the calendar year though most were conducted between May and October. More trips were made and man hours spent in 1982 than in other years.

Additionally, new state records of *Gonatopus cyphonotus* Bradley in Minnesota and *G. mimoides* (Perkins) in California are presented. Also, *G. pallidiceps* (Perkins) and *G. portalensis* Olmi are each reported from a third locality in California.

Anteon funestum.—Widely distributed throughout North America. The flume specimens represent a new state record for California and the westernmost record for the species. The nearest record is approximately 1000 km (600 mi) to the southeast in Tucson, Arizona.

Table 1. Species list, collection period(s) and number of dryinid wasps collected from the Kaweah Powerhouse #3 flume, Ash Mountain, Tulare County, California in 1982–85. Species are listed alphabetically.

| Scientific Name | Months Collected | No. Specimens Collected |
|---|------------------|-------------------------|
| <i>Anteon funestum</i> (Perkins)* | IV, IX | 2 |
| <i>A. popenoei</i> (Ashmead)* | VI | 2 |
| <i>A. rugosiceps</i> Kieffer | VI | 2 |
| <i>Aphelopus albopictus</i> Ashmead | V–VI | 13 |
| <i>A. varicornis</i> Brues | III–V | 6 |
| <i>Apterodryinus californicus</i> (Ash.) | III–V | 10 |
| <i>A. torvus</i> Perkins* | VII | 1 |
| <i>Bocchus flavipes</i> Kieffer | VI–VII | 29 |
| <i>B. hainesi</i> n. sp. ^{1*} | VI–VIII | 20 |
| <i>Crovettia theliae</i> (Gahan) | IV | 1 |
| <i>Deinodryinus atriventris</i> (Cres.)* | VI–VII | 14 |
| <i>Dryinus halsteadi</i> n. sp. ^{1*} | IV–VIII | 10 |
| <i>Esagonatopus niger</i> (Fenton)* | VII–VIII | 4 |
| <i>Gonatopus agropyri</i> Fenton* | VII | 2 |
| <i>G. herbarum</i> (Perkins) | VI–VII, IX | 10 |
| <i>G. mayori</i> Olmi | VI | 1 |
| <i>G. paraleptias</i> (Perkins) | VI–VII, IX | 15 |
| <i>Lonchodryinus bakeri</i> (Kieffer) | VII–IX | 7 |
| <i>L. flavus</i> Olmi* | VI | 1 |
| <i>L. masneri</i> (Olmi)* | VIII | 2 |
| <i>Pseudogonatopus sjoestedti</i> (Kief.)* | V | 1 |
| <i>Tetradontochelys peculiaris</i> Brues | VI–VII | 3 |
| <i>T. unicus</i> (Perkins)* | IX | 1 |

*Denotes a new state record for California.

¹Olmi, in prep.

Anteon popenoei.—Known from the central and eastern United States and Canada. The flume specimens represent a new state record for California and the westernmost record for the species. The nearest locality record is approximately 1700 km (1000 mi) to the northeast in Alberta, Canada or to the southeast in Texas.

Anteon rugosiceps.—The few locality records are from southeastern Canada, the western United States, and Mexico. The flume specimens represent a new county record, the fourth locality record for California, and the second record for the Sierra Nevada Mountain Range. Other California counties include Kern, Santa Clara, and Siskiyou.

Aphelopus albopictus.—Widely distributed in North America. Recorded from four localities in California but the flume specimens represent a new county record and the second and southernmost record for the Sierra Nevada. The other Sierrian record is from Somerset, El Dorado Co. Other California records (Needles, Alameda, and Chocolate Mts.) are coastal or southern desert.

Aphelopus varicornis.—Widely distributed in North America. Several records are noted for California but the flume specimens represent a new county record and the fifth and southernmost record from the Sierra Nevada. Other Sierrian records include Alta, Placer Co; Summerset, El Dorado Co; Strawberry, Alpine Co; and Sierra City, Sierra Co. Other California counties include Monterey, Ventura, Alpine, San Luis Obispo, and Del Norte.

Apterodryinus californicus.—Known from Los Angeles and Marsh Or. Spr. in

California and Prescott, Arizona. The flume specimens represent a new county record and the third locality record for California.

Apterodryinus torvus.—Known from Arizona, Texas, and New York. The flume specimens represent a new state record for California and the westernmost locality record for the species. The nearest locality record is approximately 1200 km (700 mi) to the southeast in Nogales, Arizona.

Bocchus flavipes.—Known from Plumas Co, California and Ormsby Co, Nevada. The flume specimens represent a new county record, the second locality record for California, and the southernmost record for the species.

Crovettia theliae.—Known from British Columbia and Ontario, Canada; New York, Washington D.C., Michigan, Louisiana, Arizona, and California. The flume specimen represents a new county record and the third locality record for California. Other California localities include Glenville, Kern Co and Ione, Amador Co.

Deinodryinus atriventris.—Widely distributed in North America. The flume specimens represent a new county record and the third and northernmost locality record for California. Other California counties include San Bernardino and San Diego.

Esagonatopus niger.—Known from Ontario Canada, North Dakota, Iowa, Kentucky, Pennsylvania, and Mexico. The flume specimens represent a new state record for California. The nearest locality records are approximately 2200 km (2000 mi) to the northeast in Ames, Iowa and 4300 km (2600 mi) to the southeast in Cuernavaca, Mexico.

Gonatopus agropyrus.—Known from southeastern Canada, Texas, Wisconsin, Kentucky, Iowa, Georgia, New York, and Arizona. The flume specimens represent a new state record for California. The nearest locality record is approximately 1200 km (700 mi) to the southeast in Sunnyside, Arizona.

Gonatopus cyphonotus.—Known from Florida and throughout southern Canada. Two females from Cushing, Morrison County, Minnesota (VII-24-1983, P. S. Simpson and J. A. Halstead, sweeping grassy vegetation near marsh) represent a new state record for Minnesota.

Gonatopus herbarum.—Known from Arizona, Texas, and three California localities (Summerset, El Dorado Co; San Bernardino Co; and Apple Valley, San Bernardino Co). The flume specimens represent a new county record and the fourth locality record for California, coming from the central region of the state in the southern Sierra Nevada.

Gonatopus mayori.—The flume specimen represents a new country record. Olmi (1984) incorrectly listed the type locality and distribution as El Mayor (California, U.S.A.). A review of the holotype, deposited in the California Academy of Sciences, San Francisco, shows the type locality to be "El Mayor, L. California." The distribution should therefore read, "Nearctic region: U.S.A.: Ash Mtn. (Tulare County, California) MEXICO: El Mayor (Baja California Norte)."

Gonatopus mimoides.—Known from Utah, Arizona and Texas. Five females and one male from 3 mi SE Madera, Madera Co, California (VII-29-1985, J. A. Halstead, sweeping grass in pistachio orchard) represents a new state record for California and a westward range extension of approximately 1300 km (800 mi).

Gonatopus pallidiceps.—Known from Nova Scotia and British Columbia Canada, California, North Dakota, Kansas, Tennessee, and Florida. One female from 3 mi SE Madera, Madera Co, California (VII-29-1985, J. A. Halstead, sweeping grass in

pistachio orchard) represents a new county record and the third locality record for California. The two other California records are from Alameda Co.

Gonatopus paraleptias.—Known from Arizona, Wyoming, and five localities in California. The flume specimens represent a new county record and the first record for the Sierra Nevada. Other California counties include Riverside, Los Angeles, Santa Clara, and Marin.

Gonatopus portalensis.—Recently described from Sagehen Creek, Nevada Co and Omira, Lassen Co, California; Portal, Arizona; Ward, Colorado; and Kerrville, Texas (Olmi 1984). Three females from Hopkins Well, 18 miles West of Blythe, Riverside County, California (X-4-1984, N. J. Smith) represent a new county record, and the southernmost and the third locality record for California.

Lonchodryinus bakeri.—Widely distributed in North America. The flume specimens represent a new county record and the third locality record for California. Also, they represent the first record from the Sierra Nevada. Other California counties include Siskiyou and Del Norte.

Lonchodryinus flavus.—Recently described from throughout Canada, Michigan, Georgia, Maryland, New Jersey, New York, and New Hampshire (Olmi 1984). The flume specimen represents a new state record for California. The nearest locality record is approximately 2333 km (1400 mi) to the northeast in Alberta, Canada.

Lonchodryinus masneri.—Recently described from two localities near Portal, Arizona and Culberson Co, Texas (Olmi 1984). The flume specimens represent a new state record for California and a northwestern range extension of approximately 1200 km (700 mi). Also, one female was collected from a Gypsy Moth Trap at Clough's Cave, Tulare Co, California (I-XII-1985, R. D. Haines).

Pseudogonatopus sjoestedti.—Known from Texas, Ohio, Kentucky, North Carolina, and New York. The flume specimens represent a new state record for California and the westernmost locality record for the species. The nearest locality record is approximately 1700 km (1000 mi) to the southeast in Texas.

Tetrodontochelys peculiaris.—Known from Manitoba and Ontario Canada, Arizona, Texas, Iowa, South Carolina, and one locality in California (Stanford University, Marin Co). The flume specimens represent a new county record and the second locality record for California.

Tetrodontochelys unicus.—Known from throughout southern Canada, Washington, Idaho, Arizona, Texas, North Dakota, South Dakota, and Minnesota. The flume specimens represent a new state record for California. The nearest locality record is approximately 1200 km (700 mi) to the southeast in Nogales, Arizona.

In summary, this data improves the distribution information for several species, depicts their habitat and seasonality, indicates how common or rare each species is (flume collectability), and shows that a large diversity of species occur at the Kaweah flume location.

In all, 12 genera and 23 species of dryinid wasps were collected from the flume. This material contains 3 genera and 12 species (including 2 new species) which were not previously recorded from California. Additionally, *G. mimoides* is recorded for the first time in California. Olmi (1984) listed 9 genera and 21 species from California. The California fauna is now known to contain 12 genera and 34 species. It's astonishing to note that approximately 68 percent of the species of California's dryinid wasp fauna has been collected at a single locality, the Kaweah flume.

As denoted in Table 1, most adult wasp activity occurred at the flume in June and July though various species were collected between March and October. Despite the

many collecting trips and man-hours of collecting, most species were rarely collected. We feel that without the use of the great collecting ability of the flume and our intense collecting effort, many species would have gone undetected. Also, we feel that flumes collect a better representation of an area's fauna, at least at the Kaweah locality, than do other collecting techniques such as Malaise traps and screen sweeping.

In addition to improving the knowledge of the Nearctic Dryinidae and especially that of California, this paper illustrates that flumes can be an important collecting source and we hope that it encourages other researchers to utilize them.

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**A New Species of *Mordellistena* from North America
(Coleoptera: Mordellidae)**

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Abstract.—A new species of *Mordellistena* Costa, one of the few very small ones found in North America north of Mexico, *Mordellistena stephani* Downie, is described and named.

While working over a box of mordellids for Karl Stephan, a series of specimens that was apparently new was observed. This new species is described below.

***Mordellistena stephani* Downie, NEW SPECIES**

Length to tip of anal style 1.5 mm; body shape typical of the genus; body black, head and pronotum reddish-brown to yellowish; antennae yellow, becoming darker distally; pronotum with the basal third or so sometimes clouded with piceous; elytra with two transverse bars of grayish pubescence, one half way between base and middle and the other half way between middle and apex; venter black with the last two abdominal sternites and the style reddish yellow; legs testaceous with the metafemora darker; pubescence, except for that on the elytral bars, fine, indistinct, the venter and legs with longer, yellow, rather dense pubescence.

Discussion.—In this species the ridges of the hind legs are poorly developed. In those specimens in which the ridges are most distinct, there are two ridges on the metatibiae, two on the first metatarsal segment and one on the second. These ridges would cause this species to key to item 17, page 70 of Liljeblad's (1945) key to the genus. Four species key out here, all larger than this species and differing in overall habitus. Neither Khalaf, 1971a, 1971b, nor Ray, 1937, 1944, 1946a, 1946b, 1946c, 1947, contain material relevant to this species. In all specimens, the posterior, transverse pubescent band is distinct, whereas the anterior one is variable in the amount of development.

Specimens examined 14. Holotype, Latimer Co., OK., 5 miles west Red Oak, May 1981, K. Stephan, deposited in the U.S. National Museum; paratypes: OK., Latimer Co., Nov. 1983; 2 specimens, OK., Latimer Co., 5 miles west Red Oak, May 1981, K. Stephan; 3 specimens, OK., Latimer Co., May 1982, K. Stephan; 4 specimens, OK., Latimer Co., May 1983, K. Stephan; 1 specimen, OK., Latimer Co., June 1983; 2 specimens, OK., Latimer Co., July 1983; 1 specimen, GA., Lumpkin Co., 18 miles northwest Dahlonega, July 1982, R. H. Turnbow. The paratypes are in the collection of the Florida Collection of Arthropods, the California Academy of Sciences, and the collections of N. M. Downie, K. Stephan, and R. H. Turnbow, Jr.

Little is known about the habits of this species. The Oklahoma specimens were taken sweeping low vegetation in an upland forest.

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