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**TRANSFER OF THE TAIWANESE *PSEUDOPYROCHROA*
UMENOI AND THE JAPANESE *P. AMAMIANA* TO
PSEUDODENDROIDES (COLEOPTERA: PYROCHROIDAE:
PYROCHROINAE)**

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Abstract.—On the basis of salient characters, particularly those associated with the head, eighth abdominal sternite and genitalia of the male, both *Pseudopyrochroa umenoi* Kôno of Taiwan, and *Pseudopyrochroa amamiana* Nakane of Amami-Oshima Island, Japan are transferred from *Pseudopyrochroa* to *Pseudodendroides* where they are hypothesized to represent species closely related to the Japanese *Pseudodendroides niponensis* (Lewis).

Key Words.—Insecta, Coleoptera, Pyrochroidae, *Pseudopyrochroa*, *Pseudodendroides*, generic transfers, phylogeny, confocal microscopy, Japan, Taiwan.

In an effort to redefine *Pseudopyrochroa* Pic (1906) as a monophyletic taxon, part of a larger project on the taxonomy of the genus, several taxonomic changes have become necessary. The body of this paper proposes two changes involving *Pseudopyrochroa* and another pyrochroine genus, *Pseudodendroides* Blair (1914).

Pseudopyrochroa was proposed as a subgenus of *Pyrochroa* Geoffroy for several Southeast Asian pyrochroids previously assigned to the European *Pyrochroa*. *Pseudopyrochroa* was said to differ by having a smaller head, compound eyes, and reduced genae. But even Pic applied the name inconsistently, and the generic use of *Pseudopyrochroa* did not begin to stabilize until Pic (1913) briefly elaborated on his misplacement of several *Pseudopyrochroa* species that he had originally attributed to the circumboreal genus *Schizotus* Newman.

Although the largest genus in the family with approximately 70 species names attributed to it, *Pseudopyrochroa* is among the least known of all pyrochroine genera from both taxonomic and ecological perspectives. Species richness is greatest along the Pacific coast of the Asian continental plate and forested inland montane regions. The only previous attempt to synthesize information on *Pseudopyrochroa* came in the form of Blair's (1914) provisional comments and key. This effort was, according to Blair (1914:318), "intended merely as a temporary measure, in the hope of stimulating further study of the genus. . . ."

Pseudodendroides was proposed for two Indian and two Japanese species previously assigned to *Dendroides* Latreille. Two additional species were added by Pic from China (1938) and the Himalayan regions of Sikkim and Tibet (1955). At the time of its description, *Pseudodendroides* was said by Blair (1914: 314) to differ from *Pseudopyrochroa*, "by the large eyes, approximate above in the male." This is certainly the case in males of the Japanese *P. niponensis* (Lewis), the type species of *Pseudodendroides*. However, this derived character state appears to be homoplasious, having arisen independently several times in both pyrochroine and pediline pyrochroids (Young, unpublished observations), and *Pseudodendroides* as characterized by Blair is, at best, paraphyletic.

Depositories, Procedures, and Abbreviations.—Taxonomic material for this

study came from my personal collection (DYCC), and material borrowed from the collection of Darren Pollock, Winnipeg (DAPC), the Florida State Collection of Arthropods, Gainesville (FSCA), the Naturhistorisches Museum Wien, Wien (NHMV), the Muséum National d'Histoire Naturelle, Paris (PMNH), the Taiwan Agricultural Research Institute (TARI), and the Museum für Naturkunde der Humboldt-Universität, Berlin (ZMHB). The holotype male of *Pseudopyrochroa umenoi* Kôno was also borrowed from the Hokkaido University, Sapporo, Japan (HUSC), as was the holotype female of *Pseudodendroides uraiana* Kôno. Type and other pyrochroid material in The Natural History Museum, London (BMNH) was studied on site.

MATERIALS AND METHODS

As I discuss below, the presence, number and configuration of cranial pits (Young 1975) in several genera of male pyrochroines offer important characters for hypothesizing relationships among genera. Unfortunately, these three-dimensionally complex structures are virtually impossible to draw and for many species, only the type or small type series is known.

Using scanning electron microscopy (SEM) and photomicrography to capture and illustrate features of insect gross anatomy and exoskeletal ultrastructure has become a well established research tool. However, SEM techniques have several unfortunate drawbacks, usually including the necessity of coating the specimen with a thin layer of a heavy metal to prevent electron charging, exposure of the specimen to a high vacuum environment, and the possible need to trim or dissect the specimen to fit the sample holder.

As SEM proved unfeasible for this and related studies, I investigated techniques of laser-scanning confocal microscopy. Standard confocal techniques such as a 3D z-series reconstruction or projection were unsatisfactory because exoskeletal opacity inhibited laser penetration and the full vertical range of the cranial complex could not be imaged. Finally, in a nod to well known SEM "stereo-pair" techniques, images of exoskeletal autofluorescence were collected from a straight vertical view and a tilted view.

A low-magnification lens for the confocal microscope (3.5 \times) was selected. Its wide field of view permitted imaging of the entire dorsoanterior region of the head, including all of the cranial apparatus, without resorting to making montages of micrographs. The large depth of field (optical section thickness) of the lens allowed the protrusions and concavities to be imaged in a single image frame. Finally, the large working distance of the lens made it possible to image intact beetles, without resorting to perturbation of any kind. Not only could the specimens remain on their pins, point, or card mounts, but it was not even necessary to remove any of the specimen labels.

The 488 nm line of the Kr/Ar laser was utilized to excite the autofluorescence of the exoskeletal material. The standard fluorescein imaging cube was used for detection of the emitted signal.

Preparation of the specimen for imaging was quickly accomplished by inserting the mounting pin into a 7.6 \times 7.6 \times 1.9 cm (3" \times 3" \times 3/4") foam block. This entire assembly was able to be placed under the microscope's objective lens for imaging. After a straight vertical, "head-on" image was taken, fiducial marks were made on the microscope's imaging screen using a felt-tipped marker. Three

standard microscope slides were then placed under one corner of the foam block, thereby effectively tilting the block (and specimen) by approximately 5–7°.

After re-aligning the “live” image with the fiducial marks on the screen, a second image was obtained. When printed side-by-side, these two images form a stereo pair (Figs. 7 and 8). It should be noted that to create the stereo effect, it is generally necessary to view the figures with a stereo viewer.

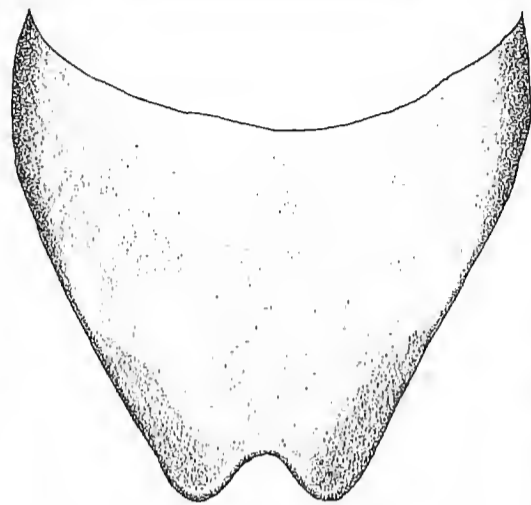
DISCUSSION

The presence of complex, cranial pits in adult males is an important synapomorphy establishing the monophyly of several pyrochroine genera. Pyrochroine genera exhibiting cranial pits, have them located behind the eyes, as in males of *Schizotus*, or between the eyes. In the latter case, the pit may consist of a single, shallow impression, as in the European *Pyrochroa* and Asian *Eupyrochroa* Blair, or pits may be well developed and paired: *Pseudodendroides*, *Phyllocladus* Blair, *Neopyrochroa* Blair and *Pseudopyrochroa*. Using this clade of seven genera for outgroup comparisons, the monophyly of *Pseudopyrochroa* species may be hypothesized by a synapomorphy associated with the external male genitalia. In *Pseudopyrochroa*, the dorsolateral apices of the parameres are bilaterally toothed, with each tooth projecting basally (Fig. 2). In the plesiomorphic character state, the apices of the parameres are rounded. Additionally, in *Pseudopyrochroa* the apex of the penis (Fig. 3) is provided with a dorsomesal, basally recurved hook (= apomorphic). In other pyrochroine genera (e.g., Fig. 6) the apex of the penis is generally rounded and lacking a hook (= plesiomorphic). A similar, apically hooked penis is present in males of *N. flabellata* (Fabricius), from the eastern United States and Canada. However, males of *N. femoralis* (LeConte) and *N. sierraensis* Young lack the modification and its autapomorphic presence in *N. flabellata* is hypothesized to be homoplasious with respect to *Pseudopyrochroa*.

Although exhibiting considerable interspecific variation, the cranial pits of male *Neopyrochroa*, *Phyllocladus* and *Pseudopyrochroa* are paired and typically well excavated. Those of *Pseudodendroides*, as illustrated by *P. niponensis* (Fig. 7) have an additional transverse ridge, making them nearly four-chambered (= apomorphic); very similar to those of both *P. umenoi* (Fig. 8) and *P. amamiana*.

In *Pseudodendroides* the parameres of the male genitalia are short and widely separated for approximately half their length (Fig. 5). This character represents a probable synapomorphy also exhibited by the Asian *Phyllocladus*, *Neopyrochroa*, a genus endemic to North America with two eastern and two western species, and an undescribed genus and species from the Darjeeling District of India. Males of *Pseudodendroides*, *Phyllocladus*, and the undescribed genus and species from Darjeeling also share an apomorphy associated with the eighth sternite: the apical margin is widely emarginate and conspicuously concave (Fig. 4). In males of other pyrochroine genera, including *Pseudopyrochroa*, the eighth sternite (Fig. 1) is tapered distally and narrowly emarginate mesally (= plesiomorphic).

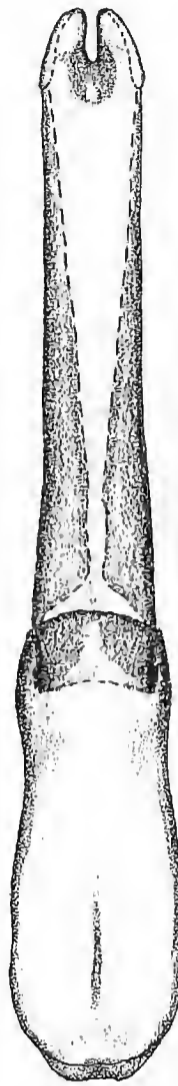
Although there has never been a comprehensive assessment of pyrochroine antennae, the gross anatomy is rich in characters; this is particularly true in the case of males (Young, unpublished observations). In males of *Pseudodendroides*, the scape is long and parallel-sided (= apomorphic); this condition is not seen in *Pseudopyrochroa* or any other pyrochroine genera. Males of both *P. umenoi* and *P. amamiana* have an elongate, parallel-sided antennal scape.



1



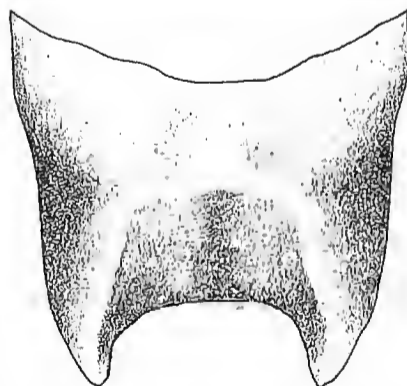
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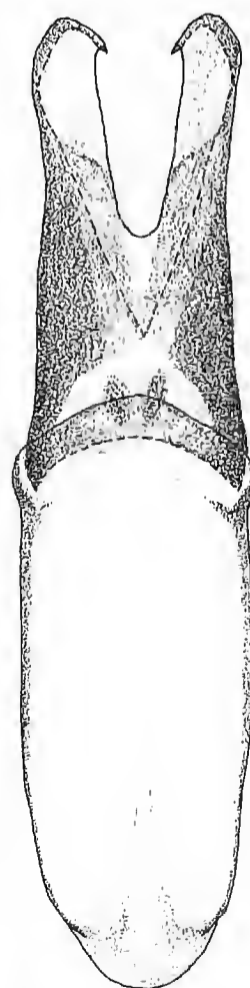
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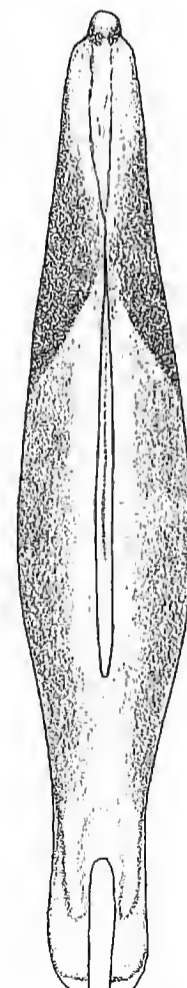
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Employing these criteria, the Taiwanese *Pseudopyrochroa umenoi* Kôno and the Japanese *P. amamiana* Nakane must be transferred to *Pseudodendroides*:

Pseudodendroides umenoi (Kôno), 1936, NEW COMBINATION
Pseudodendroides amamiana (Nakane), 1988, NEW COMBINATION

Pseudodendroides umenoi was originally described under the generic name *Pseudopyrochroa* on the basis of both males and females collected at Numanohira, Taiwan. In 1960, Nakane outlined and briefly discussed the Pyrochroidae of Japan, recording what he understood to be *P. umenoi* from Amami-Oshima Island. In that paper, Nakane also expressed some uncertainty regarding the relationships between *Pseudopyrochroa* and *Pseudodendroides*, noting that *P. umenoi* appeared to lack the retrorsely acuminate processes at the apex of the parameres characteristic of most *Pseudopyrochroa*. This topic was briefly revisited by Ohbayashi (1968). He illustrated the genitalia of *P. umenoi*, noting the "small teeth" at "the apex of male paramera of the species." However, in *P. umenoi* as in *P. nipponensis* (Fig. 5), the "teeth" are formed from the excavate inner margins of the distal parameres. The tooth-like paramereal processes characteristic of most *Pseudopyrochroa*—as seen, for example, in *P. harmondi* (Pic) (Fig. 2)—are formed by the splaying and sclerotization of the outer and dorsal distal surfaces of the parameres, which are narrowly and shallowly separated distally.

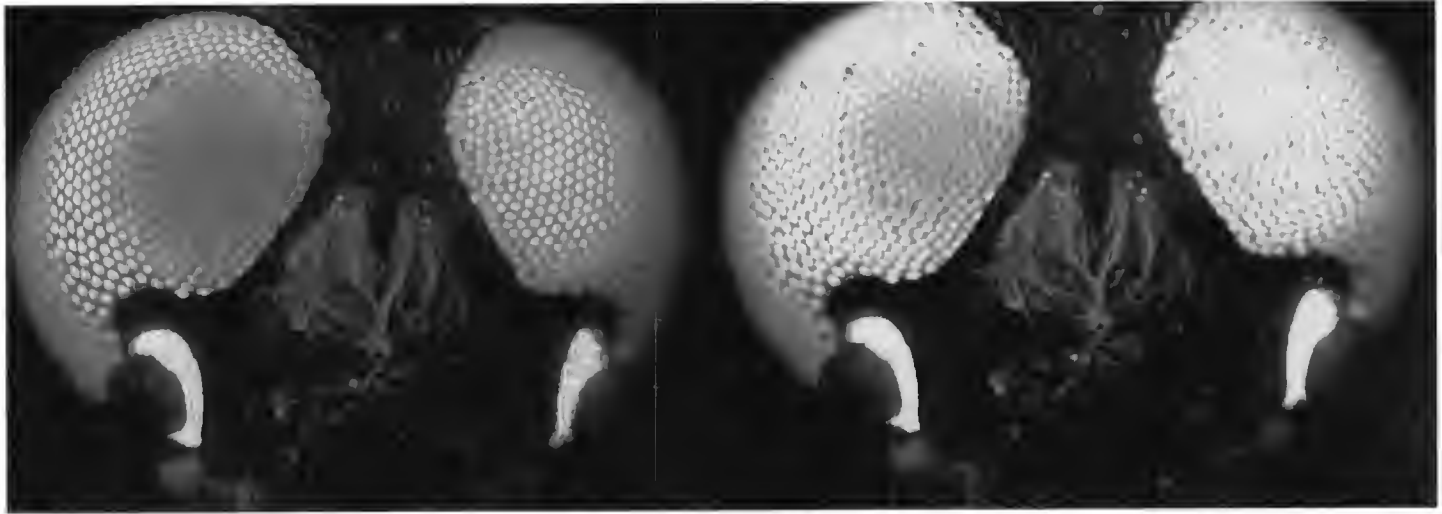
After years of reflecting on the material from Amami-Oshima Island, Nakane (1988) described *Pseudoedendroides amamiana*, under the generic name *Pseudopyrochroa*, stating that it differed consistently from *P. umenoi* in several characters associated with the head, including secondary sexual characteristics of the cranium, prothorax, and male genitalia. No further comments relative to generic relationships were made.

On the basis of the characters discussed above, it is clear that both *Pseudopyrochroa umenoi* Kôno and *Pseudopyrochroa amamiana* Nakane are incorrectly placed in *Pseudopyrochroa*. The evidence suggests that both species belong to *Pseudodendroides*.

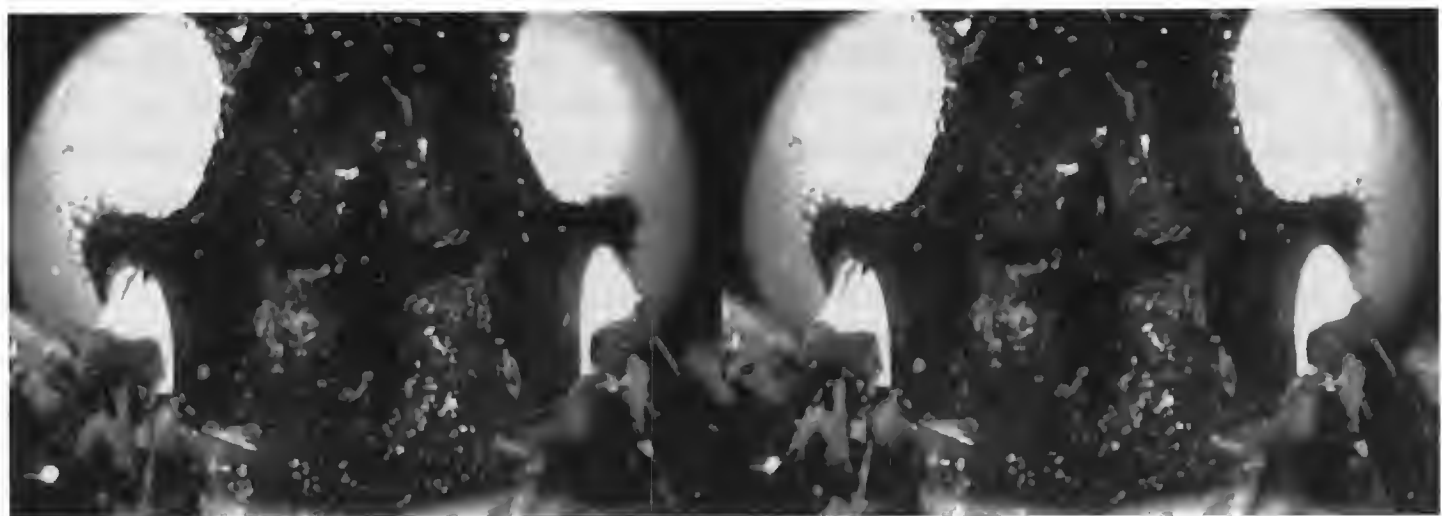
Material Examined.—*Pseudodendroides amamiana*: JAPAN. AMAMI OSHIMA: Hatsumo, 1 Apr 1968, ex Tamanuki, 1♂ (DYCC); 28 Mar 1964, Y. Miyake, 1♀ (DYCC). *Pseudodendroides nipponensis*: JAPAN. [country only] G. Lewis, 2♂♂, 1♀ (BMNH); Kiou-Siou (Kiushiu), Bassin Supérieur de la Sendaigawa, 1906, E. Gallois, 1♂, 4♀♀ (PMNH) KYUSHU: Higo, G. Lewis, 1♂ (BMNH); Higo, 1881, G. Lewis, 1♀ (BMNH); Higo, G. Lewis, 1♀ (BMNH); Kumamoto Pref., Momiki, Izumi v., 6 Jul 1991, T. Ueno, 1♂ (DAPC); HONSHU: Akita [underside of mounting card], Nikko, G. Lewis, 1♂ (BMNH); Akita, G. Lewis, 1♀ (BMNH); Nikko, 29–31 Oct 1880, G. Lewis, 1♀ (BMNH); Miyayoshita, G. Lewis, 1♀ (BMNH); Chiuzenji, 19–24 Aug 1881, G. Lewis, 1♀ (BMNH); Tokio, [G. Lewis material], 1♀ (BMNH); Nagano Pref., Tobira Spa, 31 Jul 1973, S. Hisamatsu, 1♂ (DYCC); Env. de Tokio et Alpes de Nikko, 1901, J. Harmond, 4♀♀ (PMNH); Env. de Tokio, 1906, J. Harmond, 2♀♀ (PMNH); Kofou, 1906, L. Drouard de Lezey, 1♀ (PMNH). *Pseudodendroides umenoi*: TAIWAN. NUMANOHIRA: 19 Jun 1932, Umeno & Taira, No. 21, *Pseudopyrochroa umenoi* Kôno, ♂ [Holo]Type (HUSC); NANTOU HSIEN: Meifeng, 2150 m, 20–22 Jun 1979, K. S. Lin & H. Chen,

←

Figures 1–3. *Pseudopyrochroa harmondi* Pic, adult male. Figure 1: Abdominal sternite 8, ventral view. Figure 2: Tegmen (= basal piece + parameres), dorsal view. Figure 3: Penis, dorsal view. Figures 4–6. *Pseudodendroides nipponensis* (Lewis), adult male. Figure 4: Abdominal sternite 8, ventral view. Figure 5: Tegmen (= basal piece + parameres), dorsal view. Figure 6: Penis, dorsal view.



7



8

Figures 7–8. Figure 7: *Pseudodendroides niponensis* (Lewis), adult male, cranium, including cranial pits, stereo-pair, dorsal view. Figure 8: *Pseudodendroides umenoi* (Kôno), adult male, cranium, including cranial pits, stereo-pair, dorsal view.

2 ♀♀ (TARI); 15 Jul 1982, S. C. Lin & C. N. Lin, 1 ♀ (TARI); Tsuifeng, 2300 m, 23–25 Jun 1983, K. S. Lin & S. C. Lin, 2 ♀♀ (TARI); TAICHUNG HSIEN: 8 Mar 1977, HOMEOTYPE: *Pseudopyrochroa umenoi* Kôno, Daniel K. Young, Elytra of type a bit lighter, 1 ♂ (DYCC); Jul 1977, 1 ♀ (DYCC); Anmashan, 2275 m, 6–9 Jul 1979, L. Y. Chou, 1 ♀ (TARI); HSINCHU: Kwangou, 2000 m, 24 Jun 1985, J. B. Heppner, 1 ♂ (FSCA). *Pseudodendroides uraiana*: TAIWAN. [Formosa], Urai [underside of label], 24 Apr 1925 [underside of label], T. Kano, *Pseudodendroides uraiana* Kôno, ♀ [Holo]Type, “description based on 1 ♀, this must be the HOLOTYPE, Daniel K. Young, 1992” (HUSC); HOOZAN: [Formosa], Sauter, 2 ♀♀ (DYCC); [Formosa], Sauter, 2 ♀♀ (NHMV); Apr 1910, H. Sauter S. G., Zool. Mus. Berlin, 2 ♂♂ (ZMHB); Apr 1910, H. Sauter S. G., Zool. Mus. Berlin, HOMEOTYPE: *Pseudodendroides uraiana* Kôno, Daniel K. Young, Type is slightly more teneral - lighter pn. etc., 1 ♀ (ZMHB); [Formosa, (Hoozan) Hosan], Mar 1910, Sauter S., Zool. Mus. Berlin, 1 ♂, 1 ♀ (ZMHB); POLISHA: [Formosa], Apr 1910, Sauter S., Zool. Mus. Berlin, 1 ♀ (ZMHB).

ACKNOWLEDGMENT

This study represents part of a larger project relating to the systematics and phylogeny of *Pseudopyrochroa*. I thank Malcolm Kerley, Christina von Hayek and Sharon Schute (BMNH) for their kind assistance during my visits, Darren Pollock (DAPC), Mike Thomas (FSCA), Heinrich Schönmann (NHMV), Claude Girard (PMNH), Liang-yih Chou (TARI), and Fritz Hieke and Manfred Uhlig

(ZMHB) for loans of material, Sadao Takagi, Entomological Institute, Hokkaido University for loan of type material for *Pseudodendroides umenoi* and *P. uraiana*, and Takehiko Nakane for exchanges of pyrochroid material that enabled me to make the necessary comparisons. Mr. Charles Thomas, University of Wisconsin Integrated Microscopy Resource, was instrumental in helping me resolve the problem of illustrating the cranial pit apparatus. To our knowledge, this represents the first application of stereo-pair techniques to confocal microscopy. This research was supported in part by grants from the National Science Foundation (BSR-9006342), the University of Wisconsin Graduate School (900159), and the University of Wisconsin's Natural History Museums Council Small Grants Program.

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**STUDIES ON THE CHRYSOMELIDAE (COLEOPTERA) OF
THE BAJA CALIFORNIA PENINSULA: A NEW SPECIES
OF *SCELOLYPERUS* (GALERUCINAE), WITH NOTES ON
THE GENUS IN BAJA CALIFORNIA**

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Abstract.—*Scelolyperus clarki* NEW SPECIES is described from Baja California, Mexico. Notes on the hosts and distribution for *Scelolyperus* Crotch species in Baja California are presented.

Key Words.—Insecta, *Scelolyperus*, *clarki*, *phoxus*, *torquatus*, *varipes*, Baja California Peninsula, Baja California, Mexico, Coleoptera, Chrysomelidae, Galerucinae.

The North American species of the genus *Scelolyperus* Crotch have very recently been reviewed by Clark (1996). During a visit to the University of California Essig Museum to obtain specimens for our continuing work on the Chrysomelidae of the Baja California Peninsula, a series of specimens of *Scelolyperus* was found that at first was thought to be a very common species, *S. torquatus* (LeConte). A precautionary check of the aedeagus revealed a new species. All species of *Scelolyperus* found on the Baja California Peninsula occur in the northern part of the State of Baja California (Fig. 7).

Specimen Depositories.—The following abbreviations refer to: CAS—California Academy of Sciences, CDFFA—California Department of Food & Agriculture, UNAM—Universidad Nacional Autonoma de Mexico, UCBC—University of California, Berkeley Collection.

SCELOLYPERUS CLARKI Gilbert & Andrews, NEW SPECIES

Types.—Holotype (male) and Allotype (female): MEXICO. BAJA CALIFORNIA: 11.3 km (7 mi.) SE Maneadero, 25 Mar 1973, 100' el., J. Doyen, on *Ceanothus*: Type and Allotype deposited in the University of California, Berkeley Collection. PARATYPES (20)-(9) Same data as holotype; (11) same data as holotype, except no host data given (2) [CAS]; (2) [CDFFA]; (2) [UNAM]; (14) [UCBC].

Description.—Male (holotype). Length 3.9 mm; width 1.5 mm. Form elongate; prothorax testaceous, narrower than elytra. Body color black, elytra metallic green or blue. Head dark brown to black, vertex alutaceous, basically impunctate with metallic luster, a few inconspicuous setae near eyes and along margin with interocular sulcus; interocular sulcus distinct; interocular width approximately 1.5 times width of eyes (on a line drawn through center of eyes when viewed head on); eyes entire; frontal tubercles distinct, smooth, flat, separated from each other by a distinct sulcus; tubercles separated from interantennal carina by shallow sulci; antennal fossae separated by a distance subequal to length of antennomere II; interantennal carina well developed, forming a longitudinal, angulate ridge; genal length subequal to maximum width of antennomere I; antennae extending beyond humeri; antennomeres 1–4 totally or partially testaceous; 5–11 dark brown. Pronotum 1.2 times wider than long (width measured at the widest portion—apical one-third); virtually glabrous (setose punctures visible under high magnification), alutaceous with shallow punctures that become more coarse and dense posteriorly.

Scutellum dark brown, polished, impunctate. Elytra 1.9 times longer than wide; slightly rugose (viewed at an angle), alutaceous, investitus (very scattered inconspicuous setae visible under high magnification) with dense, coarse, broad, irregularly placed punctures; most punctures separated by the width of the punctures or less, occasionally coalescing. Venter black, pubescent; procoxal cavity open; procoxae conical, narrowly separated; last ventrite with a short, broad, truncate lobe. Legs all of approximately equal size, shape; femora black, tibia and tarsi brown (except base of protibia which is testaceous). Genitalia as in Figs. 1 and 2.

Female (Allotype).—Similar to holotype, differing in the following characters: size slightly larger (length 3.8 mm; width 1.4 mm); last abdominal sternum not lobed; dorsum shining, only faintly alutaceous.

Variation.—Male: length 3.3–3.9 mm; width at elytral humeri 1.1–1.5 mm. Female: length 3.1–3.9 mm; width 1.1–1.5 mm.

Diagnosis.—*Scelolyperus clarki* NEW SPECIES would key to couplet 11 in the key presented by Clark (1996). However, it can be readily distinguished from the two species in this couplet, *S. torquatus* (LeConte) and *S. phoxus* Wilcox, by the aedeagus (Figs. 1–6) and the coarser elytral punctation. Examination of the aedeagus will provide positive identification. The only other *Scelolyperus* species recorded from Baja California, *S. varipes*, is larger, has a dark pronotum and a very different aedeagus.

Host.—Eleven of the twenty-two specimens in the type series of *Scelolyperus clarki* were collected from *Ceanothus* (Rhamnaceae). No plant association was given for the other 11 specimens in this series. Adults of *S. torquatus* are also associated with *Ceanothus* and occupy the same habitat in Baja California.

Etymology.—Named for Shawn Clark.

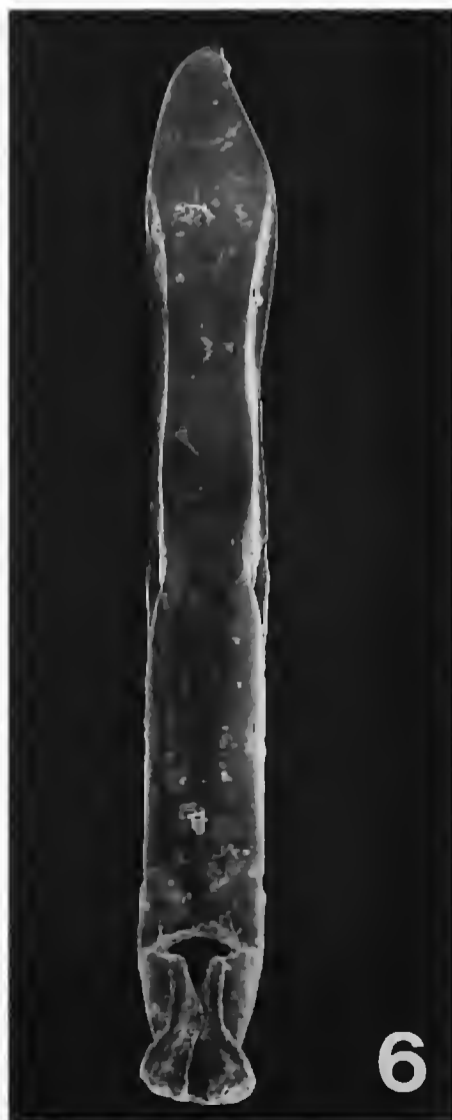
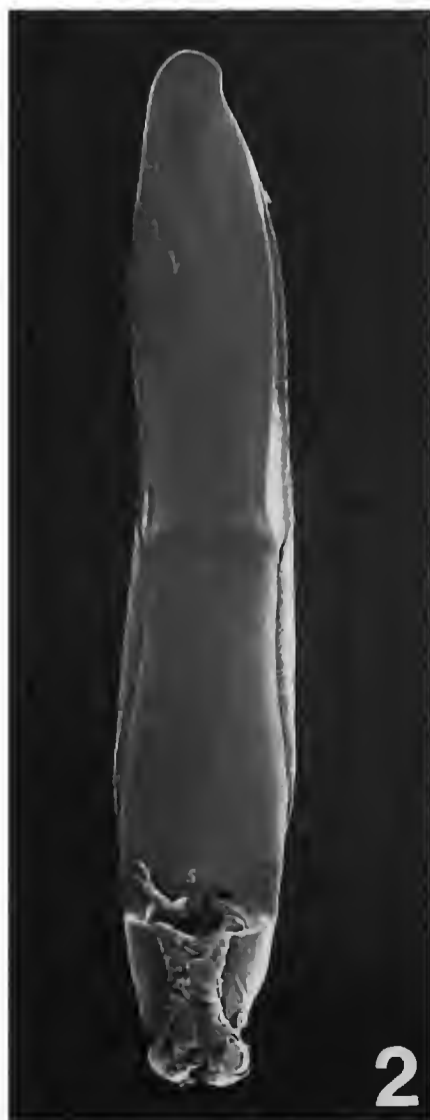
Material Examined.—See types.

SCELOLYPERUS PHOXUS Wilcox

Clark (1996) reports this species from Los Angeles and Riverside Counties in California. A single female specimen collected 3.2 km (2 mi) SE of El Topo (Fig. 7), without host data, appears to be *S. phoxus*, but without a male specimen this determination cannot be certain. This would extend the range into northern Baja California. Most likely this species occupies similar habitat as in that portion of California between Los Angeles County and Baja California. The senior author has collected a large series of this species in association with *Adenostoma fasciculatum* Hooker & Arnott (Rosaceae) in the Mt. Baldy area of Los Angeles County. The *Adenostoma* must be in bloom for the adults to be found. It may be that the adults are pollen feeding. However, beetles were very concentrated on individual plants possibly indicating that they may be congregating for mating or have just emerged from pupae in the soil beneath these plants. Other species of perennial plants that were in bloom did not have beetles associated with them. *A. fasciculatum* extends into Baja California (Wiggins 1980, Roberts 1989) and may also have the same association with *S. phoxus*.

SCELOLYPERUS TORQUATUS (LeConte)

In California *S. torquatus* is a very common and widely distributed species. Clark (1996) reports this species collected on a variety of plant species. However, it can be found most commonly and abundantly on *Ceanothus* and *Adenostoma* when these plants are in bloom. Clark (1996) and Wilcox (1965) both report *S. torquatus* from Baja California. We have examined numerous specimens also



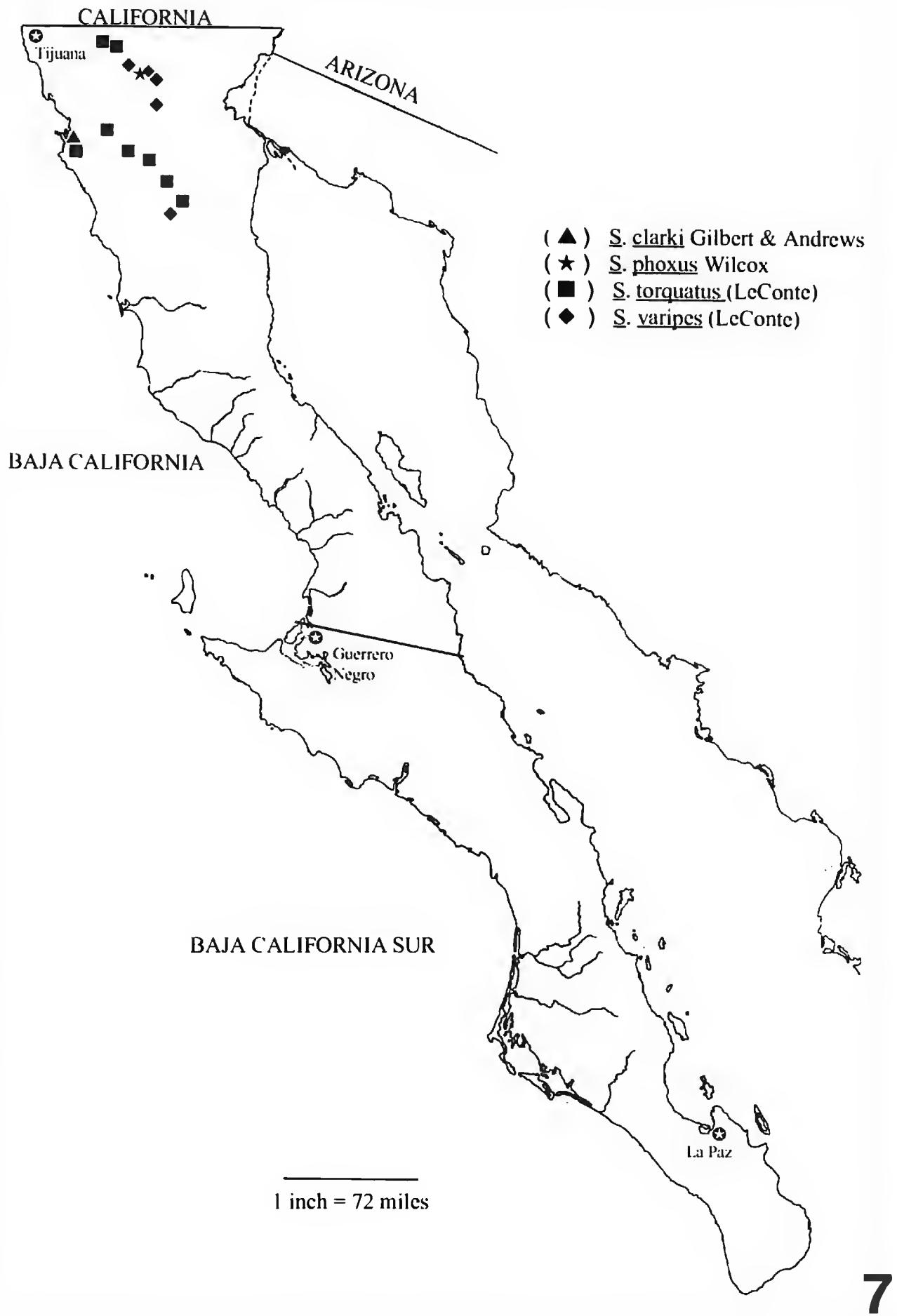


Figure 7. Known geographical distribution of *Scelolyperus* species in the Baja California Peninsula.

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Figures 1–6. Male aedeagus. Figure 1. *Scelolyperus clarki*, lateral view. Figure 2. *Scelolyperus clarki*, ventral view. Figure 3. *Scelolyperus torquatus*, lateral view. Figure 4. *Scelolyperus torquatus*, ventral view. Figure 5. *Scelolyperus phoxus*, lateral view. Figure 6. *Scelolyperus phoxus*, ventral view.

collected in the very northern portion of Baja California; 0.62 km (1 mi) S El Condor, 3.2 km (2 mi) (no direction given) Santo Tomas Arroyo, upper Canyon del Cantil, Sierra Juarez, Ejido Uruapan, 23 km E. Ensenada, 47 km E. Ensenada, 77 km SE. Ensenada and 98 km SE. Ensenada (Fig. 7).

SCELOLYPERUS VARIPES (LeConte)

Scelolyperus varipes is distributed from British Columbia to Montana to New Mexico and California (Clark 1996). We have examined five specimens from the following five localities in Baja California: El Topo; 4.8 km (3 mi) S Laguna Hansen; Las Encinas, Sierra San Pedro Martir; 9.7 km (6 mi) N Laguna Hansen, Sierra Juarez and 3.5 km (2.2 mi) S El Topo, Sierra Juarez (Fig. 7).

ACKNOWLEDGMENT

Specimens were made available for this study by Cheryl Barr, University of California, Berkeley—California Insect Survey, E. L. Sleeper, California State University, Long Beach and Dave Faulkner, San Diego County Natural History Museum.

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**A NEW SPECIES OF *METAPHYCUS* (HYMENOPTERA:
ENCYRTIDAE) PARASITIC ON *SAISSETIA OLEAE*
(OLIVIER) (HOMOPTERA: COCCIDAE)**

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Abstract.—A new encyrtid species of the *zebratus*-group of *Metaphycus* is described: *Metaphycus hageni* NEW SPECIES. This parasitoid was reared from black scale, *Saissetia oleae* (Olivier), collected on olives near Almuñécar, Spain. This species is similar to *M. lounsburyi* (Howard)¹, but can be distinguished by the relative length of the ovipositor, the shape of the male genitalia, and the shape of the antennal club in both females and males. Characters that differentiate *M. hageni* from closely related species are given.

Key Words.—Insecta, Hymenoptera, Encyrtidae, *Metaphycus*, *Saissetia oleae*.

Saissetia oleae (Olivier) were collected on olives, *Olea europaea* L., near Almuñécar in southern Spain, in 1985, and shipped to the quarantine facility at the (former) Division of Biological Control, University of California, Berkeley. Numerous specimens of an encyrtid, identified by K. S. Hagen as *Metaphycus* sp. nr. *lounsburyi* (Howard), using the Annecke & Mynhardt (1971) key to the *zebratus*-group of *Metaphycus* species, emerged from the scales. We consider this an unnamed and undescribed species, which we name and describe here. Our description is based on specimens reared from *S. oleae* collected in Almuñécar, individuals from their progeny reared in the insectary using *S. oleae* on oleander (*Nerium oleander* L.), and specimens recovered from various sites in California where the parasitoid was released in olive orchards infested with *S. oleae* (Daane et al. 1991).

METHODS AND MATERIALS

Described specimens were preserved by different methods. Some specimens were mounted dry, without previous treatment, on paper cards or points using book-binders' glue (Yes[®]) as adhesive. Others were mounted on glass slides, some whole, some dissected as needed. Some specimens were cleared in chloral-phenol (10 g phenol crystals, 10 g chloral hydrate, 3 ml distilled water) and mounted in Faure's medium (60 g lump gum arabic, 100 g chloral hydrate, 25 ml 50% glucose, 25 ml glacial acetic acid, 120 ml distilled water). Measurements of various structures were taken from slide-mounted specimens. The holotype is card mounted, paratypes are both card mounted and slide mounted in Canada balsam following Noyes (1982). Specimens are deposited in the Essig Museum (UCB), University of California, Berkeley; United States National Museum (USNM), Washington D.C.; and the National History Museum (BMNH), London.

¹ According to E. Guerrieri and J. S. Noyes (personal communication) the name *M. lounsburyi* (sensu Compere [1940] and Annecke & Mynhardt [1971]) is based on a misidentification of the type material (Howard 1898), which is redescribed in their manuscript (in preparation) that deals with the European species of *Metaphycus*.

METAPHYCUS HAGENI Daane and Caltagirone, NEW SPECIES

Types.—Holotype: female; data: SPAIN, ANDALUCIA: \approx 5 km west of Almuñécar near "La Punta de la Mona" tunnel, 6 Jun 1985, L. E. Caltagirone, reared from *Saissetia oleae* (Olivier) collected on olive (*Olea europaea* L.), deposited: UCB. Paratypes: same data as holotype, 6 females, 4 males, deposited: UCB. Albany, CALIFORNIA, ALAMEDA Co.: Insectary colony, University of California, 11 Jan 1986, K. M. Daane, reared from *S. oleae* on oleander (*Nerium oleander*), 6 females, 4 males, deposited: USNM; 6 females, 4 males, deposited: BMNH.

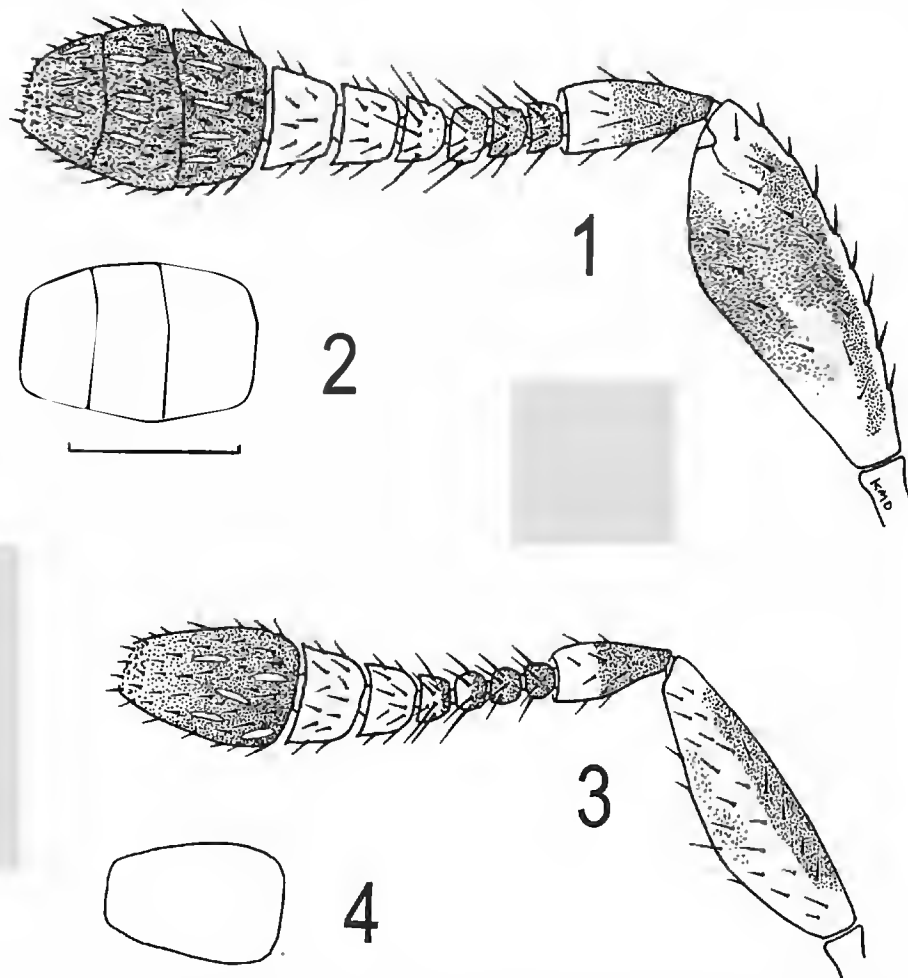
Female.—Length of air-dried specimens 1.3 mm (from frons to tip of ovipositor sheath, range 1.025–1.5, $n = 11$). Color variable: white to pale yellow to golden brown. Frons, upper half of scrobes, mesoscutum, axillae, and scutellum orange yellow, sometimes with a brownish hue; spot on middle of scape extending longitudinally ventrally and dorsally, basal half of pedicel, basal 2 or 3 funicular segments, club, occiput except ridges, a spot on each side and middle of pronotum, anterior of mesoscutum (seen in dissected, slide-mounted specimens), metanotum, propodeum, metasoma dorsally (except for a narrow outer margin) dark brown. Tibiae basally, two oblique rings medially and apically brown, sometimes with faded sections. Mandibles reddish brown fading to pale yellow at base. Ocelli reddish brown. Eyes gray with greenish hue. Wings hyaline. Ocelli forming an acute triangle ($\approx 45^\circ$), lateral ocelli about one-half their longest diameter from eye margin, distance from each other about their longest diameter; middle ocellus separate from lateral ocelli by a distance about twice its longest diameter. Scape width $0.36 \times$ length (range 0.32–0.40, $n = 32$); pedicel width $0.53 \times$ length (range 0.50–0.57, $n = 20$); pedicel $1.08 \times$ length of basal 3 funicular segments combined (range 1.05–1.27, $n = 13$); basal 3 funicular segments subequal in width, the apical 3 gradually widening so that the apical segment width $1.94 \times$ basal segment width (range 1.69–2.12, $n = 14$); club 3-segmented, ovate, its width $0.66 \times$ its length (range 0.55–0.74, $n = 31$), its length $0.81 \times$ length of funicle (range 0.69–0.93, $n = 31$) (Fig. 1). Fore wing width $0.44 \times$ its length (range 0.41–0.46, $n = 30$); length of stigmal vein $0.22 \times$ length of submarginal vein (range 0.17–0.29, $n = 32$). Length of middle tibia $0.98 \times$ length of middle femur (range 0.94–1.04, $n = 18$); length of middle tibial spur $0.81 \times$ length of middle basitarsus (range 0.71–0.85, $n = 30$). Length of hind tibia $1.08 \times$ length of hind femur (range 1.08–1.22, $n = 17$); length of hind tibial spur $0.45 \times$ length of hind basitarsus (range 0.41–0.50, $n = 18$). Length of ovipositor (measured as length of 2nd valvulae) $0.80 \times$ length of metasoma (range 0.71–0.85, $n = 13$), and $1.06 \times$ length of hind tibia (range 1.0–1.15, $n = 14$); length of ovipositor sheaths (3rd valvulae) $0.19 \times$ length of 2nd valvulae (range 0.17–0.21, $n = 14$) (Fig. 5).

Male.—Similar to female. Club entire, its length $0.74 \times$ (range 0.66–0.78, $n = 12$) length of funicle (Fig. 3). Genitalia long-elliptical (Fig. 6).

Diagnosis.—Females of *M. hageni* can be separated from those of *M. lounsburyi* (Howard) and *Metaphycus bartletti* Annecke & Mynhardt, the two morphologically similar species found in California, by the following characters. *M. hageni* ovipositor is as long or slightly longer than hind tibia, *M. lounsburyi* and *M. bartletti* ovipositors are shorter than respective hind tibia. The antennal club of *M. hageni* (Fig. 1) and *M. bartletti* is ovate, the apex gradually narrowing, the antennal club of *M. lounsburyi* is truncate (barrel-shaped) (Fig. 2). Torular sensillae present in *M. hageni*, absent in *M. lounsburyi* and *M. bartletti*. The genitalia of male *M. hageni* is long-elliptical (Fig. 6), the antennal club rounded at apex; the genitalia of *M. lounsburyi* is wedge-shape (Fig. 8), the antennal club truncate at apex (Fig. 4).

DISCUSSION

Species of *Metaphycus* Mercet are important natural enemies of soft scale (Homoptera: Coccidae). *Metaphycus* species in the *zebratus*-group are parasitic on lecaniine scale (Annecke & Mynhardt 1971). The most commonly known of these

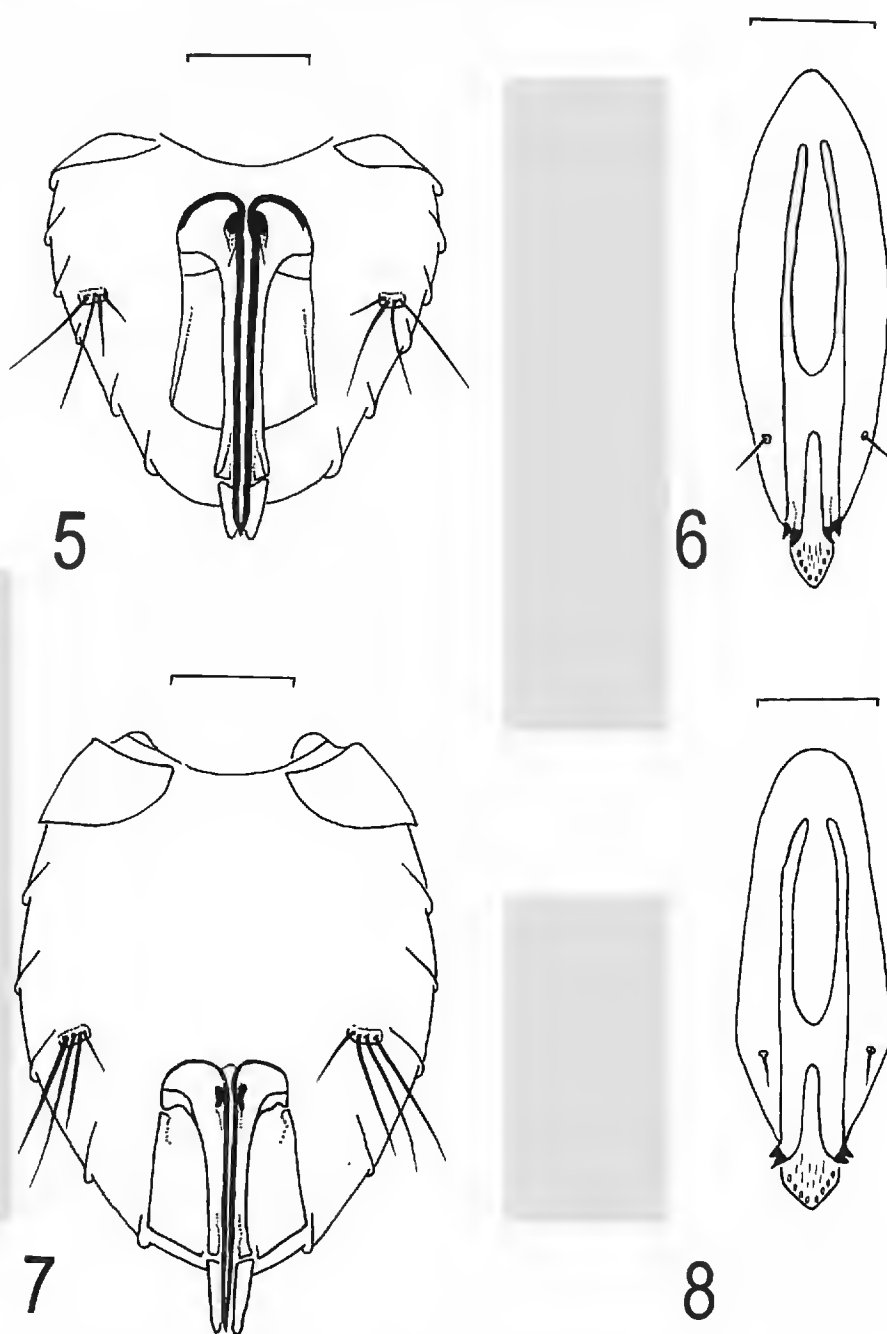


Figures 1–4. Figure 1. *Metaphycus hageni* NEW SPECIES, female antenna. Figure 2. *Metaphycus lounsburyi* (Howard), female antennal club in outline. Figure 3. *Metaphycus hageni* NEW SPECIES, male antennae. Figure 4. *Metaphycus lounsburyi* (Howard), male antennal club in outline. Scale = 0.1 mm.

is *M. lounsburyi*, a parasitoid of black scale, *S. oleae*. *Metaphycus lounsburyi* has a wide geographic distribution, a result of South African material being imported to many areas for improved control of *S. oleae* (Bartlett 1978). During initial taxonomic and behavioral studies with the material imported from Spain, one of us (LEC) and K. S. Hagen noted inconsistencies between specimens of *M. lounsburyi* from California and the imported *Metaphycus* specimens. These observations led to taxonomic, cross-mating, and behavioral studies to determine if imported material was a biotype of *M. lounsburyi*, as has been reported to occur by Panis & Marro (1978), or a different species. Females were never produced in cross-mating experiments (Barzman et al. in press). Observations of oviposition behavior and host-feeding revealed *M. lounsburyi* females deposit eggs through the ventral side of the scale and were not observed host-feeding. *Metaphycus hageni* females deposit eggs through the dorsum of the scale and frequently feed on host body fluids exuding from a puncture through which an egg is never deposited. The collective evidence indicates that *M. lounsburyi* and *M. hageni* are separate species.

Etymology.—This species is named in honor of our esteemed colleague, the late Kenneth S. Hagen, who was an invaluable adviser during the early stages of our research with this parasitoid and a friend throughout our careers.

Material Examined.—See types. CALIFORNIA, ALAMEDA Co.: Insectary of the (former) Division of Biological Control, University of California, Albany, California, 11 Jan 1986, K. M. Daane, reared from *S. oleae* on oleander (*N. oleander*), 20 females, 9 males; slide mounted in Faure's; deposited:



Figures 5–8. Figure 5. *Metaphycus hageni* NEW SPECIES, female ovipositor, ventral view, showing position on metasoma. Scale = 0.1 mm. Figure 6. *Metaphycus hageni* NEW SPECIES, male genitalia, ventral view. Scale = 0.05 mm. Figure 7. *Metaphycus lounsburyi* (Howard), female ovipositor, ventral view, showing position on metasoma. Scale = 0.1 mm. Figure 8. *Metaphycus lounsburyi* (Howard), male genitalia, ventral view. Scale = 0.05 mm.

Kearney Agricultural Center (KAC), University of California, Parlier. CALIFORNIA, TEHAMA Co.: 1 km east of Corning, 200 m, 13 Nov 1985, K. M. Daane, reared from *S. oleae* on olive (*O. europaea*), 3 females; slide mounted in Faure's; deposited: KAC.

ACKNOWLEDGMENT

We thank John S. Noyes (The National History Museum, London) for reviewing this manuscript and help with diagnostic characters of species in the *zebratus*-group of *Metaphycus* and Gregory Zolnerowich (Texas A&M University) for discussions on *Metaphycus* species taxonomy.

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SYNONYMY OF *DASYMUTILLA NOCTURNA* MICKEL (HYMENOPTERA: MUTILLIDAE)¹

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Abstract.—*Dasymutilla nocturna* Mickel and *D. subhyalina* Mickel were thought to be female and male, respectively, of the same species since their description in 1928. One female is known from Blythe, Riverside County, California. Another female bears a collection label from Preston, Nevada. All other known females and males are from the Colorado Desert of Imperial County, California. In 1947, *D. paranocturna* Barr & Hurd was described. The known specimens of *D. paranocturna* probably represent two different species, *D. nocturna* and *D. arenivaga* Mickel. Subsequent collections, the use of caged females, and comparison with type specimens have led to the conclusion that *D. nocturna*, *D. subhyalina*, and at least part of the *D. paranocturna* specimens are the same species. A complete synonymy is included.

Key Words.—Insecta, Hymenoptera, Mutillidae, *Dasymutilla nocturna*, *Dasymutilla subhyalina*, *Dasymutilla paranocturna*, *Dasymutilla arenivaga*, California.

Dasymutilla nocturna was first described by Mickel (1928) on the basis of two females. At the same time, Mickel described *D. subhyalina* from two males, acknowledging that these specimens most probably were female and male of the same species. The holotype female and both the holotype and paratype males were collected at light at about 23:00 h on 10 Aug 1917 near Andrade, California, Colorado Sand Desert (Imperial County), by J. Bequaert. The paratype female was collected on 9 Aug 1914 near Brawley, Imperial County, California, by J. C. Bradley. The male paratype was in the collection of J. Bequaert. It is now in the Museum of Comparative Zoology, labeled as *D. nocturna*. All of these specimens have been examined by this author.

Dasymutilla paranocturna was described by Barr & Hurd (1947) on the basis of two female specimens. The holotype was collected from Blythe, Riverside County, California, on 6 Jul 1946, by W. F. Barr. The paratype was collected from San Felipe Creek, Imperial County, California on 17 Jun 1940, by R. G. Dahl. It is in the collection of the University of California, Berkeley. No mention was made of the time of day when these two specimens were collected although they were most likely collected at night (Barr, personal communication). Both of these specimens have also been examined by this author.

Nearly all of the approximately 150 known species of *Dasymutilla* are diurnal. There are only five known exceptions. These include *D. nocturna* and some of the *D. paranocturna*, both of which are known from females only, and *D. subhyalina*, known from males only. All three of these occupy the same geographic range. They also include *D. arenivaga* Mickel and the remaining *D. paranocturna*, known from females only, and *D. megalophthalma* Mickel, known from males only. These occupy the same geographic range.

¹ Technical contribution no. 4320 of the South Carolina Agricultural Experiment Station, Clemson University.

Material Examined.—In addition to the type specimens mentioned above, the following material has been examined (all are females of *D. nocturna* and males of *D. subhyalina*, except as noted): USA. CALIFORNIA. IMPERIAL Co.: Westmoreland, 20 Jul 1928, 1 female; Holtville, 22 Oct 1936, A. T. McClay, 1 female; Laguna Lake, 9–11 Jun 1950, 1 female (identified as *D. paranocturna*, probably *D. arenivaga*); Grays Well, 6 Jun 1951, D. J. and J. N. Knull, 1 male; Fort Yuma, near Colorado River, 1 Jul 1951, 1 female (identified as *D. paranocturna*, probably *D. arenivaga*); Algodones Sand Dunes, 9.6 km W of Glamis, 18 Nov 1963, M. E. Irwin, 2 females; 9.6 km W of Glamis, 18 Nov 1963, E. I. Schlinger, 1 male; Glamis, 8 February 1964, M. E. Irwin, E. I. Schlinger, 1 female; 32 km E of Brawley, 13 Jun 1965, G. R. Balmer, 1 male; Glamis, 11 Oct 1972, C. Goodpasture, 1 male; 4.8 km SW of Glamis, 10 Jul 1974, J. Doyen, 2 males; 1.6 km NW of Glamis, 11 Jul 1974, D. G. Manley, 4 males; 4.8 km SW of Glamis, 12 Jul 1974, J. Doyen, 5 males; 1.6 km NW of Glamis, 7 Aug 1974, D. G. Manley, 13 males; 3.2 km NW of Glamis, 4 Nov 1974, J. A. Powell, 4 females; 6.4 km NW of Glamis, 1 May 1975, R. Aalbu, 7 females; 3.2 km NW of Glamis, 22 May 1975, D. G. Manley, 4 females; 3.2 km NW of Glamis, 4 Jun 1975, T. Allen, 1 female; 1.6 km S of Glamis, 29 Mar 1978, R. Dietz and J. Powell, 2 females; 1.6 km S of Glamis, 31 Mar 1978, R. Dietz, 1 female; Glamis, 19 Sep 1980, K. A. Smith, 1 male; 1.6 km NW of Glamis, 12 May 1992, D. G. Manley, 8 females; 1.6 km NW of Glamis, 13 May 1992, D. G. Manley, 9 females; 1.6 km NW of Glamis, 11 Jul 1992, D. G. Manley, 6 females; 1.6 km NW of Glamis, 11 Jul 1992, D. G. Manley, 1 female (*D. paranocturna*); 1.6 km NW of Glamis, 28 Aug 1992, D. G. Manley, 7 females; 1.6 km NW of Glamis, 28 Aug 1992, D. G. Manley, 2 females (*D. paranocturna*); 1.9 km W of Glamis, 24 Apr 1993, J. D. McCarty, 2 females; Glamis, 24 Jul 1995, D. G. Manley, 5 females and 22 males. RIVERSIDE Co.: Salton Sea, 22 Jul 1952, H. L. Mathis, 1 female (identified as *D. nocturna*, clearly *D. arenivaga*). SAN BERNARDINO Co.: 8 km NE of Yermo, 26 Jun 1939, W. M. Pearce, 1 female (identified as *D. paranocturna*, probably *D. arenivaga*); Kelso Dunes, 12.8 km SW of Kelso, 14–15 Jul 1974, J. Doyen, 2 females (identified as *D. nocturna*, clearly *D. arenivaga*). ARIZONA, YUMA Co.: Yuma, 6 May 1939, R. M. Bohart, 1 female (identified as *D. nocturna*, probably *D. arenivaga*). NEVADA. WHITE PINE Co.: Preston, Oct 1941, U. N. Lanham, 1 female. NO DATA. 1 male.

DISCUSSION

From the time of their original descriptions, it seemed likely that *D. nocturna* and *D. subhyalina* were female and male of the same species. However, Mickel (1928) did not want to make such a definitive statement solely on the basis of the fact that one female and two males were collected at the same time and location.

Females and males of many species of *Dasymutilla* are very similar in color and pattern. However, in many other species, male and female color patterns are very different from each other. This has made sex correlation of many *Dasymutilla* species quite difficult.

Nearly all species in the genus *Dasymutilla* are diurnal. The only five exceptions have already been mentioned. Of those, *D. nocturna*, some of the *D. paranocturna* specimens, and *D. subhyalina* all share the same colors, pattern, and geographic range. *Dasymutilla arenivaga*, some *D. paranocturna* specimens, and *D. megalophthalma* have different colors, pattern, and geographic range.

Two other specimens of *D. nocturna* were collected prior to the description of *D. paranocturna* (Hurd, 1951), both from Imperial Co., California. On the basis of the type specimens, and the slight variations between those examined by Mickel and those examined by Barr and Hurd, the latter saw fit to describe their specimens as a new species.

The holotype of *D. paranocturna* is undoubtedly a specimen of *D. nocturna*, with only slight variation in color of the pubescence and integument. Likewise, the paratype of *D. paranocturna* is undoubtedly a specimen of *D. arenivaga*, with only slight variation in color of the pubescence and integument. The specimens

identified as *D. paranocturna* that more closely resemble *D. nocturna* tend to be from the Algodones Sand Dunes or very nearby. The specimens identified as *D. paranocturna* that more closely resemble *D. arenivaga* are more widely distributed.

It is possible that all five of the "nocturnal" *Dasymutilla* represent a single species. However, numerous specimens of *D. arenivaga* and *D. megalophthalma* have been examined, including both holotypes. Although they are obviously closely related to *D. nocturna* and *D. subhyalina*, respectively, they appear to be distinct. These undoubtedly represent female and male, respectively, of the same species.

The specimen of *D. nocturna* that bears the collection locality of Preston, Nevada presents another problem. There is no question that the specimen is *D. nocturna*. However, no other specimen of this species has been found within 1100 km of Preston, Nevada. It seems much more likely that the specimen was collected in or near Imperial Co., California, and that it was mislabeled.

In July and August of 1974, 17 additional specimens of *D. subhyalina* were collected by the author from the Algodones sand dunes in Imperial County, California. No females were collected during that time. In May and June of 1975, the author collected 12 additional specimens of *D. nocturna* from the same location. However, no males were collected at that time. All specimens were collected at night. These specimens were subsequently compared to the respective holotypes and found to be identical. Although these additional specimens were all collected at night from the same location, no definitive statement could be made on conspecificity as specimens were not collected at the same time.

Additional specimens of *D. nocturna* were collected by the author in 1992, all from the same location. All were either crepuscular, matinal, or nocturnal in their habits. Eight specimens were collected on 12 May, and nine others on 13 May. Seven additional females were collected on 11 July. One of these specimens differed slightly with respect to color of pubescence and integument. It was subsequently compared to the holotype of *D. paranocturna* and found to be morphologically identical. On 28 August, an additional nine specimens were collected by the author from the same location. Seven had the pubescence and integumental coloration characteristic of *D. nocturna*; two had the slightly lighter-colored pubescence and reddish integument characteristic of *D. paranocturna*. Again, no males were taken during any of these collection dates. Diurnal collecting was done during all of the preceding collection dates. However, no mutillid specimens were ever taken except at dusk, during darkness, or right at dawn.

A female of *D. nocturna* was collected on 24 Jul 1995 on the Algodones sand dunes shortly after dark, and placed in a small, plastic cage from which the ends had been cut out and replaced with wire screen. A short time later, a male of *D. subhyalina* was attracted to the caged female, and attempted to mate with her through the wire screen. Later in the evening, another male was attracted to an uncaged female. Both were collected. In all, four females and 22 males were collected between 19:45 h (PDT) and 22:00 h (PDT).

Caged females have been used previously to attract males, both in cases where the male was already known and where the male was unknown. Males are not always attracted to the caged females. However, in all cases in which males have been attracted to the caged females, they have been subsequently shown to be

conspecific. And in cases where the males were previously known, they have always been of the same species as the caged female. Thus, the use of caged females is a reliable method for use in sex correlations among *Dasymutilla*.

CONCLUSIONS

Even before the addition of the present evidence, it seemed likely that *D. nocturna* and *D. subhyalina* represented female and male, respectively, of the same species. Furthermore, it seemed likely that *D. paranocturna* was also just a slight variant of the same species. The following facts lead me to believe that *D. nocturna*, many of the specimens of *D. paranocturna*, and *D. subhyalina* are members of a single species: 1) all are nocturnal, 2) all share the same geographic range, the Colorado Desert, 3) new evidence that numerous individuals have been found in the same place at the same time, 4) males have been observed attracted to and trying to mate with caged females. Because the name *D. nocturna* has precedence over the other two, that name shall stand. A synonymy for the species follows.

DASYMUTILLA NOCTURNA MICKEL

Dasymutilla nocturna Mickel, 1928: 279. Type locality: CALIFORNIA. *IMPERIAL Co.*: Colorado Sand Desert, near Andrade. Holotype deposited University of Minnesota. ♀

Dasymutilla subhyalina Mickel, 1928: 281. Type locality: CALIFORNIA. *IMPERIAL Co.*: Colorado Sand Desert, near Andrade. Holotype deposited University of Minnesota. NEW SYNONYM. ♂

Dasymutilla paranocturna Barr & Hurd, 1947: 88. Type locality: CALIFORNIA. *RIVERSIDE Co.*: Blythe. Holotype deposited California Academy of Sciences, Entomology (No. 5619). NEW SYNONYM. ♀

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**HOST RECORDS OF BRACONIDAE (HYMENOPTERA)
OCCURRING IN MIRIDAE (HEMIPTERA:
HETEROPTERA) FOUND ON LODGEPOLE PINE
(*PINUS CONTORTA*) AND ASSOCIATED CONIFERS**

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Abstract.—The plant bug (Hemiptera: Heteroptera: Miridae) fauna of lodgepole pine (*Pinus contorta* Douglas ex Loud) and associated conifers was examined in Oregon and Wyoming, United States of America. Parasitoid larvae of Braconidae were recovered from 20 species of Miridae previously unrecorded as braconid hosts, representing 10 genera of bugs, four of which have not been previously recorded as hosts. The parasitoid larvae were found only in the immature stages of the bugs. A sequence of species of Miridae occurs on the host tree through time but only the earlier species are parasitized. *Pinus contorta* is the most widespread conifer in North America, its four subspecies extending from Baja California Norte to the Yukon Territory, Canada. Over 50 species of Miridae have been found on this tree species. Other parasitized species will certainly be found.

Key Words.—Insecta, Braconidae, conifers, Miridae, parasitoids, plant bugs, *Pinus*.

The only known Hymenoptera parasitoids of immature and adult Miridae are the Braconidae, *Leiophron* Nees and *Peristenus* Foerster (Brindley 1939; Leston 1959, 1961; Loan 1974a, b, 1980, 1983; Glen 1977; Marsh 1979; Wheeler & Loan 1984). Some of the Miridae genera contain economically important species (e.g., *Adelphocoris* Reuter, *Leptopterna* Fieber, and *Lygus* Hahn) and work is being carried out to utilize these parasitoids for biological control. Considerable effort has been made to collect these two genera of Braconidae from various parts of the world and bring them into North America for ultimate release. Leston (1961) reported 31 genera and 51 species of Miridae parasitized by Braconidae in Great Britain and Lattin & Ozanne (1993) added additional species there. Marsh (1979) listed 19 genera and 28 species parasitized by species of *Leiophron* and *Peristenus* in North America. Loan (1980) reported additional bug genera and species, bringing the total to 22 genera and 34 species. Here, we add 20 additional bug species found in 10 genera that were parasitized by braconids, including four additional genera.

We collected Miridae at six sites in Oregon and Wyoming during the 1986 season. Seven sites in Oregon, including the three in this study, were sampled every two weeks in 1985 and in 1988. Most of the effort was made on three subspecies of *Pinus contorta* Douglas ex Loud and, to a limited extent, the other species of conifers found in association with these pines. *Pinus contorta* is the most widespread species of pine in North America and is considered to have four subspecies (Critchfield 1957, 1980, 1984, 1985; MacDonald & Cwynar 1985, but

see Forrest 1980a, b). Three subspecies were sampled: *Pinus contorta latifolia* Engelmann in Wyoming and Oregon, *P. contorta contorta* Douglas ex Loud and *P. contorta murrayana* (Greville and Balfour) Engelmann in Oregon. Approximately 20 genera and 50 species of Miridae are found on *Pinus contorta* based on the available literature and our studies, and material supplied to us by several mirid specialists. Because parasitism was known to occur chiefly in the nymphal stages, samples of late instar nymphs were dissected, but samples of adults also were examined. We found 10 genera and 18 species of Anthocoridae (Hemiptera: Heteroptera) on the same sites and "host" trees (Lattin & Stanton 1992).

Leston (1959, 1961) described a group of mirids he referred to as "arboreal and early" whose parasitoids emerged from the adult stage. At least four other species he listed had the larva emerging from mature bug nymphs during the same period. Brindley (1939) stated that the mirid is usually parasitized as a second- or third-instar nymph. That would place the time of parasitoid oviposition about three or four weeks ahead of emergence of the mature parasitoid larva. Parasitism prolongs the time required for the bug to reach maturity, if it ever does (Leston 1959, Loan 1983). The stylized life history of a mirid parasitoid is shown in Fig. 1 (after Loan 1983). We found mature parasitoid larvae only in nymphs and none in adults. Observation numbers were low for some taxa because of the scarcity of parasitized nymphs but species of other genera (e.g., *Phoenicocoris* Reuter and *Microphylellus* Reuter) were well represented.

MATERIALS AND METHODS

We collected Hemiptera: Heteroptera from six sites in Oregon and Wyoming during the 1986 season. Seven sites in Oregon, including the three in this study, also were sampled regularly during 1985. Sampling was done by a beating sheet held under a branch. Ten beats with an ax handle were made and all bugs collected. If any bugs were found, another ten beats were made. This effort was continued until no further bugs were collected in a ten beat effort. Ten trees were sampled at each site every two weeks throughout the season. At times, such efforts would produce over 100 specimens of Miridae on a single branch. Such regular sampling collected all instars of most species. Sampling dates began before most bugs appeared and continued into late summer until no further specimens were recovered.

Site Descriptions

Oregon

Site 5—South Beach State Park (SBSP) is 1.6 km south of Newport, Lincoln County, Oregon at an elevation of 7 m (SW $\frac{1}{4}$ of Sec. 20, T11S, R11W) and is adjacent to the Pacific Ocean. A vigorous young stand of shore pine (*P. contorta contorta*) was sampled on a partially stabilized low dune behind the foredune. A few, very small, Sitka spruce (*Picea sitchensis*) (Bongard) Carrière) were scattered through the stand with low willow (*Salix* sp.) adjacent. Older, stabilized dunes to the east contained larger shore pine and some large Sitka spruce.

Site 7—Ochoco Mountains (OM) is 40 km east of Prineville, Crook County, Oregon at an elevation of 1476 m; specifically 0.3 km south of Hwy 25 on FS road 2620 (Sw $\frac{1}{4}$ of Sec. 2, T13S, R19E). Most sampling was done on the west side of FS 2620, on an easterly facing slope. The site contained an open stand of



Figure 1. Generalized life cycle of braconid parasitoid and host mirid (after Loan 1983).

mature ponderosa pine (*P. ponderosa* Douglas ex Lawson) with some regeneration, a few larch (*Larix occidentalis* Nuttall), and mostly young lodgepole pine (*P. contorta latifolia*). A few mature trees also were present.

Site 8—Three Creeks Meadow (TCM) site is 26 km south of Sisters, Deschutes County, Oregon at an elevation of 2069 m (Sw ¼ of Sec. 13, T17S, R9E). It is a moist, subalpine meadow dissected by several small streams. Sierra lodgepole pine (*P. contorta myrrayana*) occurs around the edge of the meadow and up onto the drier slopes surrounding it. Engelmann spruce (*Picea engelmanni* Parry ex Engelmann) was scattered within the pine stand in the meadow. Subalpine fir (*Abies lasiocarpa* (Hooker) Nuttall) occurred among the pine on the drier slopes surrounding the meadow. Sampling was done on trees in the southeastern corner of the meadow, which consisted of both mature and young trees. A few of the older trees were being attacked by the mountain pine beetle, *Dendroctonus pon-*

derosa Hopkins. The dwarf mistletoe, *Arcanthobium americanum* Nuttall ex Engelman, was common on the pines, especially on the older trees.)

Wyoming

Site 2—Happy Jack road (HJR) sites are in the Laramie Range, Medicine Bow National Forest, 19 km east of Laramie, Albany County, Wyoming at an elevation of 2500 m. Site 2.1 (Yellow Pole Campground). They had open stands of mature timber (*P. flexilis* James) and ponderosa pine (*P. ponderosa*) on a south-facing slope (Sec. 25, T15N, R72W). Stands of mature lodgepole pine (*P. contorta latifolia*) were sampled a few km east of this spot at site 2.2 (Sec. 30, T15N, R71W). Lodgepole pines were sampled in both open stands on a south-facing slope, and closed stands on a north facing slope.

Site 3—Sand Lake Road (SLR) site is on the east side of the Snowy Range Mountains about 60 km west of Laramie, Albany County, Wyoming (Sec. 17, T16N, R78W). The specific site lies immediately east of the North Fork campground at an altitude of 2800 m. The stand had been thinned and consisted of second growth lodgepole pine (*P. contorta latifolia*) interspersed with subalpine fir (*A. lasiocarpa*) and some Engelmann spruce (*P. engelmannii*).

Site 4—French Creek Road (FCR) sites are about 90 km west of Laramie (Carbon County) on the west side of the Snowy Range and lie along a back road cutting south from Hwy 130 to French Creek. Site 4.1, at an altitude of 2750 m, was a clear cut east of and adjacent to the highway. (Sec. 1 and 17, T15N, R81W). Regeneration consisted primarily of lodgepole pine (*P. contorta latifolia*) with occasional fir and spruce. Site 4.2 (Sec. 14, T15N, R81W) was at 2650 m. Site 4.3 (Sec. 19, T15N, R80W) was at 2600 m.

PARASITIZED TAXA

Taxonomic problems in several of these plant bug genera prevent precise species assignment and, in at least one instance, involves an undescribed species (to be described later). The presentation of species follows the catalog of Henry & Wheeler (1988) and several later publications that appeared after that date (Stonedahl 1988, 1990; Schuh 1995; Stonedahl & Schwartz 1996).

Deraeocorinae: Clivinematini

Largidea Van Duzee is a North American genus containing 10 species (Henry & Wheeler 1988) all confined to conifers and most on *Pinus* spp. *Largidea shoshonea* Knight was the only species found with braconid larvae: Collection was made in Wyoming, site 2.2 (HJR) ex. *Pinus contorta latifolia*, 9 and 25 Jul 1986 from V instar nymphs.

Deraeocorinae: Deraeocorini

Deraeocoris Kirshbaum is a large, cosmopolitan genus containing around 200 species world-wide (Carvahlo 1957, Razafimahatratra 1980, Razafimahatratra & Lattin 1982). Most known species of *Deraeocoris* are predaceous. *Deraeocoris brevis* (Uhler) is a predator of the pear psylla (Westgard 1973) but Fichter (1984) found it to feed on the douglas-fir tussock moth. Parasitized nymphs of *Deraeocoris diveni* Knight were taken in Oregon: site 8 ex *Picea engelmannii*, 23 Jul 1986 from IV and V instar nymphs. *Deraeocoris kennicotti* Knight yielded parasitized

V instar nymphs in Wyoming: site 2.2 ex *P. ponderosa* and *P. flexilis* on 25 Jul 1986. A *Deraeocoris rubroclarus* Knight V instar nymph was collected in Oregon, Benton County, Lobster Valley ex *Pseudotsuga menzessii* on 3 Aug 1986.

Mirinae: Mirini

Dichrooscytus Fieber is Holarctic with 48 described species in America north of Mexico (Henry & Wheeler 1988) where they occur on conifers and usually are regarded as phytophagous (but see Fichter 1984). Loan (1974 b) described the Braconidae, *Peristenus juniperinus*, from Canada, based on species from *Dichrooscytus tinctipennis* Knight. Fifth instar nymphs of *Dichrooscytus* sp. A from Oregon: site 7, ex *Pinus contorta murrayana* were collected 25 Jun–9 Jul 1986 while V instar nymphs of *Dichrooscytus* sp. C were collected from Oregon: site 8 ex *Picea engelmanni* on 6 Aug 1986. Species of *Dichrooscytus* were found at five of the six sites sampled but parasitized nymphs were found only at the sites listed above.

Phytocoris Fallén has world-wide distribution and may be the largest genus in the family. Stonedahl (1988) stated that over 200 species occur in North America alone. Most species are thought to be predaceous (Fichter 1984) but many show remarkable fidelity to "host trees". Leston (1961) reported 2 species that were parasitized. Marsh (1979) reported *Peristenus dumestris* Loan as a parasitoid of *Phytocoris* sp. and Loan (1980) reported the same braconid as a parasitoid of *Phytocoris lasiomerus* Reuter and *P. pallidicornis* Reuter. He reported euphorine larvae from *Phytocoris tibialis* Reuter and *Phytocoris* sp. Four additional species of *Phytocoris* were found parasitized in this present study.

Phytocoris comulus Knight was collected at Wyoming: site 2 ex *Pinus contorta latifolia* and IV instar nymphs were parasitized as was a parasitized V instar nymph ex *P. ponderosa* on 9 Jul 1986. *Phytocoris fraterculus* Van Duzee was collected in Oregon, Deschutes County, 4 km S. of Sisters ex *Pinus ponderosa* on 29 Aug 1989 with V instar nymphs parasitized. *Phytocoris heidemanni* Reuter was collected at Wyoming: site 2 from *Pinus ponderosa* on 9 Jul 1986 where seven IV instar nymphs contained parasite larvae. *Phytocoris stellatus* Van Duzee was recovered from Wyoming: site 2.2 ex *Pinus contorta latifolia* on 9 Jul 1986 where one IV instar nymph was parasitized while a IV instar nymph from site 3 ex *Pinus contorta latifolia* was collected 11 Jul 1986 and a V instar parasitized nymph from the same host tree was collected from site 4 on 17 Jul 1986. This was a common species at Oregon: sites 5 and 8 but no parasites were recovered.

Platylygus Van Duzee is a North American genus containing 31 species (Kelton & Knight (1970). Although four species have been reported on various subspecies of *Pinus contorta* (Kelton and Knight 1970), only two of these were found parasitized. Species occur early in the season and appear to feed on both male and female cones. Rauf et al. (1984a) and Rauf et al. (1984b) reported that *Platylygus luridus* (Reuter) caused conelet abortion on *Pinus banksiana* resulting in 74% damage. *Platylygus luridus* (Reuter) was taken at Wyoming: site 2.2 ex *Pinus ponderosa* on 9 Jul 1986 where four of the seven V instar nymphs contained larvae. *Platylygus rubripes* Knight was recovered at Oregon: site 7 ex *Pinus contorta latifolia*, 10 Jun 1986 where a IV instar nymph contained a parasitic larva.

Phylinae: Phylinae

Knightomiroides Stonedahl and Schwartz contains a small group of species found on conifers, largely *Pinus* (Stonedahl & Schwartz 1996). *Knightomiroides contortae* Stonedahl & Schwartz was collected at Wyoming: site 2 ex *Pinus contorta latifolia* where a V instar nymph, collected on 25 Jul 1986, and a V instar nymph from Wyoming: site 4 from the same host tree contained parasitoid larvae.

Microphylellus Reuter, a North American genus, contains 21 species including one undescribed species found during this study. Knight (1923) reported *M. modestus* Reuter as a predator. Species occur on both broad-leaf and coniferous trees. Condit & Cate (1982) stated that *Peristenus stygicus* Loan, a Braconidae, attacked *Microphylellus maculipennis* (Knight) in the laboratory. *Microphylellus alpinus* Van Duzee was collected at Oregon: site 8 ex *Pinus contorta murrayana* on 25 Jun 1986 and parasite larvae were recovered from IV and V instar nymphs. *Microphylellus* sp. A. occurred at Oregon: site 5 ex *Pinus contorta contorta* where parasitized V instar nymphs were collected on 26 May and 2 Jun 1986.

Phoenicocoris Reuter is a Holarctic genus with nine species found in North America (Schuh 1995). Stonedahl (1990) moved a number of species into this genus, chiefly from *Lepidopsallus* Knight. *Phoenicocoris hesperus* (Knight) was taken at Oregon: site 5 ex *Pinus contorta contorta* where a parasitized V instar nymph was collected on 18 Jun 1986. *Phoenicocoris longirostris* (Knight) occurred at Oregon: site 8 ex *Pinus contorta murrayana* where V instar nymphs collected on 25 Jun and 9 Jul 1986 were parasitized. This bug was also found at Wyoming: site 2 ex *Pinus contorta latifolia* where a V instar nymph collected on 9 Jul 1986 was parasitized.

Sthenarus Fieber is another Holarctic genus with four species described from North America. There is confusion over the exact placement of the species reported here that will be clarified when a new generic placement is established. *Stenaris* sp. A. was collected at Wyoming: site 2 ex *Pinus contorta latifolia* from V instar nymphs collected on 9 Jul 1986 and a V instar nymph from *Pinus ponderosa* collected 26 Jul 1986, which contained parasitoids.

Phylinae: Pilophorini

Pilophorus is a Holarctic genus with 44 species in the New World (Schuh & Schwartz 1988). These anti-mimics are found chiefly on trees and shrubs with many on conifers where some species feed on aphids. *Pilophorus americanus* Poppius was the only species found parasitized in this study and parasitoid. V instar nymphs were taken at Wyoming: site 2.2 on *Pinus flexilis* on 25 Jul 1986 and at site 3 on *Pinus contorta latifolia* on 11 Jul 1986. Figure 2 shows a fifth instar nymph of *Pilophorus americanus* with a mature braconid larva inside.

DISCUSSION

The occurrence of braconid larvae in the nymphs of Miridae is not surprising (Leston 1959, 1961; Loan 1980). The absence of such parasitoids in some species of Miridae we collected should not be considered non-occurrence because some mirid species were collected in small numbers. As we learn more about the specific habits of both parasitoids and bugs, some of these points will be clarified. It does appear that parasitism is chiefly an early season phenomenon, at least of tree-inhabiting Miridae, as Leston (1959, 1961) suggested. We collected no par-

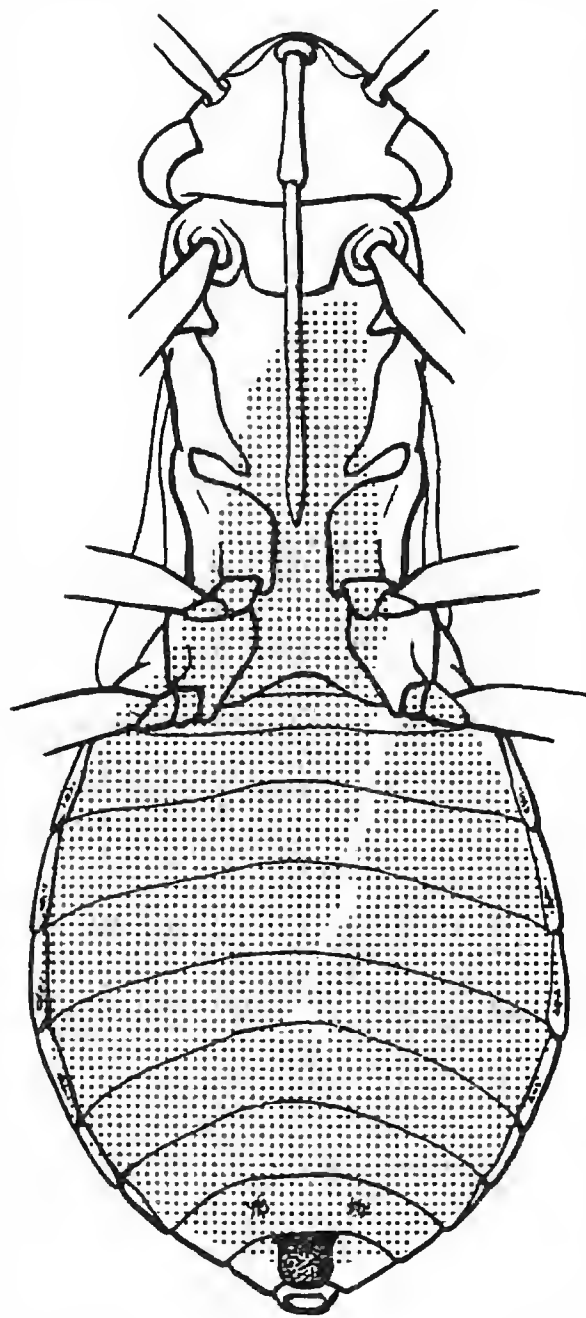


Figure 2. Fifth instar nymph of *Pilophorus americanus* from below, showing parasitoid larva occupying most of the body cavity.

asitized individuals after July so it is possible that the species of bugs occurring later may escape the parasitoids. For example, *Ceratopsus apicatus* Van Duzee was one of the last species to appear in the season from early July to late September, was quite abundant at several sites and yet no parasitoids were recovered from it.

Just why parasitism is more common in the earlier part of the season is not clear. Perhaps only a few polyphagous parasitoid species might be involved at any given site. For example, *Peristenus pallipés* (Curtis) uses at least 9 species of mirid hosts, while *P. juniperinus* appears to attack only a single bug species. Species of braconids attacking certain grass-feeding mirids (i.e., *Acetropis* Fieber, *Irbisia* Reuter, *Leptopterna* Fieber, and *Stenotus* Jakovlev) also must mature early in the season. The tree- and grass-inhabiting mirid species are almost all univoltine. The explanation may be quite simple—if the bug occurs early and is univoltine, the parasitoid must occur at the same time. An examination of the parasitoid system involving the bivoltine, grass-feeding mirid genus *Notostira* Fieber in Europe would be of considerable interest. Are both generations attacked? The same would be true of *Phytocoris stellatus*, normally univoltine in Oregon, Wash-

ington, and on north and east, but multivoltine in southern, coastal California (Stonedahl 1988). Alternatively, parasitoids attacking *Lygus* may occur throughout the season because many species of *Lygus* are multivoltine (Schwartz & Footitt 1998).

The emphasis in field work must shift to the parasitoids themselves to solve these problems. It was our purpose to expand the records of the occurrence of parasitoids in conifer-inhabiting mirid communities and call attention to their existence in many species of our Miridae.

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**A SYNONYMY FOR *PSEUDOMETHOCA DONAEANAE*
(COCKERELL & FOX) (HYMENOPTERA: MUTILLIDAE)¹**

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Abstract.—*Pseudomethoca donaeanae* (Cockerell & Fox) was described in 1897 based on females only. Its known range is recorded as Arizona, California, New Mexico and Texas. *Pseudomethoca russeola* Mickel was described in 1924 based on a single male collected in Texas. Additional specimens examined here expand that range to include Arizona, Kansas and New Mexico. Numerous females of *P. donaeanae* were collected in Doña Ana County, New Mexico in 1992, as well as two males of *P. russeola* that were attracted to a caged female. This, and the similar geographic range, have led to the conclusion that these two are the same species. The name *P. donaeanae* has precedence over *P. russeola*. A complete synonymy is included.

Key Words.—Insecta, Hymenoptera, Mutillidae, *Pseudomethoca donaeanae*, *Pseudomethoca russeola*, taxonomy, synonymy.

Pseudomethoca donaeanae was first described by Cockerell & Fox (1897) as *Sphaerophthalma donae-anae*. The description was apparently made on the basis of four females collected in 1896 in the Mesilla Valley in Doña Ana County, New Mexico. The holotype is in the collection of the American Entomological Society in Philadelphia, and has been examined by this author. Mickel examined two additional female specimens from Arizona and California (1924), and seven female specimens from Arizona, New Mexico and Texas (1935). Until now, this species has been known only from these few female specimens.

Pseudomethoca russeola was described by Mickel (1924) on the basis of a single male collected on 4 May 1901 in San Diego, Texas. This holotype is in the collection of the United States National Museum in Washington, D.C., and has been examined by this author. No other specimen of this species has been recorded in the literature.

PSEUDOMETHOCA DONAEANAE (COCKERELL AND FOX)

Sphaerophthalma donae-anae Cockerell and Fox, 1897: 136. ♀

Mutilla donae-anae Fox, 1899: 224. ♀

Pseudomethoca Donae-Anae André, 1903: 28 ♀

Pseudomethoca russeola Mickel, 1924: 44. NEW SYNONYMY. ♂

Pseudomethoca donaeanae Krombein, 1979: 1302. ♀

Material Examined.—In addition to the type specimens mentioned above, the following material has been examined (all are females of *P. donaeanae* or males of *P. russeola*): U.S.A. ARIZONA. COCHISE Co.: Portal, 2 Sep 1959, H. E. Evans, 1 male. KANSAS. DOUGLAS Co.: 8 km E of Lawrence, 15 Aug–15 Sep 1988, W. T. Wcislo and R. L. Minckley, 1 male. NEW MEXICO. DOÑA ANA Co.: 3.2 km E of Radium Springs, 1 Sep 1992, D. G. Manley, 12 females; 3.2 km E of Radium Springs, 2 Sep 1992, D. G. Manley, 16 females and 2 males; 1.6 km E of Vado, 2 Sep 1992, D. G. Manley, 18 females; 3.2 km E of Radium Springs, 3 Sep 1992, D. G. Manley, 12 females. HIDALGO

¹ Technical contribution no. 4377 of the South Carolina Agricultural Experiment Station, Clemson University.

Co.: Rodeo, 18 Aug 1959, H. E. Evans, 1 female; Rodeo, 28 Aug 1959, H. E. Evans, 1 female and 1 male. TEXAS. BEXAR Co.: U-Bar Ranch, 9.6 km E of Castroville, 29 May 1992, D. G. Manley, 1 Male. DIMMIT Co.: Chaparral W. M. A., 20–30 May 1991, A. W. Hook, 1 male. FRIO Co.: 9.6 km SE of Pearsall, 7 Jul 1972, E. E. Grissell and J. Smith, 1 male. HIDALGO Co.: Bentsen Rio Grande Valley State Park, 13 Jun 1978, C. C. Porter, 1 male; Bentsen Rio Grande Valley State Park, 30 Nov–2 Dec 1978, E. E. Grissell and A. S. Menke, 1 male. KLEBERG Co.: Site 55, 10 Oct 1978, G. E. Gillaspay, 1 male.

DISCUSSION

Both the females of *P. donaeanae* and the males of *P. russeola* have been known from only a few specimens since their original descriptions. The known geographic ranges of southeastern Arizona, New Mexico and Texas are similar for the two. I have not examined the specimen from Calexico, California that was noted by Mickel (1924). Even if correctly identified, I find the collection data on that specimen to be suspect. I have collected extensively throughout Arizona and southern California, including the Calexico area, and have not found (or seen) specimens of either of these species from those areas. The female specimens of *P. donaeanae* and the male specimens of *P. russeola* collected by Evans in the Portal, Arizona/Rodeo, New Mexico area (only about 16 km apart) on or about the same collection dates add further evidence for the synonymy of these two species.

A female of *P. donaeanae* was collected on 2 Sep 1992 about 1.6 km E of Radium Springs, New Mexico. It was placed in a small, plastic cage from which the ends had been cut out and replaced with wire screen. Two males were attracted to the caged female and attempted to mate with her through the screen. They were subsequently captured a short time later and determined to be *P. russeola*. No other males were attracted to the caged female, although there were numerous males and females of other mutillid species in the area at the time. The use of caged females has been used previously to attract males, both in cases where the male was already known and where the male was unknown. Males are not always attracted to the caged females. However, in all cases in which males have been attracted to the caged females, they have been subsequently shown to be of a single species. And in cases where the males were previously known, they have always been of the same species as the caged female. Thus, the use of caged females is a reliable method for obtaining sex correlations among mutillid wasps.

CONCLUSIONS

The known geographic ranges for *P. donaeanae* and *P. russeola*, the present collection data, and the use of caged females for the attraction of conspecific males, all lead to the conclusion that these two are a single species. Because *P. donaeanae* has precedence over *P. russeola*, that name shall stand.

ACKNOWLEDGMENT

I thank Donald Azuma, Philadelphia Academy of Sciences, for allowing me to examine the holotype of *Pseudomethoca donaeanae*, and Arnold Menke, United States National Museum, for allowing me to examine the holotype of *Pseudomethoca russeola*. Fieldwork for collection and study of the specimens in 1992 was supported, in part, by a grant from the National Science Foundation (BSR-9106369).

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**THE LEIODIDAE (COLEOPTERA) OF THE CARNEGIE
MUSEUM OF NATURAL HISTORY. NEW DATA AND
DESCRIPTION OF TWO NEW SPECIES**

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Abstract.—The collection of the family Leiodidae at the Carnegie Museum of Natural History (CMNH) was studied. Two new species, *Catops davidsoni*, NEW SPECIES (USA) and *Adelopsis chapadaensis*, NEW SPECIES (Brazil) are described. Also, new biogeographic data on several species from America and Europe are given.

Key Words.—Insecta, Coleoptera, Leiodidae, systematic, *Catops davidsoni* n.sp., *Adelopsis chapadaensis* n.sp., new data.

Resumen.—Se ha examinado la colección de la familia Leiodidae del Carnegie Museum of Natural History (CMNH). A partir de tan interesante material entomológico se han descrito dos especies nuevas, *Catops davidsoni* n. sp. y *Adelopsis chapadaensis* n. sp., y además se proporcionan nuevos datos biogeográficos de varias especies de la familia Leiodidae de América y de Europa.

This paper widens our knowledge of the beetle family Leiodidae by studying 745 specimens belonging to the Carnegie Museum of Natural History (CMNH) collection, Pittsburg, Pennsylvania, U.S.A.

The material examined has enabled me to differentiate 45 American species and 15 European ones. The American species include two new ones, *Catops davidsoni*, NEW SPECIES and *Adelopsis chapadaensis*, NEW SPECIES; of the remaining 43 species, the number of specimens studied and their distribution is reported and attention is brought to those species which are new state records in the U.S.A. An appendix of the 15 European species is included at the end.

MATERIAL STUDIED

I follow the suprageneric classification proposed by Newton & Thayer (1992).

Family Leiodidae Fleming, 1821
Subfamily Coloninae Horn, 1880

Colon (Colon) horni Szymczakowski, 1981

Widespread species, known from Nova Scotia and Massachusetts, west to Ontario and Minnesota (Peck & Stephan 1996).

Records: Pittsburgh (PA), 1m; 1f. This record is new for Pennsylvania.

Colon (Colon) bidentatum Sahlberg, 1834

This species is known from central and northern Europe (Szymczakowski 1969a, von Peez 1971) and from North America, northern transcontinental (Peck & Stephan 1996).

Records: DC, 1m, NY, 1f. PA, 2m; 6f. VA, 1m; 1f. New record for the District of Columbia.

Colon (Colon) tibiale Hatch, 1957

Known from North America, northern transcontinental distribution.
Records: CA, 1f.

Colon (Colon) asperatum Horn, 1880

Very similar distribution to the previous species, northern transcontinental.
Records: DC, 1m. New record for the District of Columbia.

Colon (Euricolon) magnicolle Mannerheim, 1853

Widespread species, northern transcontinental.
Records: LA, 1f. PA, 1m. Both are new records for the states of Louisiana and Pennsylvania.

Colon (Striatocolon) thoracicum Horn, 1880

Widespread in eastern North America (Peck & Stephan 1996).
Records: DC, 1m; 1f. PA, 1m.

Colon (Myloechus) hubbardi Horn, 1880

Across all of North America. Fairly common.
Records: DC, 1m. IA, 1f. MI, 1m; 1f. PA, 1m. TN, 1m. The records from the states of Pennsylvania and Tennessee are new.

Colon (Myloechus) megasetosum Peck & Stephan, 1996

Widespread in eastern North America, Ontario and Quebec to Alabama and Georgia (Peck & Stephan 1996).
Records: DC 1f. PA, 4m; 6f.

Colon (Myloechus) celatum Horn, 1880

This species is known from southern British Columbia and Alberta to California.
Records: NV, 1f.

Colon (Myloechus) longitorsum Peck & Stephan, 1996

Distribution from North Carolina to Oregon (Peck & Stephan 1996)
Records: CA, 1f.

Colon (Myloechus) serratum Hatch, 1957

Western North America from southern Alaska to northern California (Peck & Stephan 1996)
Records: CA, 1m.

Colon (Myloechus) dentatum LeConte, 1853

This species is known in most of eastern North America.
Records: DC, 8m; 13f. IL, 1m; 3f. MD, 1m; 1f. MO., 1m; 2f. PA, 7m; 10f. TN, 1m. VA, 1m. The records for Montana and Tennessee are new.

Subfamily Cholevinae Kirkby, 1837
Tribe Anemadini Hatch, 1928

Nemadus (Laferius) brachycerus (LeConte, 1863)

Eastern half of North America and more abundant in the south.

Records: SD, 6m; 10f.

Nemadus (Nemadus) hornii Hatch, 1933

Similar distribution to that of previous species (Hatch 1933, 1957).

Records: IL, 1m; 2f. MI, 1m; 1f. PA, 7m; 9f. OH, 2m; 1f. SD, 5m; 7f. The records for Illinois and South Dakota are new.

Nemadus (Nemadus) tenuitarsis Jeannel, 1936

Known only from Ohio and Pennsylvania (Jeannel 1936).

Records: PA, 1f.

Nemadus (Nemadus) parasitus (LeConte, 1853)

Widespread in northern, central and western states of North America (Hatch 1933).

Records: DC, 10m; 13f. IL, 1m. NJ, 1m. NY, 1m; 1f. PA, 12m; 17f. VA, 1f. New locations for the states of Illinois and Virginia.

Nemadus (Nemadus) pusio (LeConte, 1853)

Known from eastern North America from British Columbia to California.

Records: CA, 1m.

Dissochaetus hetschkoi Reitter, 1884

This species is known from Brazil (Jeannel 1936, Szymczakowski 1963, Gnaspini 1991, Salgado 1991), Venezuela (Szymczakowski 1969b) and Mexico (Peck 1977a).

Records: This species was located for the first time in Rio de Janeiro, 1f; Santarem, 1f; Minas Gerais, 1m, and Chapada dos Guimaraes (Mato Grosso), 1m; 2f.

Dissochaetus murrayi murrayi Reitter, 1884

Widespread from Argentina—state of Corrientes—(Salgado 1991) to the entire central and eastern area of Brazil (Jeannel 1936, Gnaspini 1991).

Records: Aguas Vermelhas (Minas Gerais), 1m; 1f. and Alagoas (Serra Branca), 1f. The Alagoas location is new for the state of Serra Branca.

Dissochaetus oblitus (LeConte, 1853)

Present in all central and eastern states in the U.S.A.

Records: DC; 3m; 3f. PA, 3m; 3f.

Dissochaetus mexicanus Jeannel, 1936

Known from the state of Mexico (Jeannel 1936, Szymczakowski 1968, Peck 1977a).

Records: Guadalajara (Mexico), 1f.

Prionochaeta opaca (Say, 1825)

Widespread in the centre and east of North America (Peck 1977b).

Records: DC, 2m; 1f. MD, 1m; 1f. PA, 26m; 25f. WV, 2m; 3f.

Tribe Cholevini Kirby, 1837

Catops davidsoni Salgado, NEW SPECIES

Figs. 1–6

Type series.—PENNSYLVANIA. *Allegheny*: Holotype male deposited in CMNH. Paratypes: PENNSYLVANIA. *Allegheny*. 1m, *Pittsburg*. 1m, *St. Vicent*. 1f. *District of Columbia*, 3m, 1f. Deposited: CMNH (6) and Col. Salgado (University of León, Spain) (1).

Description.—Large size; length 3.10 to 3.70 mm; width 1.50 to 1.80 mm. (Fig. 1).

Elongate elyptical body. Head and pronotum dark brown, elytra more light brown. Head coarsely punctured. Antenna robust, 1.6 times as long as pronotum, passing base of pronotum when laid back; proportions of length of each segment and that of the 9th from 1st to 11th (Fig. 2): 1.42, 1.03, 1.00, 0.50, 0.50, 0.45, 1.00, 0.20, 1.00, 0.96, 1.45, the equal length of 3rd, 7th and 9th segments stands out; proportions of length and width of each segment from 1st to 11th, 2.43, 1.77, 1.50, 0.75, 0.63, 0.53, 0.75, 0.19, 0.75, 0.72, 1.23, the strongly transverse sixth antennal segment stands out, almost twice as wide as long in frontal view. Pronotum densely haired and finely granulate with setal bases; base narrower than the elytra; sides very curved in both sexes; widest at middle; 1.7 times as wide as long; hind angles almost rounded. Elytra together 1.2 times as long as wide; widest at basal third; densely granulate from setal bases. Sutural striae well marked and sutural angle feebly pointed. Flight wings fully formed. First segment of male protarsus 0.9 times as wide as the maximum width of tibia. Male profemur with broad raised area on inner margin. Male metatrochanter (Fig. 3) with very pointed curved tip, a form unique in American species of the genus *Catops*. Female metatrochanter pointed, not curved. Aedeagus in lateral view (Fig. 4) in regular curve with widened apex area; in ventral view (Fig. 5) sides parallel in centre of median lobe, becoming wider and ending in a rounded tip. Internal sac armed with very characteristic structures, such as a strongly sclerotized mid basal plaque, formed by 6 symmetrically placed robust teeth and two symmetrical rows of thick bristles along the middle. Genital segment complete, longer than broad, wide and indented lobes with some pointed setae, numerous setae on sternal face (Fig. 6).

Diagnosis.—The species is readily distinguished by the shape of the aedeagus and the curved pointed tip of the male metatrochanter.

Discussion.—It is possible that some specimens of *Catops davidsoni* have been mistaken for *C. americanus*, because the latter shows a wide polymorphism (Hatch 1933), and is also widespread, including the area of the new species with which it lives.

The differences between *C. davidsoni* and *C. americanus* are evident and are observed in the general form of the aedeagus, in the structures of the internal sac, the genital segment and the metatrochanter.

KEY

In order to assess the taxonomic status of *C. davidsoni*, I have followed the key proposed by Hatch (1933, 1957) for the genus *Catops* species.

1. Third antennal segment longer than second; eighth antennal segment more than half as long as ninth and subequal to the sixth in length; male profemora and metatrochanters and female abdomen unmodified.

Two species under this heading: *Catops alsiosus* and *C. gratiosus*.

- 1'. Third antennal segment equal to, or a little shorter than second; eighth antennal segment less than half as long as ninth, strongly transverse . . . 2
2. Antennae with sixth segment strongly transverse, nearly twice as wide as long in frontal view; pronotum slightly arcuate at sides; female with fifth abdominal sternite emarginate behind.

Three species under this heading: *C. basilaris*, *C. egenus* and *C. mathersi*.

- 2'. Antennae with sixth segment slightly transverse in frontal view; pronotum more strongly arcuate at sides; female with abdominal sternite not emarginate behind 3
3. Male with prefemora tuberculate below, the edentate metatrochanter, female with abdominal sternites third to sixth more or less impressed.

Two species under this heading: *C. luridipennis* and *C. simplex*.

- 3'. Male with prefemora not tuberculate below, flattened, the metatrochanter dentate at about apical fourth; female with abdominal sternites unimpressed or only impressed sternites fifth and sixth 4
4. Male metatrochanter with very pointed curved tip; apical zone of median lobe of aedeagus strongly narrow and elongate, with rounded tip; base of internal sac with six symmetric robust teeth
 *Catops davidsoni* n. sp.
- 4'. Male metatrochanter pointed, not curved; apical zone of median lobe of aedeagus wider or in the shape of a spear head; base of internal sac without robust teeth, only some bristle formations . . . *Catops americanus*

Etymology.—The species is dedicated to Robert L. Davidson, Curator of the Carnegie Museum, who has generously made it possible for me to study the many Leiiodids of the Museum collection.

Distribution.—The species is known from Georgetown (District of Columbia) and from Allegheny, Pittsburgh and St. Vincent (Pennsylvania):

Catops alsiosus (Horn, 1885)

Distribution northern transcontinental.

Records: AK, 1m.

Catops mathersi Hatch, 1957

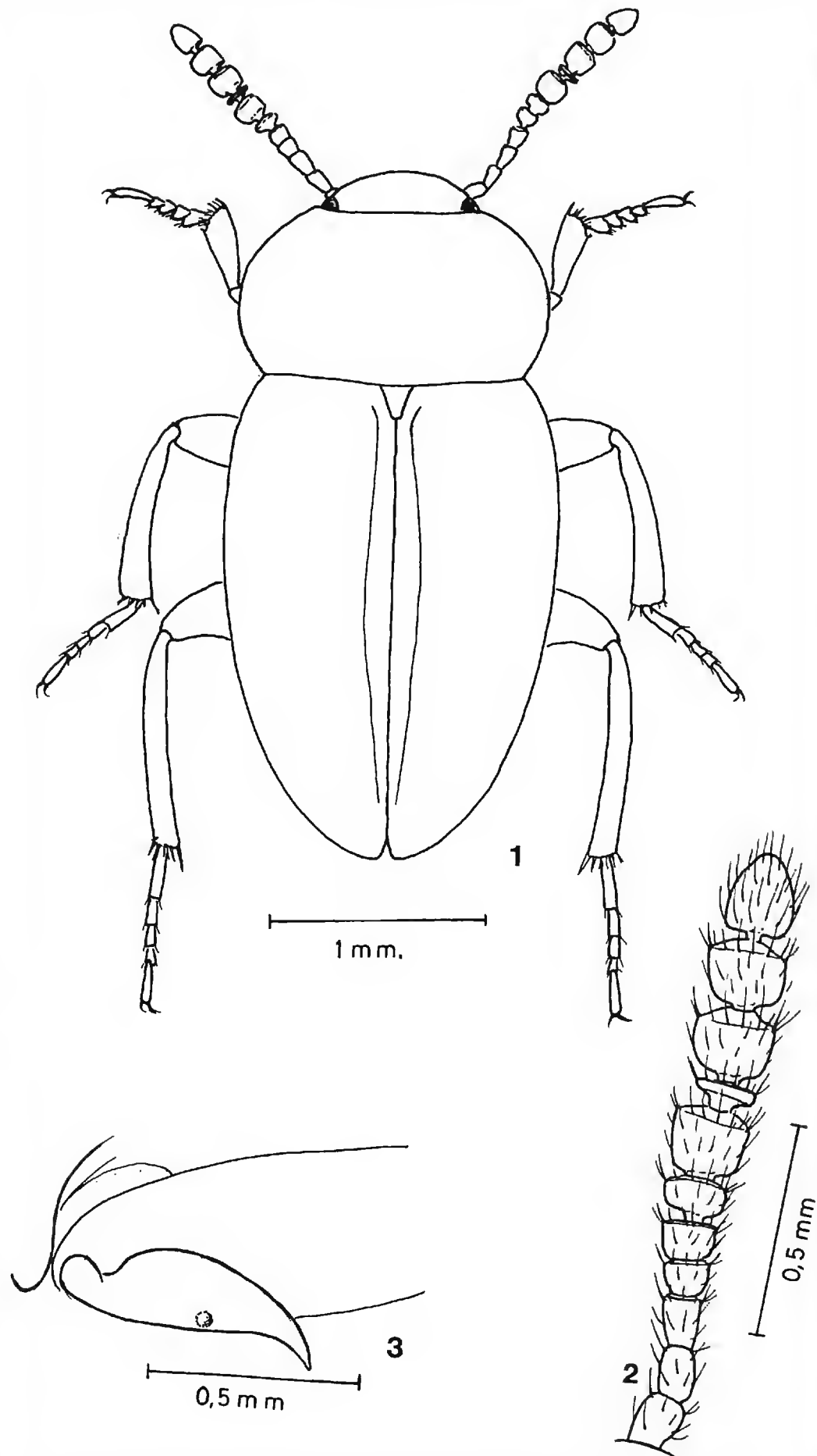
This species is known in the central-northern states of the USA and the central-south of Canada.

Records: AB, 1m.

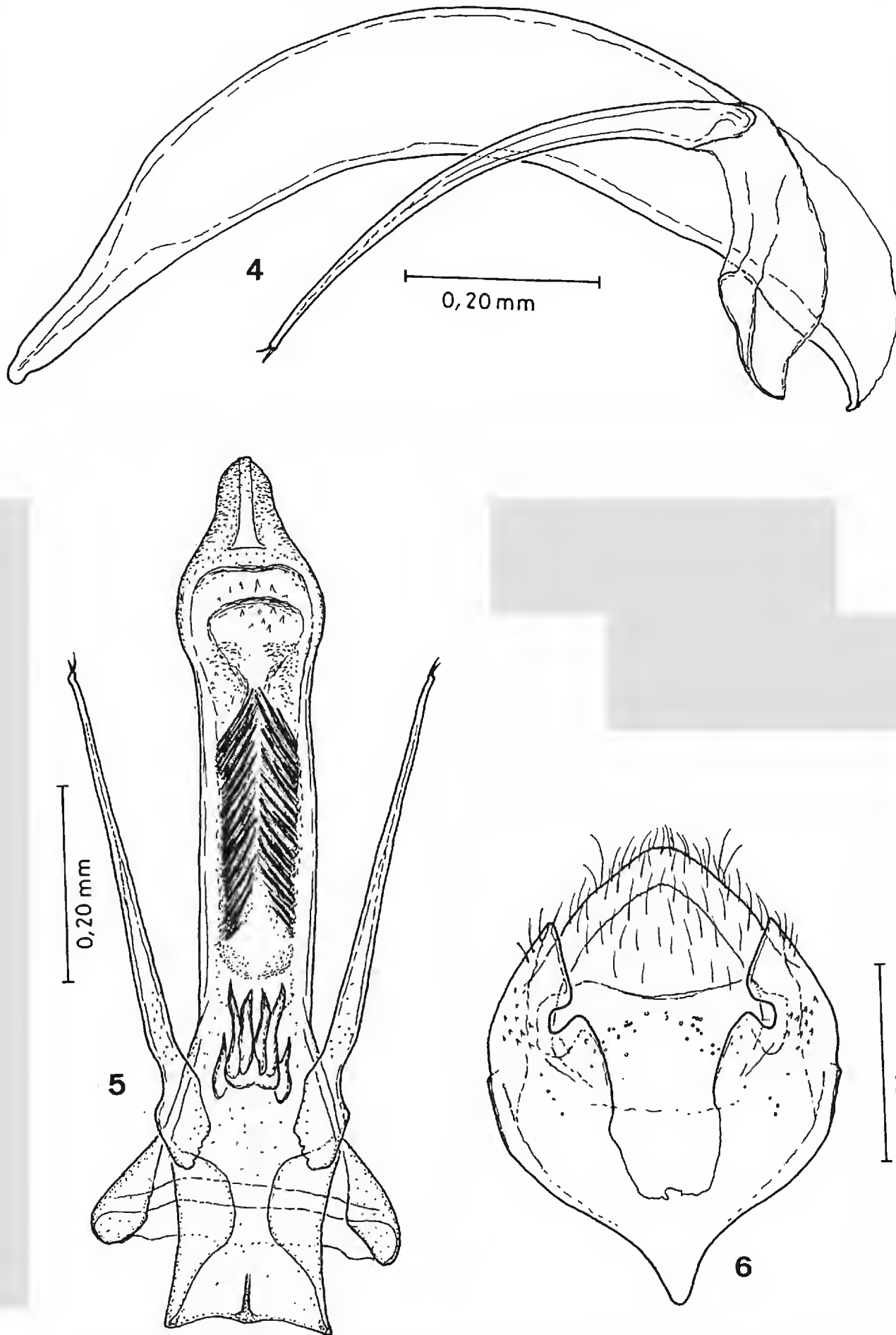
Catops gratiosus (Blanchard, 1915)

Widespread in northern and eastern North America (Hatch 1933, 1957).

Records: DC, 1m. KY, 2m; 1f. PA, 1m. VA, 1f. It is a new record for the District of Columbia.



Figures 1-3. *Catops davidsoni*. 1: habitus; 2: antenna, lateral view; 3: male metatrochanter; lateral view.



Figures 4–6. *Catops davidsoni*. 4: aedeagus, lateral view; 5: aedeagus, ventral view; 6: genital segment.

Catops luridipennis luripennis Mannerheim, 1853

Known in Alaska, almost all states in Canada and in central western states of the USA.

Records: AB, 1m. AZ, 1m; 1f.

Catops simplex Say, 1825

Widespread in all North America.

Records: AL, 1m; 1f. DC, 5m; 7f. IL, 1m; 1f. PA, 7m; 9f.

Catops egenus (Horn, 1880)

Very frequent in the states of western North America.

Records: AK, 5m; 6f. AR, 1m. CA, 1m; 1f. OR, 1m. The record is new for the state of Arkansas.

Catops basilaris (Say, 1823)

Distributed throughout most states of North America. Already indicated by Hatch (1933, 1957) in 23 states in North America.

Records: AL, 2m; 1f. CA, 1m; 1f. DC, 1f. IL, 1m; 1f. LA, 1f. MD, 1f. NC, 13m; 15f. NH, 1f. PA, 1m; 2f. The records are new for the states of Illinois and Louisiana.

Catops americanus (Hatch, 1928)

Found in most states of North America (Hatch 1933, 1957). This species is markedly variable in the form of the middle lobe of the aedeagus, which may cause a certain degree of confusion. Hence the diagrams of the two species, one of NC (Figs. 7–9) and another of DC (Figs. 10–11).

Records: DC, 4m; 1f. NC, 1m. PA, 1m.

Catoptrichus frankenhauseri Mannerheim, 1853

Known only from British Columbia, Alaska, Idaho, Oregon and Washington.

Records: I have seen 33 specimens from AK, ID, and OR.

Sciodrepoides fumatus terminans (LeConte, 1850)

Very frequent in most states of North America.

Records: I have seen 52 specimens from DC, IA, IL, NB, NY, OH, and PA. The record for the state of Illinois is new.

Sciodrepoides watsoni hernianus (Blanchard, 1915)

It lives with the above-mentioned species in several states and is likewise fairly common.

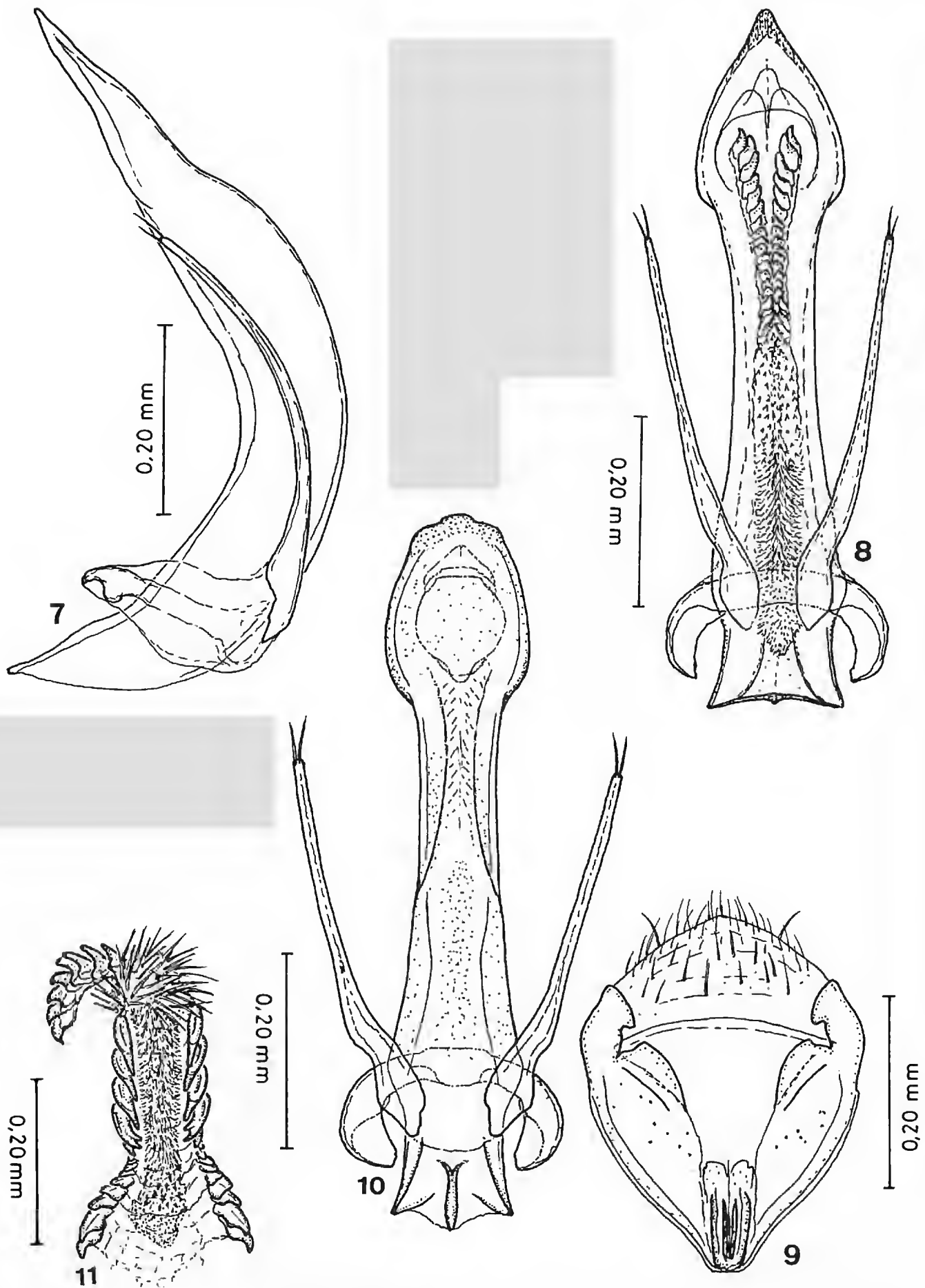
Records: I have seen 47 specimens from DC, KS, MD, PA and VT. The record for Vermont is new.

Tribe Leptodirini Lacordaire, 1854

Platycholeus leptinoides (Crotch, 1874)

Species known from the states of California, Nevada and Oregon.

Records: CA, 1f. NV, 1m, 1f.



Figures 7–11. *Catops americanus*. 7: aedeagus, lateral view; 8: aedeagus, ventral view (specimen from North Carolina); 9: genital segment; 10: aedeagus, ventral view (specimen from D.C.); 11: internal sac armature (specimen from D.C.).

Platycholeus opacellus Fall, 1909

This species, not so widespread as the previous species, only known from California.

Records: CA, 1m.

Tribe Eucatopini Jeannel, 1921

Eucatops glabricollis (Reitter, 1884)

This species is known from Brazil, Santa Catharina and Sao Paulo (Jeannel 1936) and from Blumenau (Szymczakowski 1963). Recently mentioned by Gnaspini (1994).

Records: Alagoas (Serra Branca), 1m and Para, 1f. Both records are new for Serra Branca and Pará.

Tribe Ptomaphagini Jeannel, 1911

Adelopsis chapadaensis Salgado, NEW SPECIES

Figs. 12–15

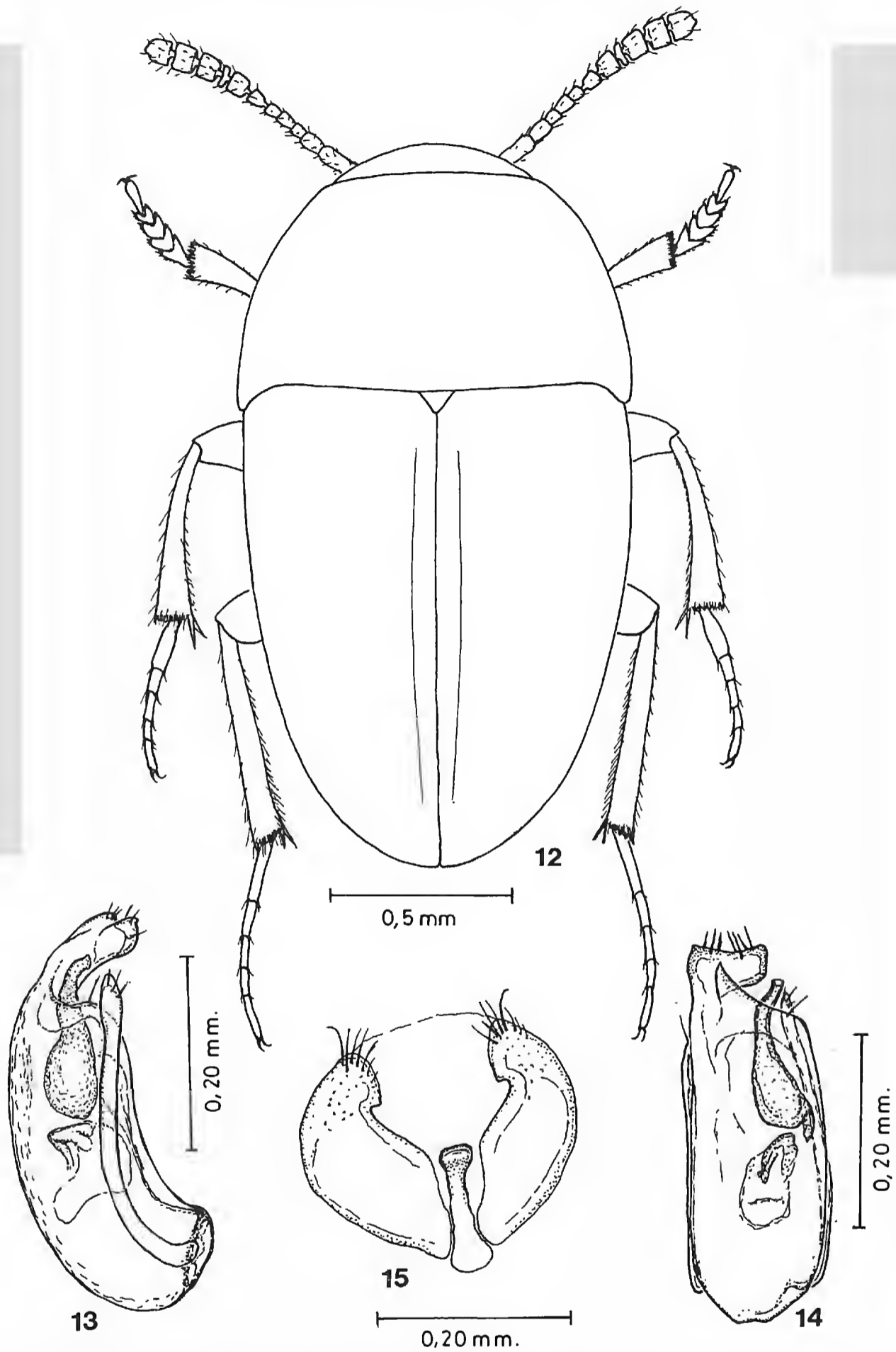
Type series.—BRAZIL. *Mato Grosso*. Chapada dos Guimaraes. Holotype male and paratype female deposited in CMNH.

Diagnosis and description.—Length: 1.85–1.95 mm; width: 0.90–0.97 mm (Fig. 12). Pubescence golden, with many short recumbent setae, setal sockets forming strigae on the head, pronotum and elytra. Color light brown. All antenna color lightening, fairly robust with flattened club, 1.22 times as long as pronotum; proportions of length of each segment and that of the 9th from 1st to 11th: 2.00, 1.85, 0.95, 0.90, 0.80, 0.65, 1.10, 0.45, 1.00, 1.00, 1.75; proportions of length and width of each segment of the club, from 7th to 11th: 0.9, 0.38, 0.79, 0.74, 1.12. Pronotum 1.54 times as wide as long, as wide as the elytra, maximum width in hind angles. Hind angles weakly pointed but slightly protruding backwards. Elongated elytra, not very convex, not pointed at back and weakly arched over the sides; together 1.40 times as long as wide; with dense oblique strigae. Sutural striae entire and deep. Mesosternal carina high and cutting, smooth rounded profile view. Summits of tibia the typical of Ptomaphagini, armed with a comb of many short and equal spines; with the first segment of male protarsus 0.75 times as broad as the maximum width of tibia. Aedeagus (Figs. 13–14) with apical plaque transversally produced, bearing a medial cavity, margins slightly protruding and 7 small setae inserted in groups of 3 and 4 setae. Genital segment (Fig. 15) slightly broader than long, lateral lobes bearing several long and short setae. Spiculum gastrale short and straight, also somewhat wider at base.

Etymology.—The name is derived from the area in Brazil where it was captured, “Chapada” (type locality).

Discussion.—Using the characteristics of the aedeagus as a basis of differentiation, *A. chapadaensis* is clearly unlike *A. bellatrix* Szymczakowski, 1968; *A. peruviana* Blas, 1980 and *A. confluens* Gnaspini & Peck, 1996 in that it does not present a small right lobe (lateral view), usually with setae surrounding the apical orifice of the aedeagus.

Moreover, *A. chapadaensis* could form a group of species with *A. brunnea* Jeannel, 1936 and their different shapes (Szymczakowski 1975), *A. coronaria* Gnaspini & Peck 1996 and *A. galea* Gnaspini & Peck 1996, having the same model of aedeagus and gastral spiculum in the genital segment. However, differences amongst these three species can be observed in the size, form of antennae and the protarsus of the male, but particularly in the shape of the aedeagus and number of setae on the apical plaque, and also in the shape, insertion and number of setae of the parameres. Finally, it should be pointed out that Gnaspini (1996) modified the generic concepts in Ptomaphagini and consequently the subgenera of *Adelopsis* have been dropped.



Figures 12–15. *Adelopsis chapadaensis*. 12: habitus; 13: aedeagus, lateral view; 14: aedeagus, dorsal view; 15: genital segment.

Paulipalpina claudicans (Szymczakowski, 1980)

The genus *Paulipalpina* was established by Gnaspini & Peck (1996) using *Adelopsis claudicans* described from Nova Teutonia, Santa Catharina (Brazil) by Szymczakowski (1980) as type species.

Records: Rio de Janeiro (Brazil), 1f. It is new record from Rio de Janeiro.

Ptomaphagus (Adelops) ulkei Horn, 1885

According to Peck (1973), this species is known from central New York, westward to central Indiana and southward to northwestern Georgia.

Records: DC, 1m. The record for the District of Columbia is new.

Ptomaphagus (Adelops) fisus Horn, 1885

Known in several states in western USA (AZ, CA, CO, ID, NV, TX) and one record from north of Mexico.

Records: CA, 2m; 1f. NB, 1m. The Nebraska record is new.

Ptomaphagus (Adelops) nevadicus Horn, 1880

This species has the widest range of any known *Adelops*. It is distributed in southern Canada, most of the western states of the USA and Durango (Mexico).

Records: CA, 6m; 8f.

Ptomaphagus (Adelops) brevior Jeannel, 1949

Widespread in eastern North America.

Records: DC, 3m; 5f. IL, 1m. NC, 1f. PA, 1m; 1f. TN, 1m. The record for the state of Tennessee is new.

Ptomaphagus (Adelops) consobrinus (LeConte, 1853)

This species is distributed in the south from Texas to Florida, and towards the north of Colorado to New Jersey (Peck 1973).

Records: PA, 4m; 2f. SC, 1m. TX, 1m. The record for Pennsylvania is new.

Ptomaphagus (Adelops) hirtus (Tellkamp, 1844)

This species only is known from the Mammoth Cave area of Kentucky.

Records: I have seen 18 specimens, Mammoth Cave (KY).

European species checklist.—*Colon (Euricolon) latum* Kraatz, 1850. 4 specimens, Sweden. *Bathysciola schiodtei schiodtei* (Kiesenwetter, 1850). 5 specimens, France. *Nargus (Nargus) anisotomoides* (Spence, 1815). 2 specimens, France. *Nargus (Demochrus) wilkini* (Spence, 1815). 3 specimens, Austria. *Choleva (Choleva) oblonga oblonga* Latreille, 1807. 3 specimens, Austria. *Choleva (Choleva) sturmi* Brisout, 1863. 1 specimen, Austria. *Choleva (Choleva) cisteloides* (Frölich, 1799). 2 specimens, Hungary. *Catops morio* (Fabricius, 1792). 2 specimens, Austria; 5 specimens, Sweden. *Catops borealis* Krogerus, 1931. 11 specimens, Sweden. *Catops fuscus fuscus* (Panzer, 1794). 12 specimens, Sweden. *Catops tristis* (Panzer, 1794). 6 specimens, Austria. *Catops subfuscus subfuscus* Kellner, 1846. 3 specimens, Austria; 3 specimens, Switzerland. *Apocatops nigrita* (Erichson, 1837). 2 specimens, Francia; 3 specimens, Sweden. *Sciodrepoides watsoni watsoni* (Spence, 1815). 5 specimens, Austria; 8 specimens, Sweden. *Ptomaphagus sericatus septentrionalis* Jeannel, 1934. 9 specimens, Sweden.

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**A SECOND SPECIES OF FOSSIL *DASYMUTILLA*
(HYMENOPTERA: MUTILLIDAE) FROM
DOMINICAN AMBER¹**

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Abstract.—*Dasymutilla albifasciatus*, a NEW SPECIES of mutillid wasp, is described from a fossil specimen embedded in a piece of Dominican amber estimated to be anywhere from 15–45 million years old. Very few fossil mutillids have been recorded, and this represents only the second description of a fossil mutillid from the New World. This male is thought to belong to the *bioculata* species group, and can be distinguished from closely related species by the band of white integument extending from the top of the propodeum along the sides of the thorax to the lower half of the pronotum.

Key Words.—Insecta, *Dasymutilla albifasciatus*, Mutillidae, new species, fossil, Dominican amber.

Fossil velvet ants, or mutillids, are extremely rare and to date all except one have been limited to Palaearctic forms. Menge (1856) found six specimens of this family in Baltic amber and Brischke (1886) cites another three from the same deposits. Larsson (1978) mentioned an additional three in the Copenhagen collection of Baltic amber insects. To our knowledge, none of the above have been described. Scudder (1891) referred to an undescribed *Mutilla* from the mid-Oligocene beds (not amber) located in Brunstatt, Alsatia (now Alsace), in northeastern France.

Bischoff (1915) described seven species of fossil mutillids from Baltic amber, placing them in a new genus, *Protomutilla*. Krombein (1979) suggested that at least one of those species may not be correctly assigned to the family Mutillidae. However, that still appears to have been the first description of a fossil mutillid.

Sharov (1957) described another new species of aculeate Hymenoptera from the Cretaceous of Siberia, which was ultimately assigned to Mutillidae. That fossil specimen, estimated to be about 80 million years old, was called *Cretavus sibiricus* Sharov, for which the author created a new family, Cretavidae. Rasnitsyn (1975) later placed it in the family Mutillidae.

Manley & Poinar (1991) described *Dasymutilla dominica* Manley & Poinar from Dominican amber estimated to be from 25 to 40 million years old. That represented the first record and description of a fossil mutillid from the New World. Here we describe another new species of fossil *Dasymutilla*, also from Dominican amber.

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Figure 1. Holotype of *Dasymutilla albifasciatus* Manley & Poinar. Lateral view showing pale felt line (arrow) and white band on thorax (fleck).

METHODS AND MATERIALS

The specimen is believed to have originated from mines in the Cordillera Septentrional of the Dominican Republic. These mines are in the El Mamey Formation (Upper Eocene), which is a shale-sandstone interspersed with a conglomerate of well-rounded pebbles (Eberle et al. 1980). The exact age of the amber is unknown but estimates based on various microfossils and chemical analyses provide a range from 15–20 million years (Iturralde-Vincent & MacPhee 1996) to 30–45 million years (Cepek in Schlee 1990). The amber piece containing the fossil mutillid is possibly between 20 to 40 million years. It is roughly triangular in shape, with the sides measuring 28 mm by 40 mm by 25 mm. The thickness of the piece varies from 5–7 mm and the weight is 3.3 g. Other prominent inclusions in the amber piece are a drosophilid fly, bush cricket, ciid beetle, erythraeid mite, crane fly and bark fragment. The amber was re-shaped and re-polished by one author (GOP) to obtain the best viewing angle.

DASYMUTILLA ALBIFASCIATUS MANLEY & POINAR, NEW SPECIES (Fig. 1)

Type.—Holotype male, data: DOMINICAN REPUBLIC. Cordillera Septentrional mountains; deposited in the Poinar amber collection, Department of Entomology, Oregon State University, Corvallis, Oregon, U.S.A.

Description.—Male. Length 10 mm. Integument predominantly black; pubescence sparse, both pale and black, erect and semierect. Head black, rounded, with sparse, pale pubescence throughout; head appears narrower than thorax, although this character is not clear. Eyes and ocelli normal; eyes large, not bulging; ocelli small; ocello-ocular distance about $3.0\times$ greatest width of ocelli. Punctures relatively large, well-separated where visible. Mandibles bidentate, black throughout. Clypeus bidentate. Antennae black; flagellomeres subequal in length; scape bicarinate beneath; punctation not apparent; antennal scrobes appear slightly carinate, although not clearly visible. Thorax black, except broad white band extending from upper part of propodeum laterally through lower half of propleura (Fig. 1); white band void of pubescence except a few sparse white hairs on the propodeum and posterior

part of the mesopleuron of the band. Thorax appears longer than broad, although this character not clearly visible. Pronotum with humeral angles rounded; anterior margin apparently not emarginate (consistent with evenly rounded posterior margin of head). Mesonotum black except white circular spot in middle; without laterally expanded lobes. Propodeum coarsely reticulate. Tegulae subhemispherical, appear glabrous, smooth and shining; anterior margin with sparse, black pubescence. Pleura coarsely punctate throughout, with relatively large, separated punctures. Prothorax and propodeum with sparse, erect pubescence. Mesonotum, scutellum, and pleura with black, recumbent pubescence. Legs black, with sparse, pale, erect pubescence; calcaria pale; apices of middle and hind femora rounded; posterior trochanters appear normal, not toothed, although not clearly visible; hind tibiae cylindrical, not flattened on inner margin. Wings folded, not clearly visible, but appear banded black and white. Abdomen black throughout. Abdomen with sparse, shallow punctures, except second tergite laterally with relatively coarse punctation. First sternite with a longitudinal carina about nine-tenths length of segment. Tergite I and tergite II anteriorly with sparse, pale, erect pubescence; tergite I terminating in apical band of pale pubescence. Sternum with sparse, pale, erect pubescence scattered throughout; sterna II-IV with apical bands of pale pubescence; sterna V-VI with apical bands of black pubescence. Apical half of tergite II, and remainder of tergum clothed with recumbent and erect, black pubescence. Sternite II with a round, median pit filled with pale hairs. Felt lines with pale pubescence (Fig. 1). Pygidium not clearly visible, but apparently with apical fringe of hairs. Hypopygium black, punctation not readily visible; posterolateral angles of last sternite rounded, not dentate.

Diagnosis.—*Dasymutilla albifasciatus*, like *D. dominica*, is placed in the *bioculata* species group. It is distinguished from all other members of the *bioculata* species group by the white band along each side of the thorax and the white spot on the mesothorax. In no other known *Dasymutilla* is there any evidence of white integument.

Etymology.—The specific name is taken from the Latinized *albus*, meaning white, and *fasciatus*, meaning broad transverse stripe, thus reflecting the specimen's diagnostic character of a transverse white band of integument along the side of the thorax.

Distribution.—Known only from the type specimen.

Material Examined.—Type.

DISCUSSION

Dasymutilla albifasciatus, like *D. dominica*, exhibits the characteristics attributed to males of the genus *Dasymutilla* by Mickel (1928). These include eyes being round, prominent, almost hemispherical in shape, polished, with the facets usually (but not always) very indistinct, and the first abdominal segment either distinctly petiolate, subpetiolate, or sessile, but never completely sessile with the second. Another important character present only in some *Dasymutilla* and some *Traumatomutilla* is the median pit filled with hairs on the second abdominal sternite. That pit is present in the specimen of *D. albifasciatus*, just as it is in the specimen of *D. dominica*.

Mickel (1928) pointed out that many of the characters present in *Dasymutilla* are present in more than one species. He used the term "species group," with members of each group being closely related. In Mickel's (1928) key to males of *Dasymutilla*, *D. albifasciatus* keys to couplet 54 or 55, with species in couplets 54–56 belonging to the *bioculata* species group. As noted in the description, it is unclear whether or not the antennal scrobes are carinate. Thus, it is not known for certain whether this species would key to couplet 54 or 55. Characters shared by males of this group include the presence of a median pit filled with hairs on the second abdominal sternite, the presence of an apical fringe of hairs on the

last tergite, the absence of a prominent tooth on the posterior trochanters, normal size ocelli and eyes, cylindrical posterior tibiae, and rounded apices on the middle and hind femora. As also noted in the description, it is not completely clear whether or not the apical fringe of hairs on the last tergite is present, although it certainly appears to be there. And the posterior trochanters are partially obscured in the specimen, although they do not appear to have the prominent tooth present in a few species.

This species is very similar to *D. dominica*, especially in the color of the integument almost entirely black. However, *D. albifasciatus* can be distinguished from the former by the presence of the broad lateral band of white integument extending from the top of the propodeum to the lower half of the pronotum. *Dasymutilla albifasciatus* also has a small, circular spot of white integument on the mesonotum. It also can be distinguished from *D. dominica* by the white hairs in the felt lines (the felt lines are black in *D. dominica*).

This species, like *D. dominica*, appears to be a highly derived species, based on the presence of the pit on the second abdominal sternite. Thus, this provides further evidence that the genus *Dasymutilla* likely radiated from a more primitive Sphaerophthalmina well over 40 million years ago.

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Scientific Note

***CHILACIS TYPHAE* (PERRIN) AND *HOLCOCRANUM SATUREJAE* (KOLENATI) (HEMIPTERA: LYGAEOIDEA: ARTHENEIDAE): FIRST WESTERN NORTH AMERICAN RECORDS OF TWO PALEARCTIC CATTAIL BUGS**

Until the mid- to late 1980s, no members of the lygaeid subfamily Artheneinae were recorded from the New World. The subfamily's presence in the Western Hemisphere was recognized with the transfer of an indigenous neotropical species, *Polychisme ferruginosus* (Stål), from Ischnorhynchinae to Artheneinae (Slater, J. A. & H. Brailovsky. 1986. J. N. Y. Entomol. Soc., 94: 409–415), but this species has now been returned to the Ischnorhynchinae (Kerzhner, I. M. 1997. Zoosyst. Ross., 6: 213–222). Two Palearctic cattail-associated artheneines—*Chilacis typhae* (Perrin) and *Holcocranum saturejae* (Kolenati)—have since been detected in eastern North America (Wheeler, A. G. & J. E. Fetter. 1987. Proc. Entomol. Soc. Wash., 89: 244–249; Hoffman, R. L. & J. A. Slater. 1995. Banisteria, 5: 12–15). In addition, with reassessment of pentatomomorphan phylogeny, the Artheneinae have been proposed as a separate lygaeoid family, the Artheneidae (Henry, T. J. 1997. Ann. Entomol. Soc. Am., 90: 275–301).

Chilacis typhae, belonging to a monotypic genus, was first reported in North America from Delaware, Maryland, New York, and Pennsylvania (Wheeler & Fetter 1987). It has since been found in Tennessee and Virginia (Hoffman, R. L. 1996. The insects of Virginia No. 14: seed bugs of Virginia (Heteroptera: Lygaeidae). Virginia Museum of Natural History, Martinsville, Virginia). This seed-feeding bug develops on and in pistillate heads (“spikes”) of cattails (*Typha* spp.; Typhaceae), typically those that have been tunneled by larvae of the Holarctic cosmopterygid *Limnaecia phragmitella* Stainton (Wheeler & Fetter 1987). In Europe, it sometimes can be found in cattail heads uninfested by this microlepidopteran (Stehlík, J. L. & I. Vavřínová. 1996. Acta Mus. Moraviae Sci. Nat., 80: 163–233). This bug is restricted to feeding on *Typha* spp. throughout its native West Palearctic range (Hoffman & Slater 1995; Stehlík & Vavřínová 1996). Populations of this apparently bivoltine species are most abundant in cattail heads from May to October (Stehlík & Vavřínová 1996).

The first North American records of *H. saturejae* were from Florida, New Jersey, North Carolina, South Carolina, and Virginia (Hoffman & Slater 1995). Hoffman (1996) noted that Wheeler & Fetter's (1987) records of *C. typhae* from New Castle Co., Delaware, and from Chester Co., Pennsylvania, were based in part on material of *H. saturejae*, thus adding those states to its known North American distribution. *Holcocranum saturejae* has been found mainly at low elevations from southeastern Pennsylvania to northern Florida, with populations also recorded west of the Blue Ridge Mountains of Virginia up to approximately 760 m above sea level (Hoffman 1996). Although all eastern U.S. collections have been made from cattail heads, this species sometimes develops in willow (*Salix* spp.; Salicaceae) catkins in Europe (Hoffman & Slater 1995). Adults overwinter in cattail heads, and in some parts of Europe, adults are found on *Typha*

spp. only from October to January. Some Old World populations, however, use cattail seeds for nymphal development (Stehlík & Vavřínová 1996).

On the basis of recent collecting, we add to the western North American fauna both European cattail bugs, whose North American distributions have been assumed to be strictly eastern: *C. typhae* from Oregon and Washington and *H. saturejae* from California to Texas. Voucher specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Chilacis typhae becomes the fifth lygaeoid species considered adventive in the Pacific Northwest; distributions of the four previously recorded adventive lygaeoids in that region, all litter-inhabiting species, were reviewed by A. Asquith & J. D. Lattin (1991. *Pan-Pac. Entomol.* 67: 258–271). Western populations of *H. saturejae*, whose Old World distribution is more southern than that of *C. typhae* (Hoffman & Slater 1995), have been found as far north as Colusa County in north-central California. Both artheneids are among several Palearctic heteropterans that likely represent separate accidental introductions to eastern and western North America (Wheeler, A. G. & T. J. Henry. 1992. A synthesis of the Holarctic Miridae (Heteroptera). Entomological Society of America, Lanham, Maryland). The possibility exists that at least *H. saturejae* might represent a long-distance (aeolian) migrant (Hoffman & Slater 1995).

Typha latifolia is a naturally Holarctic plant, but *T. angustifolia*, though often considered Holarctic, might not be a native species (Grace, J. B. & J. S. Harrison. 1986. *Can. J. Plant Sci.*, 66: 361–379). Both lygaeoids, however, should be considered nonindigenous in the Nearctic Region, based mainly on their recent detection and the absence of indigenous artheneids in the North American fauna (Wheeler & Fetter 1987, Hoffman & Slater 1995). In addition, neither lygaeoid shows a Beringian distribution that is typical of many naturally Holarctic heteropterans (Wheeler & Henry 1992).

Records.—*Chilacis typhae*: OREGON: WASHINGTON Co.: Tigard, 29 Sep 1997, A. G. Wheeler, *Typha latifolia*, old pistillate heads, 11 adults. WASHINGTON: COLUMBIA Co.: Rt. 30, 8 km W of Clatskanie, 20 May 1998, C. A. Stoops & A. G. Wheeler, *T. latifolia*, pistillate heads, 4 adults. GRAYS HARBOR Co.: McCleary, 20 May 1998, C. A. Stoops & A. G. Wheeler, *T. latifolia*, pistillate heads, 3 adults. KING Co.: Issaquah, 22 May 1998, C. A. Stoops & A. G. Wheeler, *T. latifolia*, pistillate heads, 2 adults. KITSAP Co.: Poulsbo, 28 Sep 1997, C. A. Stoops & A. G. Wheeler, *T. latifolia*, old pistillate heads, 9 adults. KITTITAS Co.: Ellensburg, 22 May 1998, C. A. Stoops & A. G. Wheeler, *T. latifolia*, pistillate heads, 1 adult. LEWIS Co.: E of Napavine, 29 Sep 1997, A. G. Wheeler, *T. latifolia*, old pistillate heads, 3 adults. MASON Co.: Shelton, 29 Sep 1997, A. G. Wheeler, *T. latifolia*, old pistillate head, 1 adult. PACIFIC Co.: Raymond, 20 May 1998, C. A. Stoops & A. G. Wheeler, *T. latifolia*, pistillate heads, 4 adults. SNOHOMISH Co.: Edmunds, 21 May 1998, C. A. Stoops & A. G. Wheeler, *T. latifolia*, pistillate heads, 4 adults. THURSTON Co.: Nisqually, 29 Sep 1997, A. G. Wheeler, *T. latifolia*, old pistillate heads, 5 adults.

Holcocranum saturejae: ARIZONA: COCHISE Co.: Gray Hawk Ranch, along San Pedro River, 13 km E of Sierra Vista, 5 Jun 1997, A. G. Wheeler, *T. angustifolia*, pistillate heads, 16 adults. PIMA Co.: Buenos Aires National Wildlife Refuge, Arivaca Cienega, E of Arivaca, 28 Jun 1997, A. Smith, *Typha* sp., pistillate heads, 5 adults. CALIFORNIA: COLUSA Co.: Rt. 20, 1.6 km W of Colusa,

9 Aug 1998, A. G. Wheeler, *Typha* sp., pistillate heads, 11 adults; Rt. 45, 1.3 km N of Yolo Co. line SW of Tisdale, 9 Aug 1998, A. G. Wheeler, *Typha* sp., pistillate heads, 6 adults. IMPERIAL Co.: Salton Sea National Wildlife Refuge, Hazard Unit, NW of Calipatria, 4–5 Dec 1997, K. Sturm & K. Haley, *T. latifolia*, pistillate heads, 4 adults. KERN Co.: nr Inyokern, 3 Nov 1997, C. A. Stoops, *Typha* sp., old pistillate head, 1 adult; Kern National Wildlife Refuge, Marsh Unit 1, 30 km W of Delano, 21 Nov 1997, J. Allen, *Typha* sp., pistillate heads, 3 adults. MONTEREY Co.: Monterey, 20 Mar 1998, C. A. Stoops, *Typha* sp., pistillate head, 1 adult. YOLO Co.: Rt. 16, NW of Rumsey, 10 Aug 1998, A. G. Wheeler, *Typha angustifolia*, pistillate heads, 5 adults. NEVADA: CLARK Co., Floyd Lamb State Park, Las Vegas, 13 Nov 1998, W. K. Reeves, *Typha* sp., pistillate heads, 6 adults. NEW MEXICO: SOCORRO Co.: Bosque del Apache National Wildlife Refuge, nr Socorro, 15 Sep 1997, M. Oldham, *T. latifolia*, pistillate heads, 8 adults. TEXAS: HIDALGO Co.: Santa Ana National Wildlife Refuge, S of Alamo, 18 Feb 1998, W. A. Jones & W. Warfield, *T. domingensis*, pistillate heads, 10 adults.

Acknowledgment.—The first collection of either Old World cattail bug in the West was at Gray Hawk Ranch in Arizona, and we thank naturalist Sandy Anderson for taking one of us (AGW) to a cattail stand on her property, Noel McFarland for his hospitality in Arizona, Walker Jones (USDA, ARS, Weslaco, Texas) for collecting *Holcocranum saturejae* in Texas, and Will Reeves (Clemson University) for collecting it in Nevada. We are indebted to personnel (and volunteers) of the National Wildlife Refuge System for making or facilitating collections of *H. saturejae*: Jack Allen (Kern), Sally Gall (Buenos Aires), Katie Haley (volunteer, Salton Sea), Alex Smith (volunteer, Buenos Aires), Mike Oldham (Bosque del Apache), and Ken Sturm (Salton Sea). We also appreciate attempts to find cattail bugs at other National Wildlife Refuges by David Blankinship at Lower Rio Grande Valley in Texas and Kim Forrest at Humboldt Bay in California. I. M. Kerzhner (Russian Academy of Sciences) called our attention to his recent paper, and P. H. Adler (Clemson University) provided useful comments on a draft of this manuscript.

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Scientific Note

**FIRST RECORD OF *GLYCASPIS BRIMBLECOMBEI*
(MOORE) (HOMOPTERA: PSYLLIDAE) IN NORTH
AMERICA: INITIAL OBSERVATIONS AND PREDATOR
ASSOCIATIONS OF A POTENTIALLY SERIOUS NEW
PEST OF EUCALYPTUS IN CALIFORNIA**

Eucalyptus spp. were first introduced to California in the mid 1800s and within a short time were planted throughout the state for fuel wood, windbreaks, cut foliage, and landscaping. In California, eucalyptus were considered pest free until the early 1980s when the situation changed with the discovery of the psyllid *Blastopsylla occidentalis* Taylor (Taylor, K. L. 1985. J. Aust. Ent. Soc., 24: 17–30), and the borer *Phoracantha semipunctata* Fabr. (Scriven, G. T., Reeves, E. L. & Luck, R. F. 1986. Calif. Agric. 40: 4–6). Subsequently, several other eucalyptus feeding insects from Australia were discovered in California (Table 1). It is noteworthy that most of the species in Table 1 are psyllids, and two of them (*Ctenarytaina longicauda* Taylor and *C. spatulata* Taylor) were not described prior to their discovery in California (Taylor, K. L. 1987. J. Aust. Ent. Soc., 26: 299–233, Taylor, K. L. 1997. Aust. J. Ent., 36: 113–115). Presently, only the borers (*Phoracantha* spp.) and the blue gum psyllid (*C. eucalypti* Maskell) are considered economic pests of eucalyptus in California. University of California biological control programs introduced parasitoids from Australia which have effectively controlled *C. eucalypti* on the ornamental foliage crop *E. pulverulenta* Sims and *P. semipunctata* on several susceptible species (Dahlsten, D. L., Rowney, D. L., Copper, W. A., Tassan, R. L., Chaney, W. E., Robb, K. L., Tjosvold, S., Bianchi, M. & Lane, P. 1998. Calif. Agric., 52: 31–34; Hanks, L. M., Paine, T. D. & Miller, J. G. 1996. Calif. Agric., 50: 14–16). This note focuses on the initial distribution and predators in northern California of *Glycaspis brimblecombei* Moore, a recently recorded and potentially serious eucalyptus pest.

The genus *Glycaspis* Taylor (Homoptera: Psyllidae) is one of the largest of the Myrtaceae-feeding psyllids and includes over 120 species which are naturally distributed from Australia to the Philippine Islands (Moore K. M. 1970 Aust. Zool., 15: 248–342). We found no previous reports of *G. brimblecombei* or any *Glycaspis* spp. outside their native range. In contrast to the other free-living eucalyptus psyllids in California, *G. brimblecombei* nymphs live individually under round glabrous, conical coverings called 'lerps' (Morgan, F. D. 1984. Psylloidea of South Australia). The presence of the 1–4 mm diameter lerps on both sides of expanding and fully expanded leaves makes this psyllid highly conspicuous even at low population densities.

Glycaspis brimblecombei was first found in El Monte, Los Angeles County in June 1998 on *Eucalyptus camaldulensis* Dehnh (Cindy Werner, personal communication), and it was found in Fremont, Alameda County in northern California a month later. By September 1998, *G. brimblecombei* had been recorded in several other cities in northern California including Alameda, Hayward, Oakland, Palo Alto, San Bruno, San Mateo, South San Francisco, and San Francisco. The new

Table 1. Exotic pests of *Eucalyptus* found in California.†

	Date found	County
Psyllidae		
<i>Blastopsylla occidentalis</i> Taylor	1983	Los Angeles*
<i>Ctenarytaina longicauda</i> Taylor	1983	San Diego*
<i>C. eucalypti</i> Maskell	1991	Monterey*
<i>C. spatulata</i> Taylor	1991	Orange*
<i>Cryptoneossa triangula</i> Taylor	1995	Orange*
<i>Glycaspis brimblecombei</i> Moore	1998	Los Angeles*
Coleoptera		
<i>Phoracantha semipunctata</i> Fabr.	1984	Orange*
<i>Gonipterus scutellatus</i> Gyllenhal	1994	Ventura*
<i>Phoracantha recurva</i> Newman	1995	Riverside*
<i>Trichomela sloanei</i> Blackburn	1998	Riverside*
Hymenoptera		
<i>Aprostocetus</i> sp.	1995	Santa Barbara*

* New record for North America.

† Gill, R.J. 1998. Cal. Plant Pest Dis. Rpt., 17: 21–24.

psyllid is responsible for severe defoliation and decline of several eucalyptus species in northern California, and has become a nuisance in ornamental settings where the lerps and honey dew coated leaves stick to shoes of pedestrians. We speculate that the damage caused by *G. brimblecombei* in California may reflect the absence of natural enemies and the unusually high rainfall this past winter. In Australia, outbreaks of several species of lerp forming psyllids are known to follow years of high rainfall (Moore, K. M. 1961. Proc. Linn. Soc. N. S. W., 86: 185–200, White, T. C. R. 1969. Ecol., 50: 905–909).

In Australia, eight *Eucalyptus* spp. are known hosts of *G. brimblecombei*: *E. blakelyi* Maiden, *E. brassiana* Blake, *E. bridgesiana* Baker, *E. camaldulensis*, *E. camphora* Baker, *E. dealbata* Cunn. ex Schauer, *E. mannifera* ssp. *maculosa* Baker, *E. nitens* Deane & Maiden, and *E. teriticornis* Smith (Moore 1970; Carver, M. 1987. J. Aust. Ent. Soc., 26: 369–372). In contrast, we have found eggs, early through late stage nymphs, and adults of *G. brimblecombei* on three other species including *E. diversicolor* F. Muell, *E. globulus* Labill, and *E. sideroxylon* Cunn. ex Woolls. We are currently studying the host associations and effects of *G. brimblecombei* on additional *Eucalyptus* spp. in California in an effort to identify resistant species and monitor the effectiveness of existing predators.

Moore (1961) reported several predators (bell-birds, spiders, mites, and larvae of Syrphidae (Diptera), Hemerobiidae (Neuroptera), Chrysopidae (Neuroptera), and Coccinellidae (Coleoptera) and parasitoids (Chalcidoidea: Hymenoptera)) attacking *Glycaspis* spp. in Australia. At the Fremont site in northern California we have observed several arthropod predators associated with *G. brimblecombei* including: spiders, mites, Heteroptera (*Anthocoris nemoralis* Fabr. and *Zelus renardii* Kolenati), Coccinellidae (*Harmonia axyridis* Pallas, *Chilocorus bipustulatus* L., *Hippodamia convergens* Guérin, and *Coccinella californica* Mannerheim), Syrphidae, Hemerobiidae, and Chrysopidae. In California, *A. nemoralis* is an accidentally introduced predator of the Australian acacia psyllid (*Acizzia uncatoides*

Ferris & Klyver) (Hagen & Dreistadt 1990). Furthermore, despite the abundance of the introduced parasitoid of *C. eucalypti*, *Psyllaephagus pilosus* Noyes (Hymenoptera: Encyrtidae), in the area, neither this wasp nor others have been observed parasitizing *G. brimblecombei*. Based on our observations, there is an apparent inability of the existing predators to control this new psyllid in California, and we conclude that additional biological control organisms will need to be introduced to effect biological control.

The economic impact of *G. brimblecombei* may be far more serious and widespread than that of other eucalyptus psyllids in California for several reasons. First, *G. brimblecombei* oviposits and successfully completes its life cycles on both expanding and fully expanded leaves, and may defoliate the host. In contrast, the other extant psyllid species (*C. eucalypti*, *C. spatulata*, *B. occidentalis*) in California do not cause defoliation, and their populations are partially controlled by host phenology because they oviposit and feed almost exclusively in buds and tender foliage (Brennan, personal observation 1995–1998). Second, *G. brimblecombei* appears to have a broader host range than the other psyllids, and, thus, may impact commercial plantations, and ornamental and forestry plantings of eucalyptus. Third, of all the Australian psyllid species established in California, *Glycaspis* is the only genus within its native range known to exhibit outbreak populations and cause severe damage to eucalyptus forests and plantings (Moore 1961). Fourth, it is likely that the repeated defoliation caused by *G. brimblecombei* may induce stress and thus increase *Phoracantha* spp. attacks as has been observed with other *Glycaspis* spp. and beetles (*Xyleborus* sp.) in Australia (Moore 1961). The 'Eucalypt Dieback' syndrome in Australia that has caused the decline and premature death of eucalyptus in agricultural environments, is thought to be caused by interactions between weather-induced stress and attacks by several guilds of insects (Landsberg, J. 1990. *Aust. J. Ecol.*, 15: 89–96).

It is clear that *G. brimblecombei* has the potential to affect eucalyptus culture in California. Existing biological controls are not effective at preventing damage and new ones are needed. Eucalyptus can no longer be considered pest-free in California, and pest resistance should be considered in selecting species for future plantings.

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Scientific Note

THE PAPER WASP *POLISTES DOMINULUS* (CHRIST) (HYMENOPTERA: VESPIDAE) IN THE STATE OF WASHINGTON

Polistes dominulus (Christ) is native to the Palearctic region, where it is broadly distributed (Carpenter 1996. Mem. Mus. Nat. Hist. Not., 173: 135–161). It is a “hitchhiker” species, apparently traveling around the world with human traffic and commerce. It has been introduced into North America; first reported as *Polistes gallicus* (L.) in Massachusetts (Hathaway 1981. Psyche, 88: 169–173). *Polistes dominulus* appears to now be generally distributed in much of the northeastern U.S., and westward at least into Ohio and Michigan (Jacobson 1994, Sphecos 27: 14; Judd & Carpenter 1996. Great Lakes Entomol., 29: 45–46; Staines & Smith 1995. Proc. Entomol. Soc. Wash., 97: 891). It has not been reported heretofore in western North America. We report here the establishment of *Polistes dominulus* at multiple sites in central Washington (in the Yakima Valley) as well as in Pierce County, west of the Cascade Mountain Range.

In an urban neighborhood of Sunnyside, Yakima County, Washington, on 4 Sep 1998, a cluster of wasps was observed on the front of a travel trailer in the front yard of a residence. On closer inspection, it was noted that wasps were entering and exiting a break in the wall of the trailer, with about 30 wasps remaining outside within 15 cm of that opening. These wasps were not collected, but were photographed, and appear to be *P. dominulus*. Later that day, five *Polistes dominulus* were collected on a hedge of planted snowberry, *Symphoricarpus albus* (L.), heavily visited by golden paper wasps, *Polistes aurifer* (Saussure). *Polistes dominulus* were also observed entering a garage at the same site via a fallen soffet under an eave and also were entering a gap in a cinder block wall.

On 5 and 6 Sep 1998, five male *P. dominulus* were netted while they were flying about an ornamental crabapple tree in a suburban neighborhood 4–8 km west of the City of Yakima. A small nest (about 40 cells) occupied by eight *P. dominulus* wasps was later (18 Oct) observed under an eave on the south side of a residence at the same location. On 7 Sep 1998, two active colonies were located near Ahtanum, in the West Valley area of Yakima County. Both nests were under an eave on the east side of a garage, with one abutting the envelope of a nest of the aerial yellowjacket *Dolichovespula arenaria* Fabr. The *P. dominulus* nest adjacent to the aerial yellowjacket nest was collected. It was 18 × 14 cm in diameter and contained 322 cells. There were 23 wasp pupae and 7 larvae in the cells of that nest. Forty-one female and 3 male wasps were collected with the nest, while 2 escaped. On 8 Sep 1998, 11 paper wasp nests were located under eaves of a house in the city of Yakima. Seven of these nests were occupied by *P. dominulus* wasps, and 4 were not occupied. The two largest nests were collected. A nest on the east side of the house was 17 cm in diameter and contained 412 cells with 27 pupae, 45 larvae and 12 eggs. Many cells appeared to contain honey; probably concentrated sugars from honeydew (Rau, 1928. Biol. Bull. Marine Biol. Lab., Woods Hole, Massachusetts, 24: 503–519). There were 42 female *P. dominulus*

Scientific Note

A NEW HOST RECORD OF *ORNITHOPHILA GESTROI* (DIPTERA: HIPPOBOSCIDAE) ON THE LESSER KESTREL (*FALCO NAUMANNI FLEISCHER*) IN GALAXIDI, GREECE

Field research on Lesser Kestrels (*Falco naumanni*) breeding in Greece revealed occurrence of the bird-lousefly, *Ornithophila gestroi* (Rondani). On 1 Apr 1994 in the town of Nikea, two to four louseflies were observed trailing a few cms behind Lesser Kestrels in flight. These louseflies easily tracked the aerial maneuvers of kestrels, even during rapidly circling courtship flights. It appeared that individual flies could enter and exit the kestrels in flight.

On 13 Jun 1995, while banding Lesser Kestrels in Galaxidi, a breeding female captured at 0800, weighing 147 gm, wing chord 244 mm, tail length 161 mm, tarsus length 37 mm, with #1 and 2 left secondaries absent: Band #000175 had seven bird-louseflies of which five were captured and preserved in an alcohol solution of a local spirit called tsipouro. These rapidly moving flies within the plumage of the female were difficult to capture. When pursued, *O. gestroi* left the falcon.

Bird-louseflies were found on young and in nests of Lesser Kestrels. Because the Lesser Kestrel is a social falcon, nesting colonially in houses and outbuildings of villages and cities, the bird-lousefly readily moves among the nesting falcons. The occurrence, however, of this hippoboscid is rare in the falcons of Greece. Infestations ranged from two to seven flies per falcon; most birds under study were free of *O. gestroi*.

T. C. Maa (Pacific Insects Monograph 20: 1–23, 1969) found the bird-lousefly, *O. gestroi* to be confined to the Mediterranean subregion and to the Falconiformes: Falconidae. Within the Ornithomyiinae, *Ornithophila* is an archaic and rare genus with a single male and four females constituting the type series in Genoa, Florence, and Harvard Museums. Galita Island near Malta, Crete, and Tangier are the only localities with host documentation on record, with specimens collected from Eleanor's Falcon (*F. eleonora* Gene) and Common Kestrel (*F. tinnunculus* L.).

The five specimens taken in this study from mainland Greece represent both a new host in Lesser Kestrels and locality at Galaxidi. Because the Lesser Kestrel migrates to subsaharan Africa during the non-breeding season, *O. gestroi* can be expected on that continent. Collected specimens reside at the California Academy of Sciences and the J. Gordon Edwards Museum of Entomology at San Jose State University, San Jose, CA 95192.

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wasps collected with the nest. The other nest collected was on the north side of the house, was 26 × 23 cm in diameter and contained 480 cells with 5 pupae, 4 larvae and no eggs. Again, many cells appeared to contain honey. Thirty two wasps were collected with the nest.

On 7 Oct 1998, six *P. dominulus* females were collected at an urban residence in the city of Puyallup, in Pierce County, Washington. This collection followed a complaint of wasps inside of a home, and the wasps were not found with a nest.

These records indicate that *P. dominulus* is not only established but is probably common and widespread in Yakima County, Washington. The presence of the same species in the city of Puyallup indicates widespread distribution within the state of Washington. Yakima and Pierce counties are east and west of the Cascade Mountains respectively, which is a major barrier to insect dispersal. *Polistes dominulus* probably was introduced into the Pacific northwest a number of years ago.

This wasp has a history of preferring nesting sites on or in structures and enclosures (Hathaway 1981. *Psyche*, 88: 169–173), making them somewhat synanthropic. Human activities and constructions provide abundant nest sites. Observations to date of *P. dominulus* made in Yakima County support this generalization, with nests under eaves of buildings and within any type of cavity. Also, intensive trapping of wasps in a rural area east of Yakima indicated large populations of *Polistes aurifer* but no *Polistes dominulus* (Landolt 1998. *Environ. Entomol.*, 27: 129–1234; Landolt 1999. *J. Kansas Entomol. Soc.*, In press).

Voucher specimens of *P. dominulus* collected in Yakima County, Washington were deposited in the James Entomological Collection, Department of Entomology, Washington State University, Pullman, Washington.

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Ferrari, J. A. & K. S. Rai. 1989. Phenotypic correlates of genome size variation in *Aedes albopictus*. *Evolution*, 42: 895–899.
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**CAENIS CHAMIE, A NEW SPECIES FROM COLOMBIA
(EPHEMEROPTERA: CAENIDAE)**

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Abstract.—The alate stages, nymph and egg of *Caenis chamie* (Ephemeroptera: Caenidae), NEW SPECIES, are described and illustrated on the basis of reared material from Colombia. A discussion of its relationships with other South American species of *Caenis* is included.

KeyWords.—Insecta, Ephemeroptera, Caenidae, winged stages, nymph, egg, *Caenis chamie*, South America, Colombia.

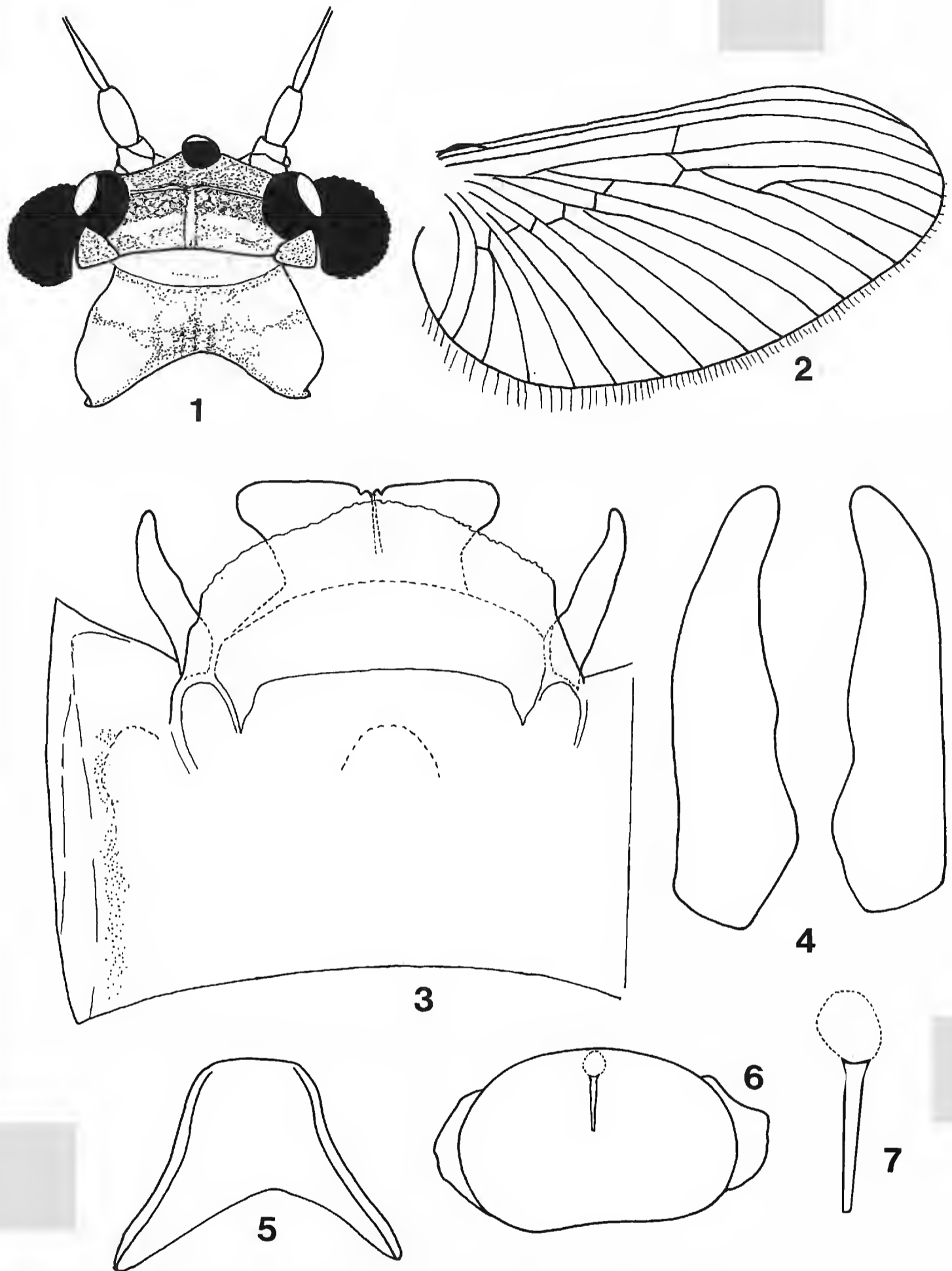
The family Caenidae (Ephemeroptera) in South America is poorly known, with 25 recorded species in four genera (*Brachycercus* Curtis 1834; *Brasilocaenis* Puthz 1975, *Caenis* Stephens 1835 and *Cercobrachys* Soldán 1986). The genus *Caenis* is the most diverse with 17 species (Navás 1915, 1929a, 1920b, 1922, 1930; Froehlich 1969; Malzacher 1986, 1990; Pereira & Da Silva 1990; Da Silva 1993): 4 species are known from Argentina (*C. albata* Navás, *C. argentina* Navás, *C. ludicra* Navás and *C. nemoralis* Navás), 8 from Brazil (*C. candelata* Malzacher, *C. cigana* Pereira & Da Silva, 1990; *C. cuniana* Froehlich, *C. fitzkau* Malzacher, *C. pfulgfelderi* Malzacher, *C. quatipuruica* Malzacher, *C. reissi* Malzacher, and *C. sigillata* Malzacher), 2 from Chile (*C. axillata* Navás and *C. nigella* Navás), and 2 from Paraguay (*C. burmeisteri* Malzacher and *C. pseudamica* Malzacher). Berthélemy (1965) reported material from Chile, deposited in the Museum of Natural History in Paris, labelled by Navás as type of *C. chilensis*. However, *C. chilensis* is a manuscript name and is therefore a *nomen nudum*.

During a general study of mayflies of southeast Colombia (Mosquera 1995), specimens of an undescribed species of *Caenis* were collected. Based on laboratory reared material herein describe all stages of the new species.

The types of the new species are deposited in the following institutions: Museo de Entomología, Universidad del Valle, Cali, Colombia (MEUV) and the senior author's collection in the Departamento de Biología Animal y Ecología (Zoología), Universidad de Granada, Spain (JAC).

CAENIS CHAMIE ALBA-TERCEDOR & MOSQUERA, NEW SPECIES

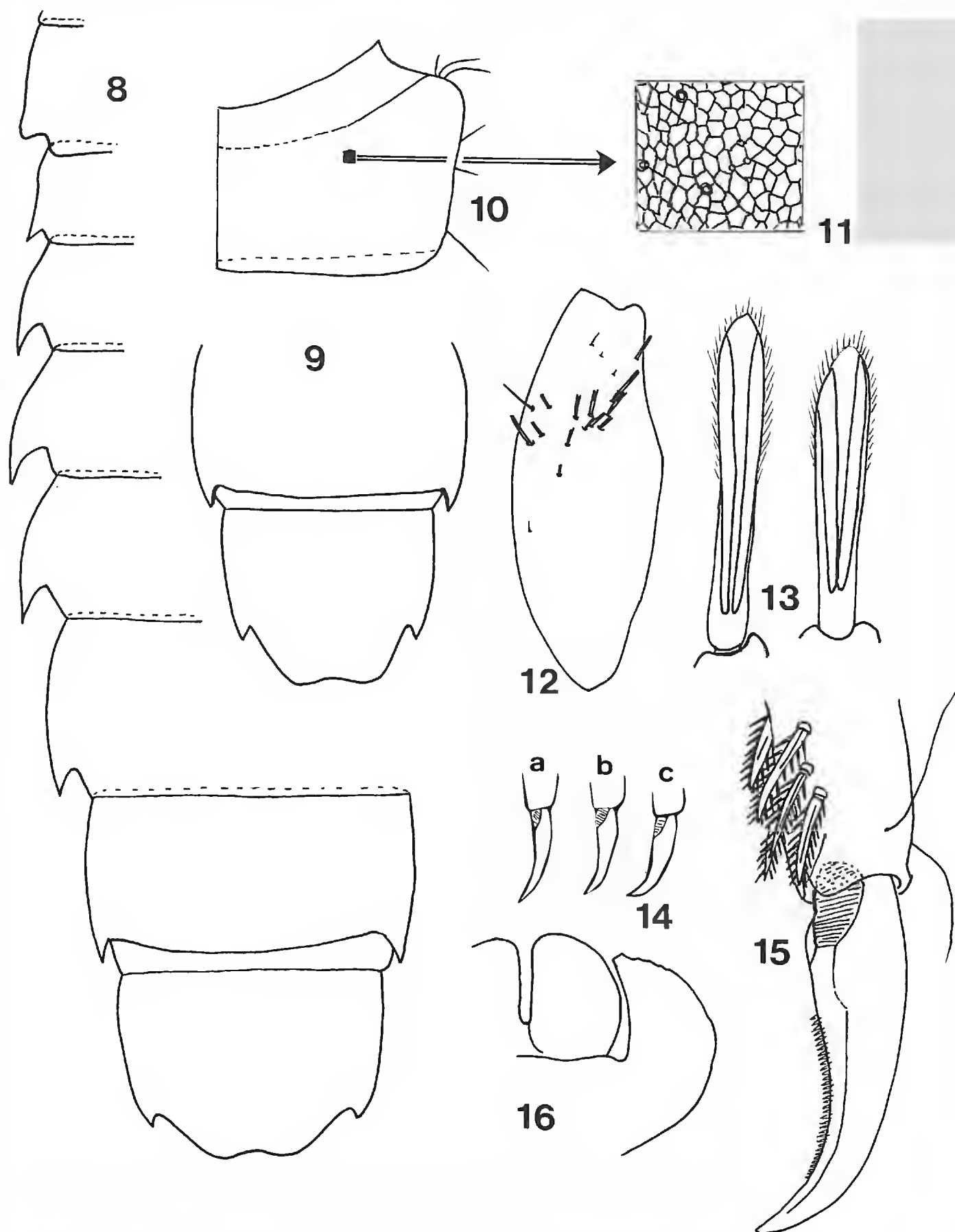
Types.—Holotype, male imago (genitalia and left wing on slide # 300); data: COLOMBIA. VALLE DEL CAUCA: Acueducto de Pavas, 1200 m. a.s.l., 76°33' W, 3°40' N, September 1994. S. Mosquera leg.; deposited MEUV. Paratypes: 1 male imago (genitalia mounted for SEM), 4 male subimagos, 5 females, 5 nymphs, 5 exuviae skins (one on slide no. 301) and eggs on slide no. 302, all from the same locality and date as the holotype; deposited in MEUV (except slides 301 and 302 deposited in JAC).



Figs. 1-7. Male imago (1-5): head and pronotum (1); wing (2); genitalia (3); forceps (4); and prosternum (5). Egg $\times 400$ (6) and detail of micropyle, in light microscope $\times 1000$ (7).

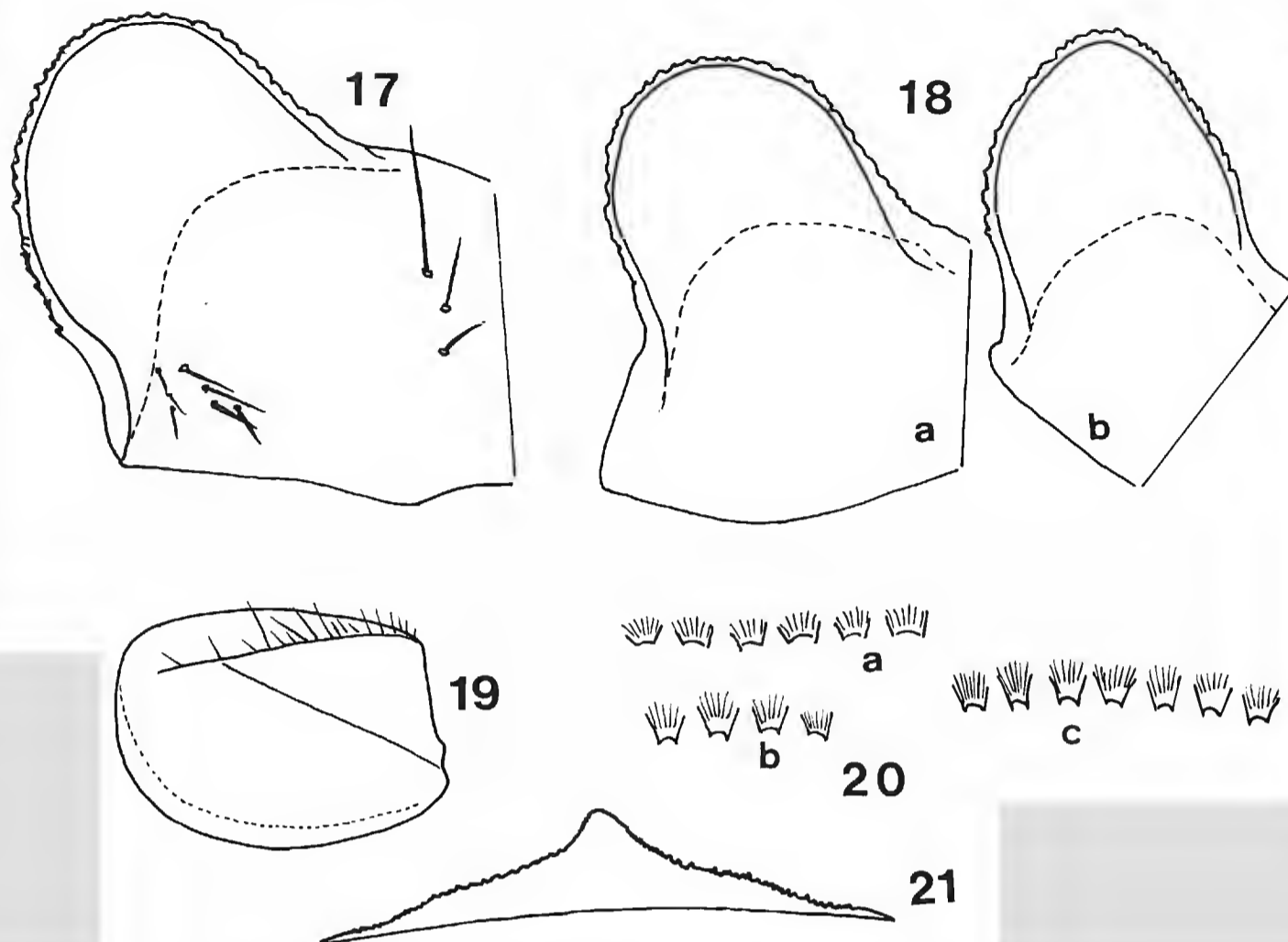
Etymology.—The new species is named after the “chamies” an ethnic group that in the past inhabited the Cauca Valley.

Male imago. (in alcohol).—Length body: 2.9–3.7 mm, wings: 2.3–2.9 mm. *Head:* (Fig. 1): middle longitudinal white line from occiput to frontal suture; dark band between lateral ocelli; antennae



Figs. 8–15. *Caenis chamie* sp.n. nymph: ventral view of female (8) and male abdominal sternites (9); pronotum (10) and detail of the surface ornamentation $\times 400$ (11); fore femur (12) and bristles in the row on the distal third (13); claws (14) (a: anterior, b: middle, c: posterior); details of distal part of posterior tibia and claw (15); labial glossa and paraglossa (16).

yellow-white, pedicel length approximately twice that of scape; flagellum basally slightly enlarged; yellow, progressively paler apically. *Thorax*: light brown pattern of pronotum as in Fig. 1; prosternum shaped as in Fig. 5; meso- and metanotum yellow with dark sutures; wings hyaline, costal, subcostal cells and veins C, Sc and R_1 shaded with light purple-grey; forefemora brown, with dark longitudinal margins; tibiae and tarsi white; femur:tibia ratio = 0.54–0.61, fore tarsal formula $1 < 5 < 4 \approx 3 < 2$. *Abdomen*: no projection on second abdominal tergum; posterior 2/3 of each tergum with grey-brown



Figs. 17–20. *Caenis chamie* sp.n. nymph: lamellar apophysis of middle (17) and hind coxae (18: a and b correspond to the right and left side); 2nd gill (19); submarginal row of scales on 2nd gill $\times 400$ (20) (a: distal zone, b: middle zone, c: distal zone); dorsal projection on the 2nd abdominal tergite (21).

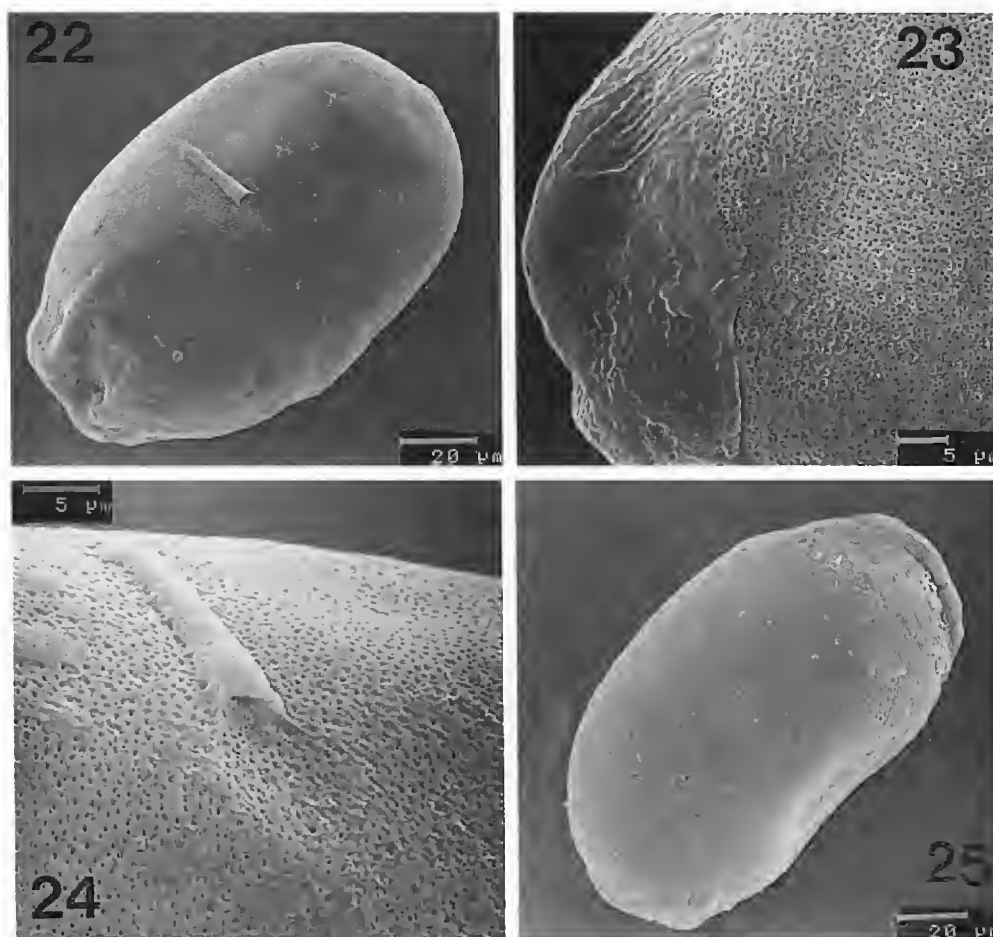
pigmentation, terga 1–2 pigmented only in distal third; longitudinal black stripe ventrally at junction of sterna and pleura. *Genitalia* (Figs. 3–4, 27–29): Penes anvil shaped, distal margin straight, with rounded and well-developed lateral lobes, and with central longitudinal incision (Fig. 3). Forceps (Fig. 4) with blunt tips, densely covered with short setae (Figs. 28 and 29). Anterior apophysis of the transversal sclerite of styliger (after Malzacher 1991) pointed (Fig. 3).

Subimago male. (in alcohol).—Similar to male in color and pattern except obscured by subimaginal cuticle.

Female. (in alcohol).—Length body: 3.5–3.7 mm, wings: 3.6–3.8 mm.; general color yellow-brown with pattern similar to that of male.

Egg.—(Figs. 6–7, and 22–26). Length: 159.5–176.2 μm . (\bar{x} = 166, n = 20); width: 83.3–100 μm (\bar{x} = 92.5, n = 20). Egg bean shaped (Figs. 6 and 25). Two epithema (polar caps) present. Micropyle long, with opening preceded by depression. Chorionic surface with small pores.

Nymph. (in alcohol).—Length body: 3.0–3.5 mm. (male), 4.3–5.3 (female). *Head:* transverse dark band between eyes; pedicel length twice that of scape, 4–7 bifid setae $\frac{1}{2}$ pedicel length; segment 3 of maxillary palpi subequal in length segment 2, or slightly longer; glossae broad, longer than paraglossae (Fig. 16). *Thorax:* Pronotum as in Fig. 10, dorsal surface with reticulate ornamentation (Fig. 11) (similar ornamentation on vertex and metanotum); forefemora with irregular row of long bifid bristles (Fig. 12); bristles distally pinnate (Fig. 13); lateral flanges of coxae as in Figs. 17 and 18; claws of fore and middle legs long and slender, without denticles (Fig. 14a, 14b); hind claws more curved with row of small denticles (Figs. 14c and 15); distal inner margin of hind tarsi with two rows of strong and pinnate bristles (Fig. 15), bristles absent on forelegs, sparse and arranged in one row on middle legs. *Abdomen:* dorsal projection on tergum 2 as in Fig. 21; postero lateral projections of abdominal segments as in Fig. 8; abdominal sternite 9 slightly emarginate, sexually dimorphic (compare Figs. 8 and 9); lateral margins of terga 4–8 with long setae; posterior margins of terga 7–8 with long setae;



Figs. 22–25. SEM of the egg of *Caenis chamie* sp.n.: general view of egg (22, 25); polar cap edge (23); micropyle showing the oval chorionic zone before the opening (24).

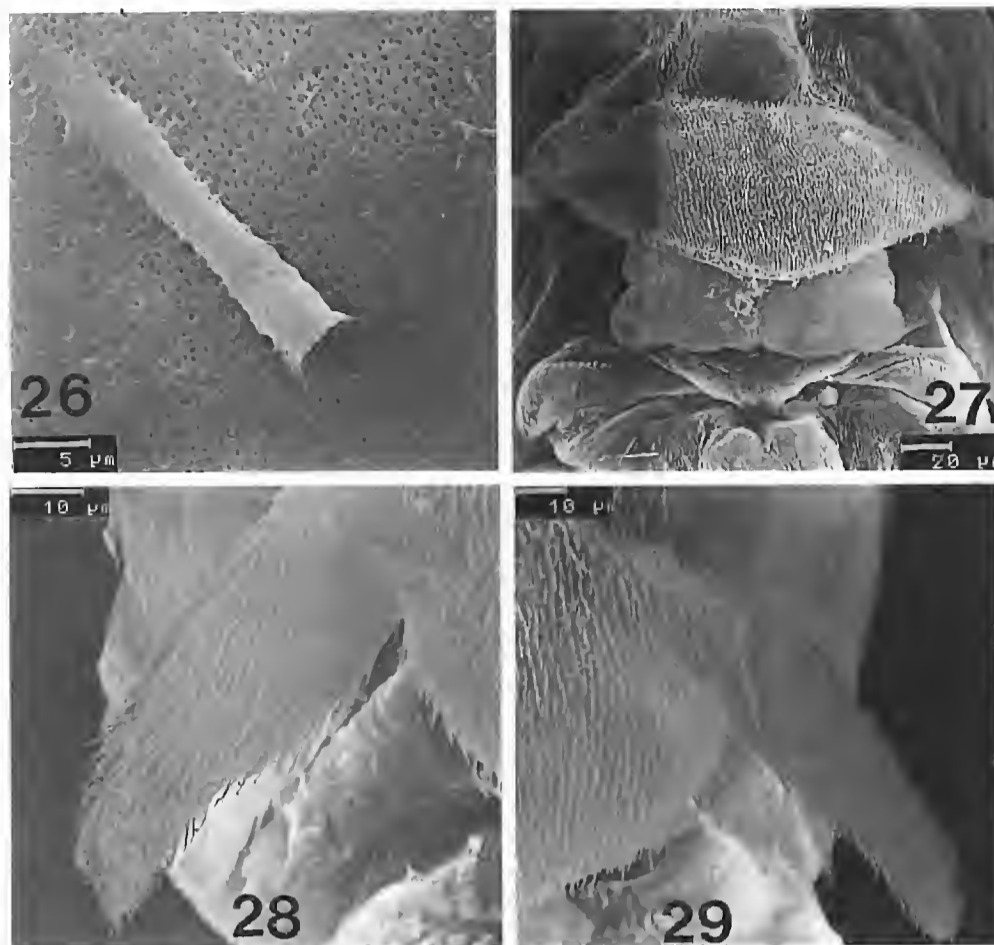
posterior margin of tergum 9 without setae but with small, somewhat rounded, denticles. Gill 2 as in Fig. 19, with setae only on mesal fork of triangular ridge; submarginal row of scales simple (Fig. 20).

Discussion.—There is some variability in the shape of the male genitaliaforceps. Thus, in one specimen the left forceps appear as normal (Fig. 29), but the right forceps is broader (Fig. 28).

Of the 17 named species of *Caenis* from South America, seven were identified and inadequately described by Navás. Material of four species (*C. argentina*, *C. axillata*, *C. ludicra* and *C. nemoralis*) are deposited in Argentina (Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, and Museo de la Plata) (Dominguez 1989), and Spain (Museo de Zoología de Barcelona) (Alba-Tercedor & Peters 1985). Recently, the senior author has examined the material deposited in Spain. The only existing specimen of *C. axillata* is extremely damaged, lacking the wings, legs, and most of the abdomen, and thus is impossible to redescribe. Malzacher (*in litt.*—29.06.1997) has been studying the type material of *C. argentina* and *C. ludicra* and he is preparing a redescription of them.

Malzacher (1986) divided the South American species of *Caenis* into two groups: the *C. fittkaui*—group (with long sclerotised and pointed forceps) and the *C. reissi*—group (with short, apically rounded forceps). The new species belongs to the *C. reissi*—group. This group includes other 7 known species (*C. argentina*, *C. cigana*, *C. ludicra*, *C. pflugfelderi*, *C. quatipurunica*, *C. reissi* and *C. sigillata*).

Diagnosis.—The winged stage of *C. chamie* sp.n. can be distinguished from *C. argentina* because in *C. argentina* the area between the subcosta and radius veins is conspicuously shaded dark brown, as was drawn by Navás (1915: fig. 4). *Caenis chamie* is close to *C. pflugfelderi*; however it can easily be distin-



Figs. 26–29. SEM of *Caenis chamie* sp.n.: micropylar rib (26); male genitalia (27) (note that penes were somewhat retracted after the deshydration process); detail and variability of forceps in a single specimen (28, 29).

guished by the straight hind margin of penes, pointed and not inwardly curved apophysis of the styliiger sclerite, and broader prosternite. The chorionic surface of egg has pores (similar to *C. reissi*, compare Figs. 23, 24 and 25 with Malzacher 1986: figs. 3 and 4) but not honeycombed as in *C. pflugfelderi*. The nymph is similar to that of *C. pflugfelderi*. Both species share middle and hind claws without denticles, but the new species can be easily distinguished by the emargination of the hind margin of sternum 9.

ACKNOWLEDGMENT

We are indebted to: Peter Malzacher from Ludwigsburg (Germany) for confirming the new species, useful comments and additional data on Navás's species; William and Janice Peters from Florida A&M University, Tallahassee, Florida (U.S.A.) for their valuable suggestions advise, comments, and editorial work; Eduardo Dominguez from Tucumán (Argentina) and Mike Hubbard from Tallahassee (U.S.A.) for bibliographic help. Support to the senior author to travel to Colombia (Centro de Investigación y Control de Contaminantes Ambientales de la Universidad del Valle, Cali) was provided by the Institute of Environmental Engineering-Bioengineering (Laussane, Switzerland). Page charges partially offset by a grant from the C. P. Alexander fund.

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**MICROCLIMATES ASSOCIATED WITH
CRYPTOTERMES BREVIS
(ISOPTERA: KALOTERMITIDAE)
IN THE URBAN ENVIRONMENT**

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Abstract.—Thirty-day studies of structural lumber infested by *Cryptotermes brevis* revealed that microclimates in Hawaii were fairly uniform with an overall mean wood-core temperature of 24.33° C. The highest wood-core temperature was 43.31° C and the lowest was 13.94° C. The mean maximum wood core temperature across all sites was 37.04° C. Temperatures varied widely over a 24 h period with the greatest diurnal variation being 23.72° C. Thermal gradients between upper and lower locations of infestations were as high as 8.71° C. Ambient relative humidity was more variable than temperature with values varying as much as 55% RH during a single month. Monthly mean RH was as high as 75.09% and ranged from 98.2% to 27.2%.

Key Words.—Insecta, West Indian drywood termite, temperature, climate.

Climate studies on termites have been conducted with the Kalotermitidae (Rust et al. 1979, Williams 1977, Williams 1976) as well as higher termites (Jones & Nutting 1989, Greaves 1964). Rust et al. (1979) recorded climatic extremes in the desert habitats of *Incisitermes minor* (Hagen) and *Incisitermes fruticavus* Rust, and found that daytime temperatures in the desert shrub habitat of these two species routinely reached lethal levels, often exceeding 60° C in exposed soil. Drywood termite colonies were present in living shrubs, where temperatures were considerably lower than those of the surrounding soil, and extended from the coolest basal portions into the peripheral branches where temperatures were much higher. Additionally, Williams (1976) reported the stress limits for *Cryptotermes brevis* (Walker), and Williams (1977) found similarities between observed macroclimatic values and physiological limits established in the laboratory. To date however, no published works have documented the microclimate, i.e., the climate existing within the microhabitat (gallery systems), of *C. brevis*.

Insects live in dynamic environments (Geiger 1965) and have various adaptations for dealing with environmental extremes. Recent work with *Hodotermes mossambicus* (Hagen) established that termites living in warmer habitats have higher thermotolerances than those from cooler habitats (Mitchell et al. 1993). Microclimatic extremes are of particular interest with *C. brevis* because high temperatures are currently being used to control this termite species (Woodrow & Grace 1997).

Hawaii represents an ideal setting to study *C. brevis* biology because it is a common pest throughout the islands. In addition, the climate is relatively constant throughout the year. In Honolulu, mean temperatures during the warmest and coolest months vary, on average, less than 4° C while diurnal variation can be on the order of 5 to 10°; varying more within a typical day than throughout the entire

year (Armstrong 1983). Thus, in contrast with more variable North American conditions, a small time period can be representative of the climate. In the present study, thirty-day observations were taken of temperature fluctuations in the warmest and coolest portions of infested lumber along with ambient temperature and relative humidity within residential and commercial structures on the island of Oahu, Hawaii.

MATERIALS AND METHODS

Four study sites were selected on the basis of accessibility. A thorough visual inspection was performed to determine the location and extent of *C. brevis* infestations prior to placing thermocouples. Thermocouples were placed in the potentially hottest (highest point facing clear sun in the case of an attic infestation), or the coolest (lowest) locations within a given infested board. Two 1.1 mm (7/64 in) dia holes were drilled to the center of the infested lumber, one at the highest and one at the lowest possible sites. Temperatures within the drilled cores were recorded with Hobo XT temperature loggers (Onset Computer Corp., Pocasset, Massachusetts) (accuracy: $\pm 0.75^\circ\text{C}$), which were pre-equipped with thermistor probes which were inserted into the cores. Ambient relative humidity was recorded with a Hobo-RH (Onset Computer Corp., Pocasset, Massachusetts) (accuracy: $\pm 5\%$) and ambient temperature with a Hobo-Temp (Onset Computer Corp., Pocasset, Massachusetts) (accuracy: $\pm 0.5^\circ\text{C}$) at the highest possible site on a given board. Data loggers were set to record temperature every 24 minutes for a period of 30 days.

Microclimate surveys took place within four non-air-conditioned structures on the island of Oahu: a warehouse at Wheeler Army Air Field, Mililani, Hawaii (7 Mar–6 Apr 1996), two single family dwellings, one at Ulua St. (19 Jan–22 Feb 1996) and one at Aina Koa St. (28 Feb–31 Mar 1997), Honolulu, Hawaii, and a warehouse on the Pearl Harbor Naval Base (14 Apr–9 May 1997). Sampling periods are purely arbitrary and based on when the infestations were reported by cooperating pest control professionals, and subsequently, when permission to do research was granted by the property owners. In the case of both residences, the readings were taken in roof-rafters; within an attic crawlspace at Ulua St. residence and in an exposed eave over the entrance to the house at the Aina Koa St. The Wheeler AAF warehouse measurements were taken in a wall stud, while the Pearl Harbor warehouse readings were taken within a hardwood shipping-pallet.

RESULTS

Thirty-day studies of the *C. brevis* microclimates revealed that habitats in Hawaii were fairly uniform with an overall mean wood-core temperature of 24.33°C (SD = 1.36) (Table 1). The highest wood-core temperature recorded across all sensors was 43.31°C in the Ulua Street residence, and the lowest wood-core temperature, 13.94°C , was recorded in the Wheeler AAF warehouse. The mean maximum wood core temperature across all sites was 37.04°C (SD = 4.47, $n = 4$).

Ambient relative humidity was more variable than temperature with values deviating as much as 55% RH during a single month (Table 2). Monthly means ranged from 56.76% for the Ulua St. residence to 75.09% at the Aina Koa St.

Table 1. Summary temperatures ($^{\circ}$ C) from four sites on the Island of Oahu.

Location	Ht. ^a (m)	C/A ^b	Dimen. ^c (cm)	Mean \pm SEM ^d	Min.	Max.
Pearl Harbor	1.2	C	pallet	25.38 \pm 0.09	18.84	35.95
Aina Koa St.	3	C	3.8 \times 8.6	24.76 \pm 0.08	16.74	34.39
Aina Koa St.	2	C	3.8 \times 8.6	24.38 \pm 0.10	20.79	31.96
Ulua St.	4	C	3.8 \times 8.6	25.91 \pm 0.14	16.96	43.31
Ulua St.	3	C	3.8 \times 8.6	24.94 \pm 0.12	16.74	39.59
Ulua St.	4	A	—	26.45 \pm 0.13	17.51	41.77
Wheeler AAF	0.1	C	3.8 \times 13.3	22.38 \pm 0.09	14.99	30.98
Wheeler AAF	5	C	3.8 \times 13.3	22.56 \pm 0.10	14.5	32.72
Wheeler AAF	5	A	—	21.57 \pm 0.08	13.94	29.87

^a Height above grade.

^b Core/Ambient temperature probes.

^c Dimensions of lumber.

^d Thirty day mean, SEM = standard error of the mean.

— No data collected.

residence, and monthly maximums and minimums ranged from 98.2% to 79.2% and 43.3% to 27.2%, respectively.

Diurnal temperature variation was measured by determining the maximum and minimum temperatures for each day. Temperatures varied widely over a 24-h period (Table 3). The greatest amount of diurnal variation occurred at the Ulua St. residence, which had a mean difference of 14.70 $^{\circ}$ C and a specific difference as high as 23.72 $^{\circ}$ C. Figure 1 illustrates a typical day in a *C. brevis* microhabitat. In almost all cases, the lowest temperatures of all the probes occurred in the early morning, with temperatures slowly rising, peaking in the late afternoon and then gradually decreasing through the night. Typically, the upper core temperature rose first, followed by either the ambient or lower core locations, which tended to trail behind the upper core probe. Thermal gradients between upper and lower sites ranged from a monthly maximum of 8.71 $^{\circ}$ C, 5.60 $^{\circ}$ C and 4.48 $^{\circ}$ C for the Aina Koa St., Wheeler AAF and Ulua St. sites, respectively.

DISCUSSION

The similarity of wood-core temperatures across all sites could be an indication that these sites represent typical conditions for this species, at least in Hawaii. The mean (37.04 $^{\circ}$ C) and absolute maximum wood core temperature (43.31 $^{\circ}$ C) reported here are similar to the macroclimatic values reported previously by Williams (1977) for *C. brevis* and other *Cryptotermes* species. Williams (1977) re-

Table 2. Summary relative humidity (%) data from one month recordings at three sites on the island of Oahu.

Location	Mean \pm SEM ^a	Minimum	Maximum
Wheeler AAF	63.54 \pm 0.27	39.90	87.20
Ulua St.	56.76 \pm 0.30	27.20	79.20
Aina Koa St.	75.09 \pm 0.31	43.30	98.20

^a Standard error of the mean.

Table 3. Wood core diurnal variation ($^{\circ}$ C) of four sites on the Island of Oahu.

Location	Mean \pm SEM ^a	Maximum	Minimum
Wheeler AAF lower core	8.83 \pm 0.45	13.44	4.22
Wheeler AAF upper core	10.69 \pm 0.51	15.30	3.13
Ulua St. upper core	14.70 \pm 0.95	23.72	3.55
Ulua St. lower core	12.49 \pm 0.77	19.87	3.19
Aina Koa St. upper core	8.13 \pm 0.46	13.91	1.75
Pearl Harbor NB pallet core	10.45 \pm 0.44	15.02	2.79

^a Standard error of the mean.

ported an absolute maximum of 46° C and a mean high temperature of 38° C for this species. Although *C. brevis* can tolerate short exposures to temperatures in excess of 43° (Woodrow and Grace 1998) extended exposures to 43° C are potentially lethal to this species (Scheffrahn et al. 1997, Williams 1976) and to the protozoan symbionts (Williams 1977).

In studies with termites in forest and desert habitats it has been reported that both mound building and tree inhabiting species live in a media that insulate the colony against high ambient temperatures during hot summer months (Greaves 1964, Rust et al. 1979). In a drywood termite shrub habitat, Rust et al. (1979) found that wood temperature lagged behind that of the air. Our observations indicate that the opposite occurs within structures in the urban environment. This phenomenon is most likely due to radiant heat from the sun heating up the roof which then in turn conducts the heat to the underlying wood structure, which then conducts the heat to the surrounding air (Fig. 1). Thus, living shrubs act as insulators to high ambient air temperatures, whereas in the urban environment, wood within structures may actually be more a conductor of stressful temperatures than an insulator in some cases.

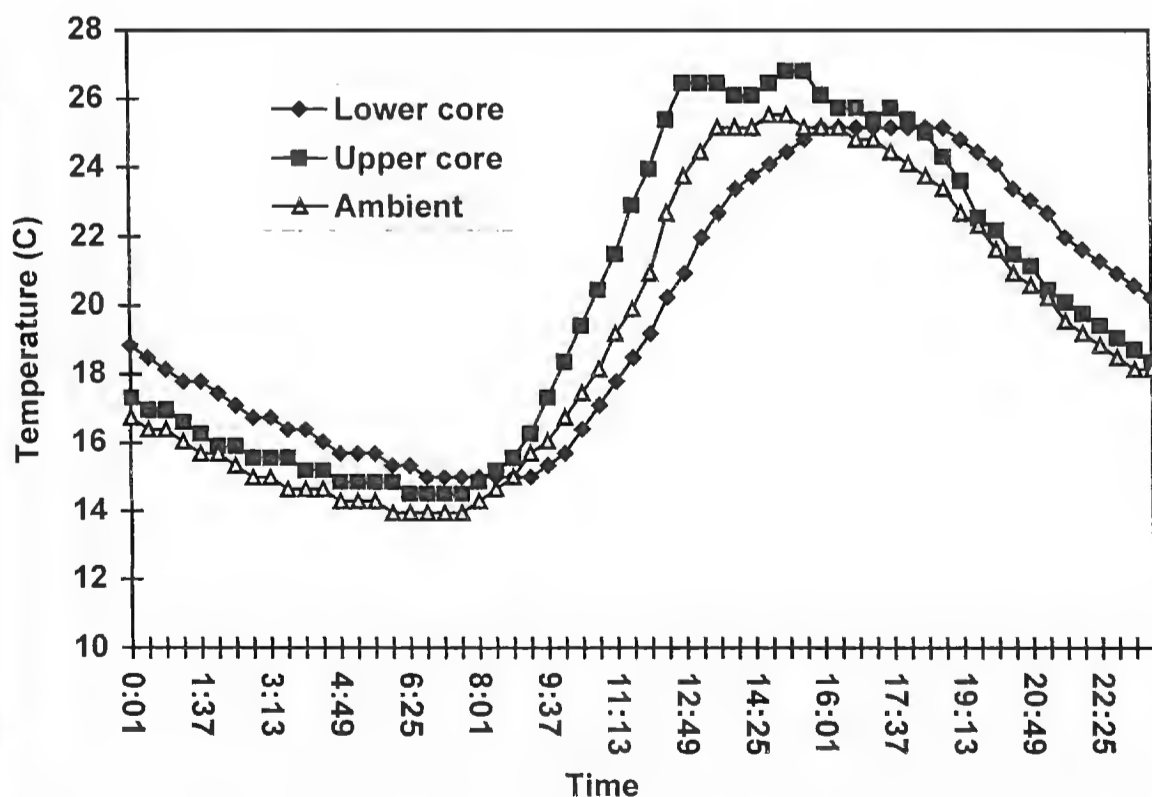


Figure 1. Twenty-four hour temperature ($^{\circ}$ C) profile of ambient and wood core temperatures of a 3.8×13.3 cm wall stud in a warehouse at Wheeler Army Air Field.

Although higher termites regulate their colony temperatures (Greaves 1964), drywood termites may move within their gallery systems according to where temperatures are most optimal (Rust et al. 1979, Cabrera and Rust 1996). The most extreme temperature measured in this study, 43.1° C, as discussed previously, has been shown to be potentially lethal. Thus, our results suggest that *C. brevis* might have either behavioral or physiological mechanisms for dealing with microclimatic extremes that could have implications on the use of extreme temperatures for the control of this termite species.

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CATALOGUE OF PIMPLINAE (HYMENOPTERA: ICHNEUMONIDAE) FROM PENINSULAR MALAYSIA

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Abstract.—A catalogue of Pimplinae (Hymenoptera: Ichneumonidae) from Peninsular Malaysia which listing 43 species under three tribes and 14 genera is presented. The genus of *Xanthopimpla* (Tribe: Pimplini), *Theronia* (Tribe: Theroniini) has the greatest number of species (21). A total of 14 species were described from Peninsular Malaysia with type specimens deposited in the U.S. National Museum of Natural History—Washington (4), British Natural History Museum—London (3), V. K. Gupta Collection (3), Berlin Museum—Germany (2), and one each in Munich—Germany and Gainesville—U.S.A.

Key Words.—Insecta, Ichneumonidae, Pimplinae, Malaysia, Peninsular Malaysia, Malaya.

Smith (1858) in describing *Pimpla punctator* Smith from Sarawak (East Malaysia) started the systematic study of the Pimplinae from Malaysia. It was followed by Krieger (1897), Cameron (1903) and Tosquinet (1903) who also covered the West of Malaysia (Peninsular Malaysia). Since then, a number of species had been described or recorded from Malaysia (Morley 1913, Cushman 1925, Beeson & Chatterjee 1935, Townes et al. 1961, Gupta 1961, Baltazar 1961, Momoi 1966, Townes & Chiu 1970, Kamath & Gupta 1972, Gupta & Tikar 1976, Kusigemati 1985).

The present catalogue lists the tribes, genera and species of Pimplinae recorded from Peninsular Malaysia. Most of the species listed have notes about the location at which it was collected or recorded. The locations for the type specimens deposited are also indicated (capital letters). Species that have no type or lectotype specimen from Peninsular Malaysia were referred to type or lectotype specimen recorded from other countries especially from the Indo-Australian region. Note that the word 'Malaya' is also referred to 'Peninsular Malaysia' in this catalogue because Peninsular Malaysia was called 'Malaya' before its independent (1957) and during early years after independent.

Museums in which type or lectotype material is located or deposited are abbreviated as follows:

AMSTERDAM. Afdeling Entomologie, Zoologisch Museum, Universiteit van Amsterdam, Plantage Middenlaan 64, Amsterdam 1004, The Netherlands.

BERLIN. Museum für Naturkunde der Humboldt-Universität zu Berlin, Berlin, Invalidenstrasse 43, Germany.

BUDAPEST. Termesztudományi Múzeum Allattara (Zoological Department of the Hungarian Natural History Museum), 1088 Budapest, Baross-Utca 13, Hungary.

COPENHAGEN. Zoologisk Museum, Universitetsparken 15, DK 2100 København, Denmark.

- EBERSWALDE. Institut f. Pflanzenschutzforschung Kleinmachnow, Abt. Taxonomie der Insekten, DDR-13 Eberswalde-Finow 1, Schickler-strasse 5, DDR Germany.
- GAINESVILLE. American Entomological Institute, 3005 S. W. 56th Avenue, Gainesville, Florida 32608, U.S.A.
- GLASGOW. University Museum, University of Glasgow, Glasgow, Scotland, U.K.
- GUPTA. Collection of Virendra Gupta, Located at the American Entomological Institute, 3005 S. W. 56th Avenue, Gainesville, Florida 32608, U.S.A.
- HONOLULU. Bernice P. Bishop Museum, Department of Entomology, Honolulu, Hawaii 96819, U.S.A.
- LEIDEN. Rijksmuseum van Natuurlijke Historie, Postbus 9517, 2300 RA Leiden, The Netherlands.
- LONDON. Department of Entomology, British Museum (Natural History), Cromwell Road, London SW7, 5BD, England.
- MUNICH. Zoologische Staatssammlung, Münchhausenstrasse 21, D-8000, München 60, FDR Germany.
- OXFORD. Hope Entomological Collections, University Museum, Oxford, OX1 3PW, England.
- STOCKHOLM. Naturhistoriska Riksmuseet, Sektionen for Entomologi, 10405 Stockholm, Sweden.
- WARSAW. Institut Zoologiczny, Polska Akademia Nauk, ul. Wilcza 64, Warszawa, Poland.
- WASHINGTON. U.S. National Museum of Natural History, Smithsonian Institute, Washington, D.C. 20560, U.S.A.
- WUFENG. Entomology Collections, Taiwan Agricultural Research.

Other abbreviations are: M = male, F = female, des = description, fig. = figured, syn = synonyms listed.

TRIBE: PIMPLINI

Pimplaetus mucronis (Gupta & Tikar)

Pimplaetus mucronis. Gupta & Tikar, 1976. Oriental Ins. Monogr., 1: 67. M, F. key, des. Type: F, Malacca & Perak (BERLIN).

Flavopimpla nigromaculata mangae Betrem

Flavopimpla nigromaculata mangae: Gupta & Tikar, 1976. Oriental Ins. Monogr. 1: 73, F. key, des., fig. Selangor: Kenny Hills.

Type: F, Taiwan (EBERSWALDE), *Exeristes gracilis* Cushman, 1933. Insecta Matsumurana, 8: 36.; F, India (WASHINGTON), *Calliephialtes bimarginatus* Cushman 1937. Indian Forest Rec. (N. S.) Ent. 3: 141.

Camptotypus rugosus (De Geer)

Trichiothecus ruficeps Cameron, 1903. J. Straits Branch Roy. Asiatic Soc., 39: 137. F. des. Type: F, Sarawak: Kuching (LONDON).

Hemipimpla rugosus: Morley, 1914. Revision of the Ichneumonidae in the British Museum, 3: 97. M, F. key, syn., des. Perak: Tengar.

Camptotypus rugosus: Gupta & Tikar, 1976. Oriental Ins. Monogr., 1: 185, M,

F. key, syn., des., fig. Malacca: Tengah Geh.; N. Sembilan: Seremban; Kedah: Gajah Mati, Gurun, Bukit Bintang; Selangor: Bukit Kutu—900 m.

Zaglyptus Indicus nigrithorax Gupta

Zaglyptus indicus nigrithorax Gupta, 1961. Indian J. Ent., 22: 250. F. key, des. Type: F, Pahang: Lubok Tamang, 3500 ft. (WASHINGTON).

Echthromorpha agrestoria notulatoria (Fab.)

Echthromorpha maculipes Cameron, 1905. J. Straits Branch Roy. Asiatic Soc., 44: 121. [F]. des. Lectotype (designated by Townes, Townes & Gupta 1961): F, Sarawak: Kuching (LONDON). Syn. With *laeva* by Morley 1913.

Echthromorpha notulatoria: Beeson & Chatterjee, 1935. Indian Forest Rec. (N.S.) Ent., 1: 159. Biol. Malay Peninsular. Host: *Hyblaea puera*.

Echthromorpha agrestoria notulatoria: Townes, Townes & Gupta, 1961. Mem. Amer. Ent. Inst., 1: 39. Lectotype design., syn. Malaya.

Xanthopimpla alternans Krieger

Xanthopimpla alternans: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 170. M, F. key, syn., des., fig. Kuala Lumpur; Penang I: Sungei Siru, Tanjung Bungah.

Type: *Xanthopimpla alternans* Krieger, F. Taiwan, Chia (BERLIN); *Xanthopimpla genualata* Krieger, Indonesia: West Sumatera (BERLIN).

Xanthopimpla clivulus clivulus Townes & Chiu

Xanthopimpla clivulus clivulus: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 161. F. key, des., Fig. N. Sembilan: Kuala Klawang, Kampai.

Type: F., Indonesia (GAINESVILLE).

Xanthopimpla curvimaculata pendleburyi Townes & Chiu

Xanthopimpla curvimaculata pendleburyi: Townes & Chiu, 1970. Mem. Amer. Ent. Inst. 14: 264. key, des., Type: F, Selangor: Kuala Lumpur.

Xanthopimpla decurtata detruncata Krieger

Xanthopimpla decurtata detruncata: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 143. M, F. n. status, key, des., fig. Pahang (4200 ft); Penang I.

Type: *Xanthopimpla detruncata*: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6); 39, 115. F, Taiwan (BERLIN).

Xanthopimpla ecaudata Krieger

Xanthopimpla hispida: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6): 24. Key; (A) 80 (7): 130. F. des., fig. Perak.

Xanthopimpla hispida: Townes, Townes & Gupta, 1961. Mem. Amer. Ent. Ints., 1: 56. Malaya.

Xanthopimpla hispida: Krieger, 1899. Sitzber. Naturf. Gesell. Leipzig, 1897/98: 70. F. key des., Type: F, Perak (BERLIN). Syn. By Townes & Chiu 1970.

Xanthopimpla enderleini Krieger

Xanthopimpla enderleini: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 118. M, F. Lectotype design., key, syn., des., fig. Selangor: Ulu Langat.

Type: *Xanthopimpla enderleini*: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6): 35. Indonesia: Sumatera (WARSAW).

Xanthopimpla exigua exigua Krieger

Xanthopimpla exigua exigua: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 203. M, F. n. status, key, syn., des., fig. Selangor: Ulu Langat, 300–390 m.

Xanthopimpla exigua: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6): 41, 100. M. key, des., fig. Type: M, Sarawak: Lundu (BERLIN).

Xanthopimpla flavolineata Cameron

Xanthopimpla flavolineata: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 114. M, F. key, syn., des., fig. Malaya.

Xanthopimpla emaculata: Kusigemati, 1985. Mem. Kagoshima univ. res. Center S. Pacific, 5: 127. M, F. Pahang: Cameron Highland.

Type: *Xanthopimpla flavolineata*: Cameron, 1907. Tijdschr. V. Ent., 50: 48. F. key, des. Indonesia: West Irian (AMSTERDAM).

Xanthopimpla gampsura Krieger

Xanthopimpla gampsura: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 56. M, F. key, des., fig. Selangor: Beting; Kuala Lumpur; Teluk Merbau: Penang: Ginting.

Type: *Xanthopimpla gampsura*: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6): 44. Indonesia (BERLIN).

Xanthopimpla glaberrima Roman

Xanthopimpla glaberrima: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 183. M, F. key, syn., des., fig. Penang I.

Type: *Xanthopimpla glaberrima*: Roman, 1913. Arkiv for Zool., 8 (15): 22. Philippines (STOCKHOLM); *Xanthopimpla sauteri*: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6): 31. Lectotype (designated by Townes, Townes & Gupta 1961), Taiwan (BERLIN).

Xanthopimpla incompleta Krieger

Xanthopimpla incompleta: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 269. F. key, des., fig. Selangor: Kuala Lumpur (WASHINGTON).

Type: *Xanthopimpla incompleta*: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6): 23. Key; (A) 80 (7): 145. F. des. Indonesia (STOCKHOLM).

Xanthopimpla jacobsoni jacobsoni Krieger

Xanthopimpla jacobsoni jacobsoni: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 172. M, F. n. status, key, syn., des., fig. Kuala Lumpur; Penang I.; Perak: Teluk Anson.

Type: *Xanthopimpla jacobsoni*: Krieger, 1914. Arch. F. Naturgesch., (A) 80 (6): 32. Indonesia: Semarang (BUDAPEST). Host: *Eulemma versicolor*.

Xanthopimpla konowi Krieger

Xanthopimpla konowi: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 48. M, F key, syn., des., fig. Malaya. Host: *Attacus dohertyi*, *Saturnia pyretorum* and other Saturnidae.

Type: *Xanthopimpla konowi*: Krieger, 1899. Sitzber. Naturf. Gesell. Leipzig, 1897/98: 87. F. key, des., fig. Japan (BERLIN); *Xanthopimpla watsoni*: Cameron, 1911. Soc. Ent., 26: 46. M. key, des. Type: M, India: Bengal (LONDON).

Xanthopimpla laticeps liturata Townes & Chiu

Xanthopimpla laticeps liturata: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 181. F. key, des., fig. Type: F, Penang I. (WASHINGTON).

Townes & Chiu 1970. Mem. Amer. Ent. Inst., 14: 372 pp.

Townes, Townes & Gupta 1961. Mem. Amer. Ent. Inst., 1: 532 pp.

Xanthopimpla modesta modesta (Smith) (Gupta 1987); *Xanthopimpla modesta* (Smith) (Yu & Horstmann 1997).

Xanthopimpla modesta modesta: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 106. M, F n. status, key, Syn., des., fig. Selangor: Kepong.

Xanthopimpla latebalteata: Cameron, 1903. J. Straits Branch Roy. Asiatic Soc., 39:137. M. des. Lectotype (designated by Townes, Townes & Gupta 1961): F, Sarawak: Kuching (LONDON). Syn. By Townes & Chiu 1970.

Xanthopimpla naenia Morley

Xanthopimpla naenia: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 268. M, F key, syn., des., fig. Kuala Lumpur.

Type: *Xanthopimpla naenia*: Morley, 1913. Fauna of British India, Hymenoptera, 3: 115. F. key. des., India (OXFORD).

Xanthopimpla pedator (Fab.)

Xanthopimpla pedator: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 39. M, F key, syn., des., fig. Penang I.

Type: *Ichneumon pedator* Fab., 1775. Systema Entomologiae, p. 828. F. des. India (GLASGOW).

Xanthopimpla pulvinaris Townes & Chiu

Xanthopimpla pulvinaris: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 271. M, F key, des., fig. Kuala Lumpur.

Type: F, Taiwan (WUFENG).

Xanthopimpla punctata (Fab.)

Xanthopimpla punctata: Momoi, 1966. Mushi, 40: 4. M, F. Malaya

Xanthopimpla punctata: Kusigemati, 1985. Mem Kagoshima Univ. Res. Center S. Pacific, 5: 127. M, F. des., Perak.

Type: *Xanthopimpla lissonota*: Cameron, 1906. J. Straits Branch Roy. Asiatic Soc., 46: 115. F. des., F. Sarawak: Kuching (LONDON). Syn. By Townes, Townes & Gupta 1961.

Xanthopimpla regina Morley

Xanthopimpla regina: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 43. M, F key, des., fig. Kuala Lumpur.

Type: *Xanthopimpla regina*: Morley, 1913. Fauna of British India, Hymenoptera, 3: 118. M, F key, des. Bangladesh: Sylhet (LONDON).

Xanthopimpla walshae walshae Townes & Chiu

Xanthopimpla walshae walshae: Townes & Chiu, 1970. Mem. Amer. Ent. Inst., 14: 191. F key, des., fig.). Pahang: Fraser's Hill, 400 ft.

Type: F, Indonesia: Java (GAINESVILLE).

TRIBE: THERONIINI

Theronia clathrata malayensis Gupta: Yu & Horstmann (1997) put it under Pimplini

Theronia (Theronia) clathrata malayensis: Gupta, 1962. Pacific Ins. Monogr., 4: 50. F key, des., Type: F, Pahang: Fraser's Hill, 1300 m (LONDON).

Theronia nigrivertex Gupta (in Gupta, 1987); Yu & Horstmann (1997) put it under Pimplini

Theronia (Theronia) nigrivertex: Gupta, 1962. Pacific Ins. Monogr., 4: 45. F key, des. Type: F, Perak: Jor Camp, 550 m, Batang Padang (WASHINGTON). Pahang: Cameron Highlands, Terbukui, 1200 m.

Theronia pseudozebra pseudozebra Gupta

Theronia (Theronia) pseudozebra pseudozebra: Gupta, 1962. Pacific Ins. Monogr., 4: 21. M, F key. des., Pahang: Fraser's Hills, 1300 m, Kedah: Kedah Peak, 1200 m. Penang I.

Type: F, Sabah: Sandakan (WASHINGTON).

Theronia zebra zebra (Vollenhoven)

Theronia (Theronia) zebra zebra: Gupta, 1961. Pacific Ins. Monogr., 4: 16. M, F n. status, key, des., fig. Kuala Lumpur.

Type: *Pimpla zebra*: Vollenhoven, 1879. Stetiner Ent. Ztg., 40: 147. F, des. Indonesia (LEIDEN).

Nomosphacia pyramida pyramida (Gupta) (in Gupta 1987): *Neotheronia pyramida* Gupta (Tribe: Pimplini) (in Yu & Horstmann 1997)

Theronia (Nomosphacia) pyramida pyramida: Gupta, 1962. Pacific Ins. Monogr., 4: 80. M. key, des.

Type: M, Kedah: Kedah Peak, 1200 m. (GUPTA). Momoi 1968. Kontyu, 36(2); 182–185; Gupta, 1987. Mem. Amer. Ent. Inst., 41 (Part 2). Pp 598–1210.

Nomosphacia zebroides zebroides (Krieger)

Theronia (Nomosphacia) zebroides zebroides: Gupta, 1962. Pacific Ins. Monogr., 4: 71. F n. comb., key, des. Penang I' Water Fall garden Host: *Eumenes arcuata*.

Type: *Theronia zebroides*: Krieger, 1906. Ztschr. Syst. Hymen. Dipt., 6: 236. F des. In key. Type: F, Indonesia: Sumatera (BERLIN).

Epitheronia tomeus (Gupta)

Theronia (*Epitheronia*) *tomeus*: Gupta, 1962. Pacific Ins. Monogr., 4: 96. M, F. key, des. Kedah: Langkawi I.

Type: F, Indonesia (LEIDEN).

TRIBE: NEOXORIDINI = POEMENIINI

Eugata nigrita Gupta

Eugalta nigrita: Gupta, 1980. Oriental Ins., 14: 106. M, F. key, des., fig. Type: F, Perak (MUNICH), Selangor: Bukit Kutu, 3500 ft.

Eugalta santoshale Gupta

Eugata santoshae: Gupta, 1980. Oriental Ins., 14: 99. F. key, des. Selangor: Bukit Kutu, 3500 ft. Type: F, Indonesia (GAINESVILLE).

Achorocephalus nigricollis malayanus (Gupta)

Pseudeugalta nigcollis malayanus: Gupta, 1980. Oriental Ins., 14: 120. M. key, des. Type: M, Perak: Larut Hills, 3700–4000 ft (GUPTA).

Achorocephalus nigricollis malayanus: Gupta, 1985. Oriental Ins., 19: 324. N. comb.

TRIBE: RHYSSINI

Lytarmes maculipeunis maculipennis (Smith)

Megarhyssa variegata: Mocsary, 1905. Ann. Mus. Natl. Hungarici, 3: 2. M. des. Lectotype: Perak (BUDAPEST). Syn. By Kamath & Gupta 1972.

Lytarmes maculipennis variegatus: Townes, Townes & Gupta, 1961. Mem. Amer. Ent. Inst., 1: 84. Lectotype design., n. comb., syn. Malaya.

Lytarmes maculipennis maculipennis: Kamath & Gupta, 1972. Oriental Ins. Monogr., 2: 23. M, F. key, syn., des., fig. Perak; Penag I: Penang Hills, Air Hitam, 300 m; Selangor: Ampang Reservoir; Malacca, Mt. Tengah.

Type: *Rgyssa varilineata*: Cameron, 1907. Ann. & Mag. Nat. Hist., (7) 20; 15. F. des. Sarawak: Kuching (LONDON). Syn. By Gupta & Kamath 1972.

Sychnostigma binarium binarium Kamath & Gupta

Sychnostigma binarium binarium: Kamath & Gupta, 1972. Oriental Ins. Monogr., 2: 135. F. key, des. Type; F, Pahang: Mt. Tahan, 800–1200 m (LONDON).

Sychnostigma flavopictum flavopictum (Smith)

Epirhyssa flavopicta: Morley, 1913. Revision of the Ichneumonidae in the British Museum, 2; 6. F. key, syn. (in part), des. Penag I; Pahang: Mt. Thau, 2500–3500 ft.

Epirhyssa flavopicta: Morley, 1914. Ann. & Mag. Nat. Hist. (8) 14: 409. Malaysia (in part).

Sychnostigma flavopictum: Townes, Townes & Gupta, 1961. Mem. Amer. Ent. Inst., 1: 87. N. comb. Penang I.

Epirhyssa curvimaculata: Cameron, 1907. Ann. & Mag. Nat. Hist., (7) 20; 16. F. des. Lectotype (designated by Kamath & Gupta 1971), F, Sarawak: Kuching (LONDON).

Sychnostigma malayanum Kamath & Gupta

Epirhyssa flavobalteata: Morley, 1913. Revision of the Ichneumonidae in the British Museum, 2: 7, (in part). F, Perak: Maxwells's Hill.

Epirhyssa flavobalteata: Morley, 1913. Fauna of British India, Hymenoptera, 3: 88 (in part).

Sychnostigma malayanum: Kamath & Gupta, 1972. Oriental Ins. Monogr., 2: 173. F. key, des., fig. Perak: Maxwell's Hill.

Type: Pahang: Cameron Highlands, 1500–1600 m (LONDON).

Sychnostigma nigrobalteatum (Cameron)

Sychnostigma nigrobalteatum: Kamath & Gupta, 1972. Oriental Ins. Monogr., 2: 190. F. key, syn., des. Kedah: Kedah Peak, 1100 m.

Epirhyssa nigrobalteata: Cameron, 1903. J. Straits Branch Roy. Asiatic Soc., 39; 134. F, des. Lectotype (designated by Townes, Townes & Gupta 1961): F, Sarawak: Kuching (LONDON).

Myllenyxis javensis Kamath & Gupta

Myllenyxis javensis: Kamath & Gupta, 1972. Oriental Ins. Monogr., 2: 212. M. key, des., fig. Selangor: Kuala Lumpur.

Type: M, Java (GAINESVILLE).

Myllenyxis muelleri (Vollenhoven)

Myllenyxis muelleri: Kamath & Gupta, 1972. Oriental Ins. Monogr., 2: 207. F. key, syn., des., fig. Perak.

Epirhyssa nigerrima: Morley, 1913. Revision of the Ichneumonidae in the British Museum, 2: 6. F. key, des. Type: F, Sarawak (LONDON). Syn. By Kamath & Gupta 1972.

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***DIMORPHOPALPA*, A NEW GENUS OF TORTRICID
MOTHS FROM CENTRAL AND SOUTH AMERICA
(LEPIDOPTERA: TORTRICIDAE: EULIINI)**

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Abstract.—*Dimorphopalpa*, NEW GENUS, is described from Central and South America. Five species are recognized: *D. albopunctana*, NEW SPECIES, from Costa Rica and Venezuela; *D. striatana*, NEW SPECIES, from Costa Rica and Venezuela; *D. striatanoides*, NEW SPECIES, from Ecuador and Colombia; *D. teutoniana*, NEW SPECIES, from Brazil (type species); and *D. xestochalca* (Meyrick), NEW COMBINATION, from Colombia. Putative synapomorphies for species of the new genus include the following: 1) sexually dimorphic labial palpi; those of the male are moderate in length while those of the female are exceedingly elongate; 2) male genitalia with a pair of unique, sclerotized, ventrally projecting extensions of the tegumen between the base of the uncus and base of the gnathos; and 3) short, rounded valvae. *Dimorphopalpa* appears to be most closely related to *Uncicida* Razowski, with which it shares similar processes from the gnathos and a pair of lateral, rounded structures distally on the caulis of the aedeagus that represent the point of attachment to the juxta.

Key Words.—Insecta, Lepidoptera, Tortricidae, Tortricinae, Euliini, *Dimorphopalpa*, Neotropics.

Sexual dimorphism in the tortricid tribe Euliini (Tortricinae) usually is restricted to slight differences in forewing length, subtle differences in intensity and definition of forewing pattern, and antennal cilia length. In addition, males of many genera possess a distinctive foreleg hairpencil (Brown 1990a). During continuing studies on the phylogeny and taxonomy of Neotropical Euliini (Brown 1989, 1990a, b, 1991a, b, 1998; Brown & Powell 1991), I discovered a small, homogeneous group of species that exhibit conspicuous sexual dimorphism in the length of the labial palpi and a slight difference in forewing shape. Males have moderate, weakly upturned labial palpi and a moderately broad forewing (length ca. 2.6 times width). In contrast, females have exceptionally elongate, porrect labial palpi and a slightly more slender forewing (length ca. 2.7–2.8 times width); females also have a slightly greater forewing length. The sexes can be associated by forewing pattern, although that of the male is slightly less defined in some species, and by the sympatry of males and females of similar phenotype. *Dimorphopalpa*, new genus, is described to accommodate this group of species which includes "*Tortrix*" *xestochalca* Meyrick and four previously undescribed species.

The description of *Dimorphopalpa* brings to 80 the number of described Neotropical genera in Euliini (Powell, Razowski & Brown 1995). An additional 50 or so described species that lack meaningful generic assignments also are included in the tribe (Brown 1989, Powell, Razowski & Brown 1995), and a large number of undescribed species are present in collections worldwide. The tribe may be the most speciose and diverse group of Neotropical Tortricidae.

MATERIALS AND METHODS

Material for this study was acquired from the following institutions: National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C.,

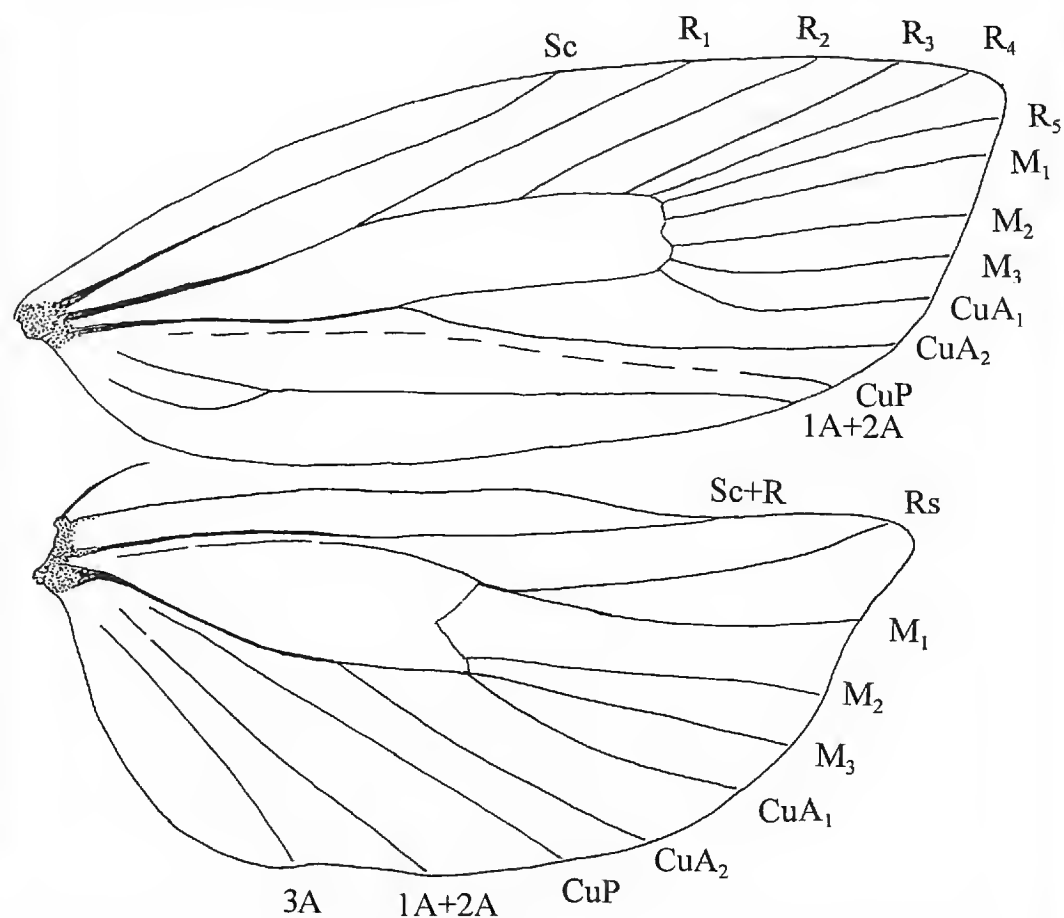


Figure 1. Wing venation of *Dimorphopalpa teutoniana*.

United States; The Natural History Museum (BMNH), London, England; Essig Museum of Entomology (UCB), University of California, Berkeley, California, United States; Instituto Nacional de Biodiversidad (INBio), Santo Domingo, Heredia, Costa Rica; and Vitor Becker personal collection, Planaltina, Brazil (VBC). A total of 98 specimens was examined.

Dissection methodology follows that presented in Brown and Powell (1991). Forewing measurements were made using an ocular micrometer mounted in a dissecting microscope. Terminology for wing venation and genitalic structures follows Horak (1984). Abbreviations and symbols are as follows: FW = forewing; HW = hindwing; DC = discal cell; n = number of specimens examined or measured; ca. = circa (approximately); \bar{x} = mean.

SYSTEMATICS

Dimorphopalpa J. Brown, NEW GENUS

Type Species.—*Dimorphopalpa teutoniana* J. Brown, NEW SPECIES.

Head.—Frons smooth, sparse-scaled below mid-eye, rough-scaled above; overhanging tuft of scales from vertex. Antennal cilia in male ca. 1.25 times width of flagellomere; cilia in female ca. 0.1 times width of flagellomere; antenna pale tan with pale yellow scales. Labial palpus (segments II and III combined) ca. 1.5 times horizontal diameter of compound eye in male, ca. 3.0 times horizontal diameter of compound eye in female; segment II expanded distally by scaling, slightly curved; segment III about one-third as long as II, partially exposed. Maxillary palpus rudimentary. Ocelli moderate to small. Chaetosema present. Proboscis present, presumably functional. Thorax: Smooth-scaled, without upraised tufts. Male without foreleg hairpencil. Forewing (Fig. 1): Length ca. 2.6 times width in male, 2.7–2.8 times width in female; length of DC 0.64–0.65 FW length; width

of DC 0.13–0.14 its length; CuA₂ originates 0.54–0.58 along length of DC; all veins separate beyond DC; R₄ to costa, R₅ to termen; CuP present at margin; M-stem and chorda absent; costal fold absent in male. Hindwing: Sc+R and Rs separate; Rs and M₁ closely approximate at base; M₃ and CuA₁ connate; CuP present. Abdomen: Dorsal pits absent; no modified corethrogyne scaling in female. Male genitalia: Tegumen short, extremely broad, rounded dorsally, with a pair of slender, elongate, free, ventrally projecting extensions between base of uncus and base of gnathos; anterodorsal suture of lateral halves of tegumen obsolete. Uncus well developed, variable, stout and straight, deflexed, or flared and enlarged submesally. Socius moderately large, narrow, pendant, with fine long scales. Gnathos smooth, highly modified; each arm with a large, lateral, distally attenuate projection and a subapical lobelike process; mesal junction of arms weakly sclerotized, short, rounded, upturned. Transtilla a simple, narrow, slightly arched, non-dentate band. Valva short, broad, rounded apically; sacculus weakly developed; costa not or only weakly sclerotized. Pulvinus absent. Neither hamini nor subscaphium developed. Juxta an irregular, somewhat triangular plate. Aedeagus short, stout; caulis with a pair of rounded lateral processes distally; vesica with lines of small, beadlike scobination; cornuti absent. Female genitalia: Papillae anales simple. Apophyses posteriores ca. 2 times length of apophyses anteriores. Sterigma a weakly sclerotized, ventrally bilobed pocket; ostium at saddle between lobes. Ductus bursae short, without distinct junction between ductus and corpus. Corpus bursae simple, elongate; spiculae and signa lacking. Ductus seminalis from corpus bursae near junction of corpus and ductus bursae.

Distribution and Biology.—*Dimorphopalpa* is known from Costa Rica south to Bolivia, and east to southeastern Brazil. The early stages are unknown.

Diagnosis.—Species of *Dimorphopalpa* feature a fawn brown ground color with a variably developed forewing pattern consisting of one or more diagonal fasciae, sometimes less defined in the male. *Dimorphopalpa* can be distinguished from all other genera in Euliini (except *Strophotina* Brown) by the conspicuously dimorphic labial palpi, i.e., moderate in length in the male, extremely elongate in the female. Among previously described genera, only *Strophotina* Brown has sexually dimorphic labial palpi (Brown 1998). It is likely that this character has arisen independently in the two genera because *Strophotina* and *Dimorphopalpa* have little else in common. Although male secondary sex structures must be used with caution in defining phylogenetic relationships because they may be evolutionarily more labile than other morphological features, dimorphism in the labial palpi in *Dimorphopalpa* apparently is consistent within the genus, and as corroborated by other morphological characters cited below, represents one of several putative apomorphies for the genus.

Male genitalia of *Dimorphopalpa* are characterized by a short, broad, rounded tegumen and short, rounded valvae. Putative synapomorphies for the included species include a pair of slender, ventrally projecting extensions of the tegumen between the base of the uncus and the base of the gnathos, and the short, rounded valva. Female genitalia are moderately uniform within the genus; the sterigma always consists of a simple, ventrally bilobed pocket. On the basis of characters of the male genitalia, *Dimorphopalpa* appears to be most closely related to *Uncicida* Razowski. Putative synapomorphies for the two genera include the elongate, distally attenuate, lateral projection from the gnathos arm and a pair of

lateral, rounded structures distally on the caulis of the aedeagus; both genera lack a male foreleg hairpencil. The female genitalia of *Dimorphopalpa* are most similar to those of *Bonagota* Razowski and *Apotomops* Powell in the development of the sterigma as a simple bilobed pocket. However, *Dimorphopalpa* differs from the latter two genera in features of the male genitalia, wing venation, dimorphic palpi, and length of the antennal cilia. The female of *Uncicida* is unknown, hence no comparisons of female genitalic structures or sexual dimorphism can be made.

The ventrally projecting extensions of the tegumen of *Dimorphopalpa* have nothing in common with the hami of Chlidanotinae. The latter structures arise at or just below the base of the uncus near the dorsum of the tegumen, and are free, digitate, movable processes. In contrast the structures in *Dimorphopalpa* are extensions of the tegumen, and are rigid and inflexible.

Etymology.—The generic name refers to the sexual dimorphism in length of the labial palpi.

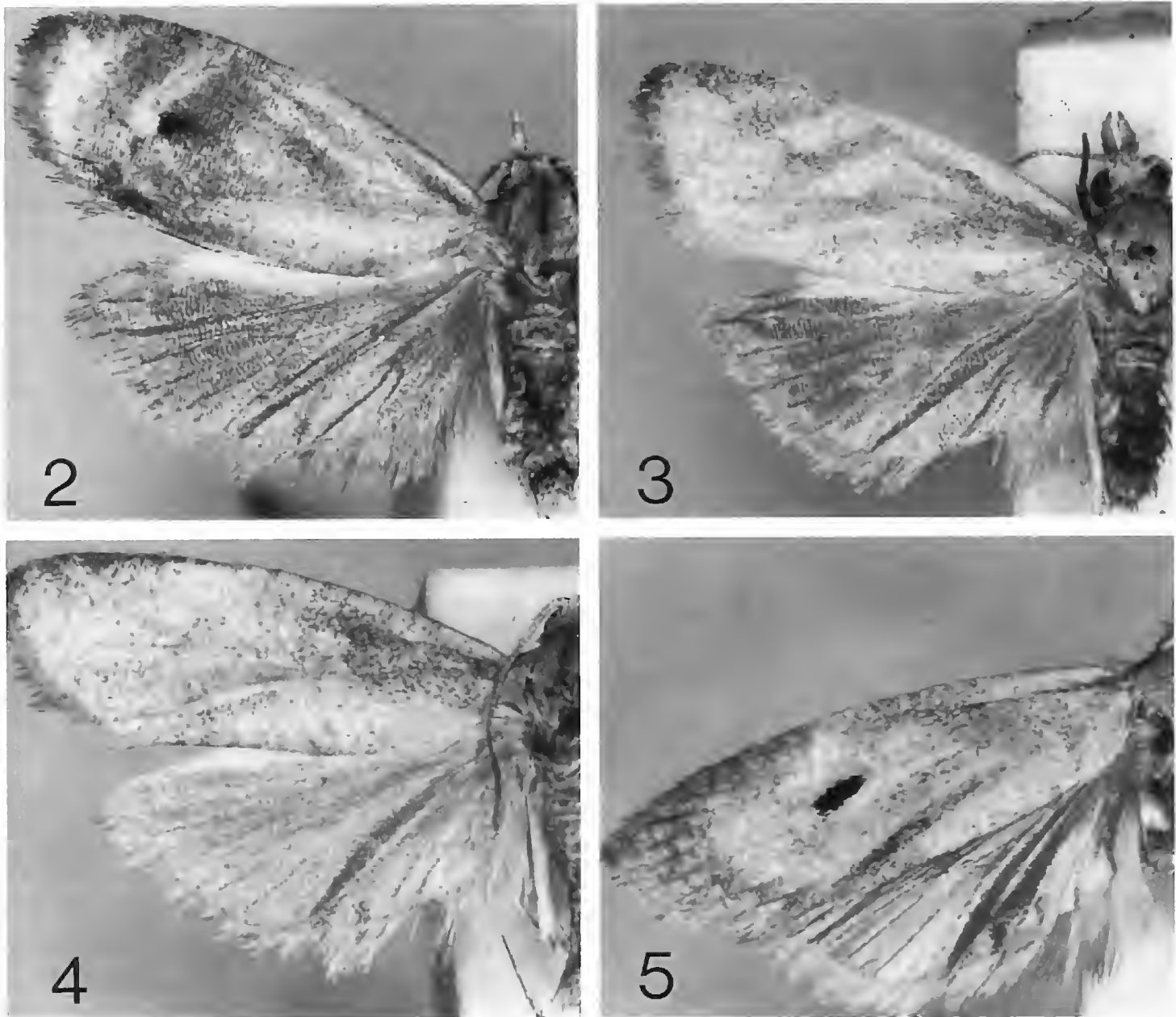
KEY TO THE KNOWN SPECIES OF *DIMORPHOPALPA*

1. FW with distinct black-brown spot or dash near apex of discal cell (Figs. 2 and 5) 2
- 1'. FW lacking distinct black-brown spot or dash near apex of discal cell (Figs. 3 and 4) 3
2. FW with small white spot adjacent to black-brown spot near the apex of discal cell (Fig. 2) *albopunctana*
- 2'. FW with a slender dark dash near apex of the discal cell (Fig. 5) *teutoniana* (in part)
3. FW with three distinct parallel diagonal brown lines extending tornad from near costa (Fig. 3) 4
- 3'. FW with fewer than three diagonal brown lines (Fig. 5) 5
4. FW ground color brown *striatanoides*
- 4'. FW ground color pale fawn *striatana*
5. Male 6
- 5'. Female 7
6. FW length less than 8.0 mm; known only from southeastern Brazil (Fig. 5) *teutoniana* (in part)
- 6'. FW length greater than 9.0 mm; known only from Colombia .. *xestochalca*
7. FW with at least one distinct diagonal brown line extending tornad from near costa *teutoniana* (in part)
- 7'. FW lacking distinct diagonal line(s), usually with a small ill-defined brown blotch near apex of discal cell; unassociated females from Costa Rica and Bolivia *xestochalca* or other spp. (see Remarks under *D. xestochalca*)

Dimorphopalpa albopunctana J. Brown, NEW SPECIES

(Figs. 2, 6, 10)

Types.—Holotype, male; data: VENEZUELA. ARAGUA: Rancho Grande, 1100 m, 16–19 Jan 1966, S. & W. Duckworth; deposited in USNM. Paratypes: COSTA RICA. CARTAGO PROVINCE: Rio Aquiares, 9 km NW Turrialba, nr. Santa Cruz, 1500 m, 1 ♀, 15 May 1985 (J. Powell & P. Opler, UCB). PUNTARENAS PROV-

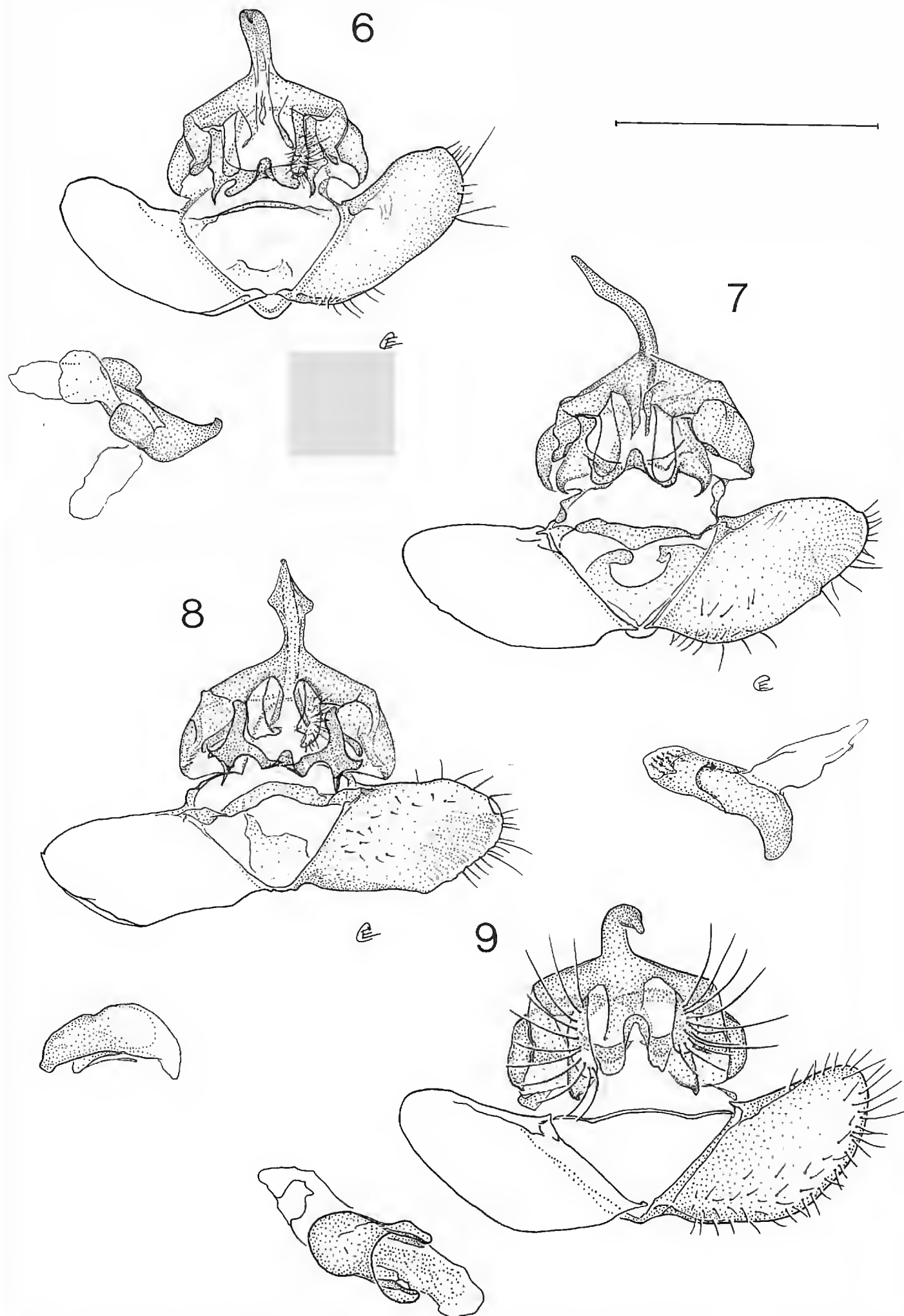


Figures 2–5. Adults of *Dimorphopalpa*. 2. *D. albopunctana*, female paratype, Costa Rica; 3. *D. striatana*, male paratype, Cost Rica; 4. *D. teutoniana*, male paratype, Brazil; 5. *D. teutoniana*, female paratype, Brazil.

INCE: Monteverde, 1300 m, 1♂, 17–20 May 1985, blacklight (J. Powell & P. Opler, UCB); Est. La Casona, 1520 m, 1♂, 1♀, Aug 1992, 1♂, Jul 1993, 1♂ Mar 1991 (N. Obando, INBio); Finca Cafrosa, Est. Las Mellizas, P. N. Amistad, 1300 m, 1♂, Oct 1989, 1♀ Oct 1990, 1♂, Nov 1990 (M. Ramirez & G. Mora, INBio). **VENEZUELA. ARAGUA:** Rancho Grande, 1100 m, 1♂, 1♀, 16–23 Oct 1966 (S. S. & W. D. Duckworth, USNM), 1♂, 1–7 Aug 1967 (R. Poole, USNM), 1♀, 30–31 Mar 1978 (J. Heppner, USNM).

Description.—Male. FW length 6.5–7.0 mm (\bar{x} = 6.6; n = 5). Head: Frons pale yellow-tan. Labial palpus pale whitish tan mesally, tan laterally. Thorax: Yellow-tan. Forewing: Pale brown, dorsum lighter, fawn brown in basal two-thirds; terminal area with diffuse whitish band extending to costa just before apex; apex of DC with black-brown spot bordered distally by a white spot roughly equal in size; faint whitish streak from latter white spot curving to costa ca. two-thirds distance from base to apex. Fringe pale whitish tan. Hindwing: Uniform pale gray-brown. Fringe pale whitish tan. Genitalia: As in Fig. 6 (drawn from JWB slide no. 264, Monteverde, Costa Rica; n = 3). Uncus relatively stout, with short attenuate tip. Gnathos with distal process oblong, lateral process elongate, spinelike, the processes together forming a somewhat chelate projection. Socius, transtilla, and valva as described for genus. Aedeagus short with strongly curved, attenuate phallobase.

Female.—FW length 7.5–8.5 mm (\bar{x} = 8.0; n = 4). As described for male (Fig. 2). Genitalia: As



Figures 6–9. Male genitalia of *Dimorphopalpa*; valvae spread, aedeagus removed. 6. *D. albopunctana*; 7. *D. striatana*; 8. *D. teutoniana*; 9. *D. striatanoides*. Scale bar = 1.0 mm.

in Fig. 10 (drawn from JWB slide no. 459, Cartago Province, Costa Rica; $n = 3$). Sterigma a deeply bilobed pocket ventrally, with lateral edge of each lobe extending nearly to posterior lip of sterigma as sclerotized line. Corpus and ductus as described for genus.

Diagnosis.—*Dimorphopalpa albopunctana* can be distinguished superficially from its congeners by the small black-brown spot and adjacent white spot near the apex of the forewing discal cell. The male genitalia are most similar to *D. striatana*; in *D. albopunctana* the uncus is relatively straight rather than deflexed subapically, and the lateral processes of the gnathos are narrow and spinelike rather than broad and curved (see Figs. 6 and 7). Autapomorphies for *D. albopunctana* include the shape of the gnathos and the deeply bilobed sterigma.

Etymology.—The specific epithet refers to the white spot on the forewing.

Dimorphopalpa striatana J. Brown, NEW SPECIES
(Figs. 3, 7, 11)

Types.—Holotype, male; data: VENEZUELA. ARAGUA: Rancho Grande, 1100 m, 21–25 Jan 1966, S. & W. Duckworth; deposited USNM. Paratypes. COSTA RICA. CARTAGO PROVINCE: Ref. Nac. Fauna Silv. Tapanti, 1250 m, 2♂♂, 1♀, Nov 1991 (G. Mora, INBio); P[arque] N[acional] Tapanti, A. C. Amistad, 1150 m, 1♂, Jan 1994 (G. Mora, INBio). PUNTARENAS PROVINCE: Est. Biol. Las Alturas, Coto Brus, 1500 m, 1♀, Aug 1991 (M. Ramirez, INBio); Finca Cafrosa, Est. Las Mellizas, P. N. Amistad, 1♂, Oct 1989 (M. Ramirez & G. Mora, INBio). VENEZUELA. ARAGUA: Rancho Grande, 1100 m, 1♂, 2♀♀, 8–14 Aug 1967 (R. Poole, USNM).

Description.—Male. FW length 7.5–7.8 mm ($\bar{x} = 7.6$; $n = 4$). Head: Frons pale yellow-tan. Labial palpus pale whitish tan mesally, tan laterally. Thorax: Pale tan-yellow. Forewing (Fig. 3): Fawn brown with faint, indistinct, slightly darker mottling; three parallel diagonal brown fasciae extending from near costa to near tornus; apex with diffuse brown patch along costa. Fringe yellow-tan. Hindwing: Uniform light gray-brown. Fringe pale whitish tan. Genitalia: As in Fig. 7 (drawn from INBio no. 331353, Cartago Province, Costa Rica; $n = 2$). Uncus deflexed dorsally in apical one-fourth, with attenuate apex. Gnathos with subapical process rounded, lobelike; lateral process broad at base, attenuating into elongate curved spine. Socius, transtilla, and valva as described for genus. Aedeagus short, stout, curved basally.

Female.—FW length 8.2–10.0 mm ($\bar{x} = 9.1$; $n = 4$). As described for male except forewing pattern more well defined. Genitalia: As in Fig. 11 (drawn from USNM slide no. 69506, Rancho Grande, Venezuela; $n = 2$). Sterigma simple, a weakly sclerotized, shallow, ventrally bilobed pocket. Ductus and corpus as described for genus.

Diagnosis.—*Dimorphopalpa striatana* is superficially most similar to *D. striatanoides* in the presence of three parallel diagonal lines of the forewing; however, it has a considerably lighter ground color. The male genitalia can be distinguished from *D. striatanoides* by the broader, more strongly curved lateral process of the gnathos. The female genitalia of *D. striatana* can be distinguished from its congeners by the extremely shallow bilobed process of the sterigma. Autapomorphies for *D. striatana* include the shape of the lateral and subapical processes of the gnathos and the deflexed tip of the uncus.

Etymology.—The specific epithet refers to the fasciae of the forewing.

Dimorphopalpa striatanoides J. Brown, NEW SPECIES
(Figs. 9 and 13)

Types.—Holotype, male; data: ECUADOR. CARCÌ: Maldonado, 2200 m, 9–11 Jan 1993, V. Becker; deposited VBC. Paratypes. COLOMBIA. MAGDALENA:

San Pedro de la Sierra, Sierra Nevada de Santa Marta, 1500 m, 1♂, 21–23 Aug 1973 (BMNH). ECUADOR. *CARCÍ*: Maldonado, 2200 m, 1♂, 2♀♀, 29–11 Jan 1993 (V. Becker, VBC).

Description—Male. FW length 6.0–7.3 mm (\bar{x} = 6.5; n = 3). Head: Frons pale yellow-tan. Labial palpus pale whitish tan mesally, tan laterally. Thorax: Pale tan-yellow. Forewing: Light brown with three parallel diagonal darker brown fasciae extending from near costa to near tornus; apex with diffuse brown patch along costa. Fringe yellow-tan. Hindwing: Uniform light gray-brown. Fringe pale whitish tan. Genitalia: As in Fig. 9 (drawn from JWB slide no. 1096, Ecuador; n = 3). Uncus weakly deflexed dorsally in apical one-fourth, with attenuate apex. Gnathos with subapical process rounded, lobelike; lateral process broadest at base, weakly curved, attenuating into elongate thorn. Socius, transtilla, and valva as described for genus. Aedeagus short, stout, only slightly curved basally.

Female.—FW length 8.5–8.7 mm (\bar{x} = 8.6; n = 2). As described for male. Genitalia: As in Fig. 13 (drawn from JWB slide no. 1097, Ecuador; n = 2). Sterigma with a weakly sclerotized, shallow, ventrally bilobed pocket; a subrectangular, weakly sclerotized area posterad of ostium. Ductus and corpus as described for genus.

Diagnosis—*Dimorphopalpa striatanoides* is most similar to *D. striatana*; the two are nearly indistinguishable superficially, although the ground color of the forewing of *D. striatanoides* is darker than that of *D. striatana*. Male genitalia can be distinguished by features described above in the diagnosis of *D. striatana*. The female genitalia of *D. striatanoides* are unique in the genus in the possession of a subrectangular sclerotized region of the sterigma immediately posterad of the ostium. Autapomorphies for *D. striatanoides* include the shape of the lateral processes of the gnathos and the sclerotized region of the sterigma.

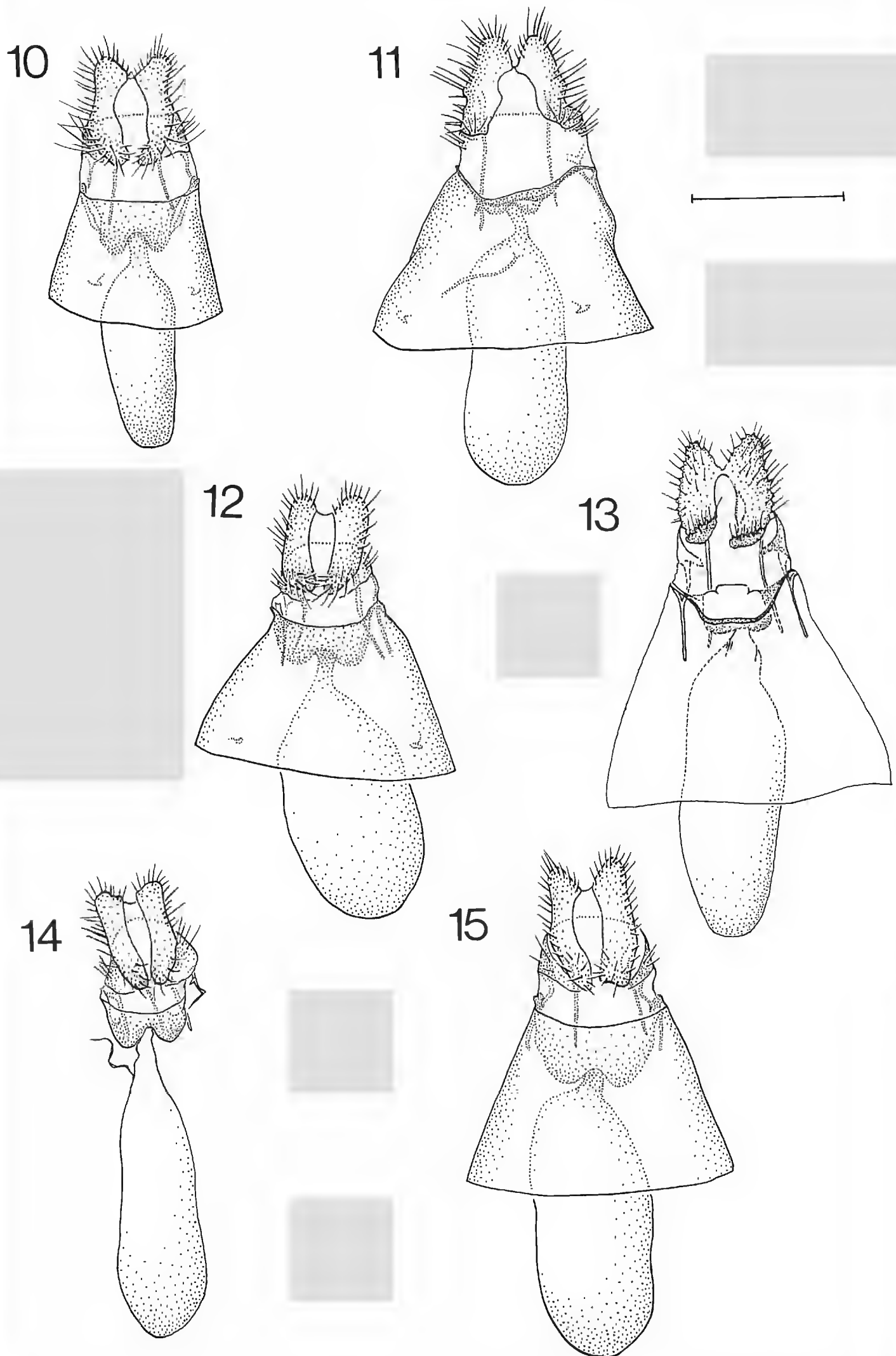
Remarks.—In the specimen from Colombia the lateral arms of the gnathos are slightly broader than those in specimens from Ecuador. However, in all other features, both superficial and genitalic, the specimens are nearly identical.

Etymology.—The specific epithet refers to the similarity of this species with *D. striatana*.

Dimorphopalpa teutoniana J. Brown, NEW SPECIES

(Figs. 4, 5, 8, 12)

Types.—Holotype, male; data: BRAZIL. SANTA CATARINA: Nova Teutonia, 27°11' S, 52°23' W, 300–500 m, Sep 1963, F. Plaumann; deposited in USNM. Paratypes. BRAZIL. BAHIA: Camaca, 400–700 m, 2♂♂, 21–30 Sep 1991, 1♂, 13–14 Apr 1992 (V. Becker, VBC). MINAS GERAIS: Caraça, 1300, 1♀, 2–4 Jan 1985, 1♀, 1–2 Apr 1992, 1♂, 4 Mar 1993, 2♂♂, 25 Oct 1994 (V. Becker, VBC), PARANÁ: Castro, 1♂, 1898 (E. Jones, BMNH); Curitiba, 920 m, 1♂, 10 Feb 1975, 1♂, Oct 1975 (V. Becker, VBC); Bahado, Quatro Barras, 800 m, 1♀, 12 Apr 1970, 2♀♀, 5 Jun 1970, 1♀, 6 Jun 1970, 1♀, 29 Aug 1970, 1♂, 28 Dec 1970, 1♂, 1♀, 22 May 1971 (Becker & Laroca, VBC); Marumbi, Morretes, 500 m, 1♂, 21 Nov 1970 (Becker & Laroca, VBC). RIO DE JANEIRO: Itatiaia, 1200 m, 2♂♂, 25 Jan 1993, 1♂, 13 May 1996 (V. Becker, VBC); Nova Friburgo, 800 m, 1♂, 22 Jan 1993 (V. Becker, VBC). RIO GRANDE DO SUL: Pinherio, 1♂, 2 Jan 1989 (A. Camargo, VBC). SANTA CATARINA: Nova Teutonia, 27°11' S, 52°23' W, 300–500 m, 2♀♀, Oct 1962, 2♂♂, Aug 1963, 3♂♂, Sep 1970 (F. Plaumann, USNM); Bom Jardim da Serra, 1500 m, 5♂♂, 1♀, 1–4 Oct 1996 (V. Becker, VBC); Joinville, 500 m, 2♀♀, 3 Jan 1989 (V. Becker, VBC); Neu [Nova] Bremen, Rio Laeiss, 1♀, Aug 1931 (F. Hoffmann, BMNH); São Joaquim, 1400 m, 1♂, 1♀, 22–24 Jan 1983 (V. Becker, UCB), 2♂♂, 2♀♀, 22–24 Jan 1983 (V.



Figures 10–15. Female genitalia of *Dimorphopalpa*. 10. *D. albopunctana*, 11. *D. striatana*, 12. *D. teutoniana*, 13. *D. striatanoides*, 14. *D.* species (Bolivia); 15. *D.* species (Costa Rica). Scale bar = 1.0 mm.

Becker, USNM), 7♀♀, 2 Feb 1993, 4♂♂, 1♀, 25 Oct 1995 (V. Becker, VBC). *SAO PAULO*: Campos do Jordao, 1600 m, 1♀, 4 May 1995 (V. Becker, VBC); Sao Paulo, 1000 m, 2♂♂, 29 Jan 1993 (V. Becker, VBC). Unknown State: Agulhas Negras, NE Cruceiro, 1♂, (B. V. Ridout, BMNH). "Saunders," "Stn. Coll. 1893-134," 1♀ (BMNH).

Description.—Male. FW length 7.0–8.0 mm (\bar{x} = 7.2; n = 7). Head: Frons pale yellow-tan, whitish gray above. Labial palpus pale whitish tan mesally, tan laterally. Thorax: Pale yellow-tan. Forewing (Fig. 4): Pale cream with light fawn brown reticulation throughout; faint, light brown, diagonal fascia from costa ca. 0.6 distance from base to apex, extending towards tornus; a diffuse, irregular, light brown fascia from costa ca. 0.6 distance from base to apex, extending toward base; a faint longitudinal brown fascia from near base, arching gently toward tornus; flattened, triangular patch along costa in apical region. Fringe off white. Hindwing: Pale gray-brown. Fringe pale whitish tan. Genitalia: As in Fig. 8 (drawn from USNM slide no. 68609, Nova Teutonia, Brazil; n = 4). Uncus bent near middle with broad lateral flange; attenuate apically. Gnathos with subapical process a weakly protruding nub; lateral process highly variable, truncate or slightly bifurcate terminally. Socius, transtilla, and valva as described for genus. Aedeagus short, stout, only slightly curved basally.

Female.—FW length 8.0–10.0 mm (\bar{x} = 8.7; n = 9). As described for male but forewing pattern more defined, fasciae considerably darker than ground color; sometimes with distinct black dash near distal end of DC (Fig. 5). Genitalia: As in Fig. 12 (drawn from JWB slide no. 358, Nova Teutonia, Brazil; n = 1). Sterigma with a pair of weakly sclerotized, rounded pockets ventrally.

Diagnosis.—*Dimorphopalpa teutoniana* is superficially most similar to *D. xestochalca* in its poorly developed forewing pattern. The absence of the abdomen of the holotype (and only known specimen) of *D. xestochalca* prevents genitalic comparisons between the two. However, geographical and elevational differences between the type localities (Santa Catarina, Brazil, 500 m vs. Mount Tolima, Colombia, 1800 m) and the difference in forewing length (greater in *D. xestochalca*) suggest that the two are not conspecific. Male genitalia of *D. teutoniana* can be distinguished from other species in the genus by the conspicuous, broad, lateral flange of the uncus. Female genitalia have the bilobed pocket of the sterigma deeper than in either *D. striatana* or *D. striatanoides*, and shallower than in *D. albopunctana*.

Remarks.—The genitalia (USNM slide no. 69364) of one of the females from Nova Teutonia are remarkably dissimilar to those of all other *Dimorphopalpa* and appear to be associated incorrectly with the specimen; this specimen is excluded from the type series.

Etymology.—The specific epithet is derived from the type locality of Nova Teutonia, Brazil.

Dimorphopalpa xestochalca (Meyrick), NEW COMBINATION

Tortrix xestochalca Meyrick 1926: 248; Clarke 1958: 256 (figure of adult). "Eulia" *xestochalca*; Powell, Razowski & Brown 1995: 146.

Type.—Holotype, male; data: COLOMBIA. Tolima Canyon, 5600' [1805 m], Nov 1920; deposited in BMNH.

Description.—Male. FW length 9.1 mm (n = 1). Head: Frons pale whitish tan, above with gray-tipped, pale whitish tan scales. Labial palpus pale whitish yellow mesally, fawn brown laterally. Thorax: Gray and dingy white. Forewing: Pale cream with light fawn brown reticulation; a pair of indistinct brown fasciae from costa ca. 0.5 distance from base to apex, one extending distad half way to termen and the other extending basad to near base; a faint longitudinal brown fascia from near mid-base, arching gently toward tornus; flattened triangular-shaped patch along costa in apical region.

Fringe pale gray-yellow. Hindwing: Pale gray-brown. Fringe pale whitish-yellow. Genitalia: Single specimen lacks abdomen.

Female.—Unknown.

Diagnosis.—The holotype of *D. xestochalca* is nearly identical to males of *D. teutoniana* in forewing color, pattern, and shape; size and scaling of the labial palpus; and length of the antennal cilia, providing strong evidence for the inclusion of *xestochalca* in *Dimorphopalpa*. The absence of an abdomen prevents genitalic comparisons. Although it is possible that *D. teutoniana* is conspecific with *D. xestochalca*, it is unlikely based on geography and elevation. A single specimen from Colombia (BMNH) also could represent *D. xestochalca*, but its forewing pattern matches *D. striatanoides* and not *D. xestochalca*; hence, it is included as a paratype of the former. Female genitalia of unassociated specimens from Bolivia (Fig. 14) and Costa Rica (Fig. 15) are illustrated. One of these may represent the opposite sex of the holotype of *D. xestochalca*; however, both have a considerably larger forewing length than the latter. Until additional material becomes available from Colombia, these females are treated as *Dimorphopalpa* spp.

ACKNOWLEDGMENT

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**IMMATURE STAGES OF *OXYPORUS JAPONICUS* SHARP
(COLEOPTERA: STAPHYLINIDAE: OXYPORINAE),
WITH NOTES ON PATTERNS OF HOST USE**

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Abstract.—Eggs, larvae, and pupae of Oriental species *Oxyporus japonicus* Sharp are described and illustrated based upon field collected and laboratory reared material. Known aspects of the life history and habits of *O. japonicus* are also described. Adults are known to feed on mature basidiocarps of various fungi, including *Pleurotus ostreatus* (Fries) Kummer, *Lampteromyces japonicus* Singer, *Armillaria mellea* (Vahl ex Fries) Karsten, *Panellus serotinus* (Fries) Kühner, and *Pholiota lenta* (Fries) Singer. Morphological comparisons of larval instar III are made to *O. stygicus* Gravenhorst. *Oxyporus japonicus* is hypothesized to exhibit a pattern of overall host selection that is relatively narrow with a well defined subset of preference, which is similar to numerous New World species of *Oxyporus*, including *O. stygicus*.

Key Words.—Insecta, Coleoptera, Staphylinidae, Oxyporinae, *Oxyporus japonicus*, mycophagy, fungus feeding, immature stages, behavior.

All members of the staphylinid subfamily Oxyporinae are included in the single genus *Oxyporus* Fabr., a primarily holarctic genus with most species-level diversity in the Nearctic and Oriental regions. Species of *Oxyporus* are obligate inhabitants of higher fleshy mushrooms (Ashe 1984; Leschen & Allen 1988; Hanley & Goodrich 1994a, b, 1995), even though they are typically placed within the staphylinine lineage of staphylinid subfamilies whose members are mostly predatory and use extra-oral digestion (Lawrence & Newton 1982). Adults and larvae burrow into and feed on the tertiary mycelia, pileus, and stipe tissue of mushrooms using various modifications of the mandibles, labial palpi, maxillae, and labrum (Hanley & Goodrich 1995). The fleshy mushrooms that serve as hosts for *Oxyporus* are members of only three orders within the class Hymenomycetes: Agaricales (the gilled mushrooms), Boletales (the bolete mushrooms), and Polyporales (the polypore mushrooms) (Hanley & Goodrich 1995).

Adults of *Oxyporus* are characterized by a large prognathous head with large mandibles and the apically expanded terminal segments of the labial palpi (Fig. 1). Larvae have a distinctive trilobed mala and stout mandibles that are deeply bifid. Both adults and larvae feed by slicing off bits of host fungi and saturating the fungal chunks with preoral digestive fluid (Newton 1984, Leschen & Allen 1988, Hanley & Goodrich 1995). Contrary to what was once thought, adults and larvae are not known to use their prominent mouthparts in a predatory manner.

The immatures of only 7 of the 90 described species of *Oxyporus* are known (Paulian 1941, McCabe & Teale 1981, Leschen & Allen 1988, Frank 1991, Hanley & Goodrich 1994a, Goodrich & Hanley 1995), and none are known for any of the Oriental species. This study describes the immature stages and life history of *O. japonicus* Sharp, a common Oriental species. Patterns of host use and other phenomena, which could be of evolutionary or taxonomic significance, are discussed.



Figure 1. *Oxyporus japonicus* Sharp, adult, dorsal habitus.

Table 1. Known fungal hosts of *Oxyporus japonicus* Sharp.

Host	Number of collections	Number of specimens taken
Tricholomataceae		
<i>Armillaria mellea</i> (Vahl ex Fries) Karsten	2	2
<i>Lampteromyces japonicus</i> Singer ¹	8	1106*
<i>Panellus serotinus</i> ² (Fries) Kühner	1	8
<i>Pleurotus ostreatus</i> (Fries) Kummer	2	7
Cortinariaceae		
<i>Pholiota lenta</i> (Fries) Singer	1	2

* Includes adults and immatures.

¹ Six records reported by Setsuda (1993, 1994a).

² One record reported by Suzuki (1986).

MATERIALS AND METHODS

Descriptions of the immature stages of *O. japonicus* are based on 51 eggs, 116 larvae (36 instar I, 52 instar II, and 28 instar III), and 2 pupae. The chaetotaxy used in the description of the immatures of *O. japonicus* is based on the system used by Hanley & Goodrich (1994a) in the description of the immatures of *O. stygicus* Say.

RESULTS

Host Relationships.—Adults of *O. japonicus* were found on five fungal hosts from 3 families of fungi (Table 1), but larvae were found only on *Lampteromyces japonicus* Singer.

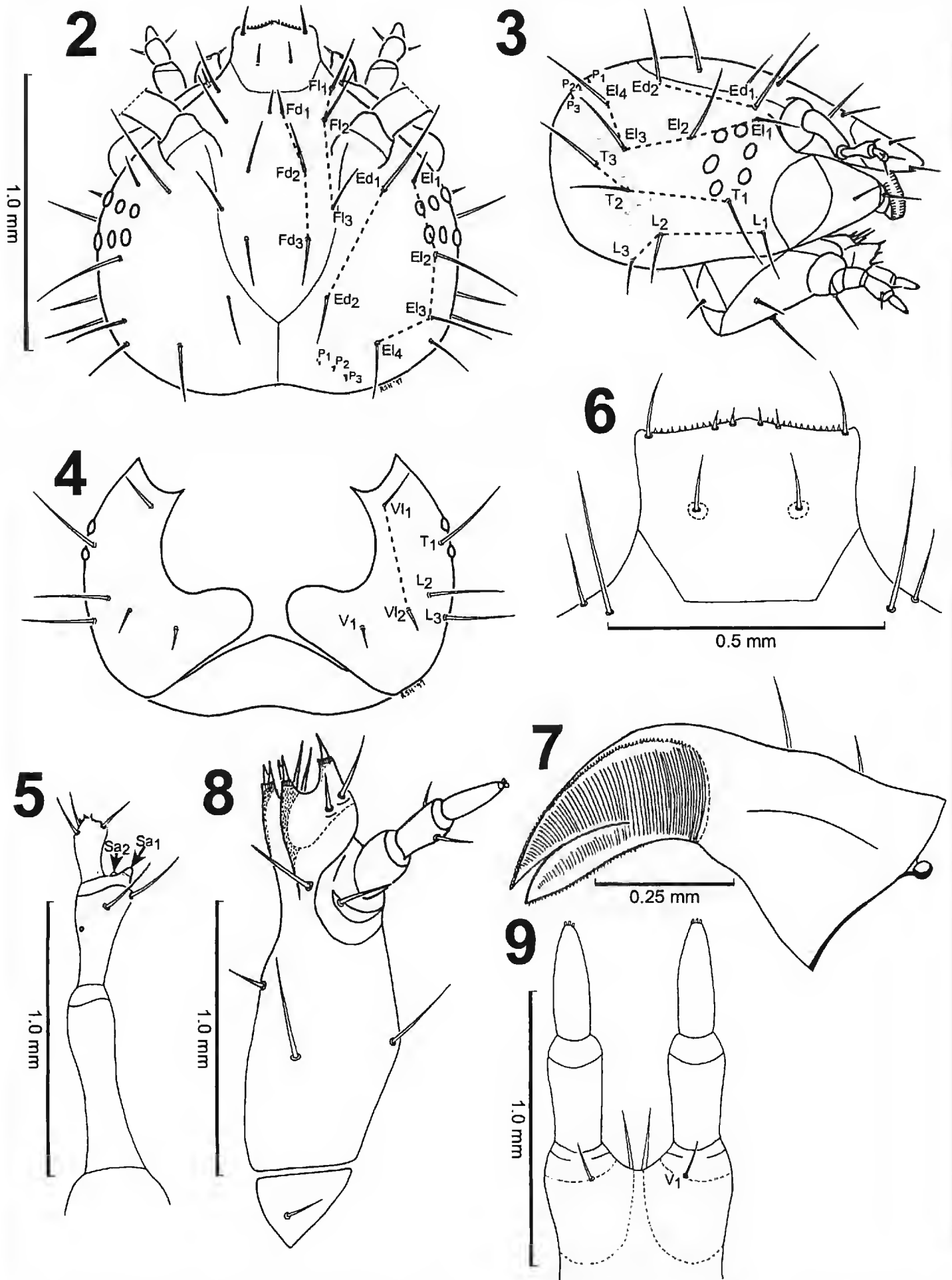
Behavior.—Females of *O. japonicus* were found within cylindrical tunnels extending from an opening on the undersurface of the fungal cap into the center of the basidiocarp of *L. japonicus*. These tunnels likely serve as feeding chambers for both adults and larvae. An enlarged chamber was typically found at the apical end of each tunnel within the stipe tissue of young mushroom fruiting bodies. Within this chamber, eggs were usually found covered with fungal frass. Females remained within their egg chambers after oviposition and repelled conspecific female adults and other predacious beetles before and after the eggs hatched. This behavior has been regarded as subsocial (Setsuda 1994b). Males were less frequently collected within the basidiocarps, but were present. Similar behavior has been reported for some North American species: *O. occipitalis* Fauvel (Hanley & Goodrich 1993), *O. stygicus* (Hanley & Goodrich 1994a, b), and *O. major* Gravenhorst (Goodrich & Hanley 1995). *Oxyporus japonicus*, however, is the first species in which subsocial behavior has been adequately quantified.

Development.—The rapid development of species of *Oxyporus* is well known, and *O. japonicus* fits previously reported patterns. In *O. stygicus* the developmental time from egg to adult was 16–18 days, with 7–10 days in the pupal stage (Hanley & Goodrich 1994a); in *O. major* developmental time was even more rapid (13–15 days) (Goodrich & Hanley 1995). Development of *O. japonicus* from egg to pupa required 12–13 days at room temperature (22–24°C), slightly longer than for *O. stygicus* and *O. major*.

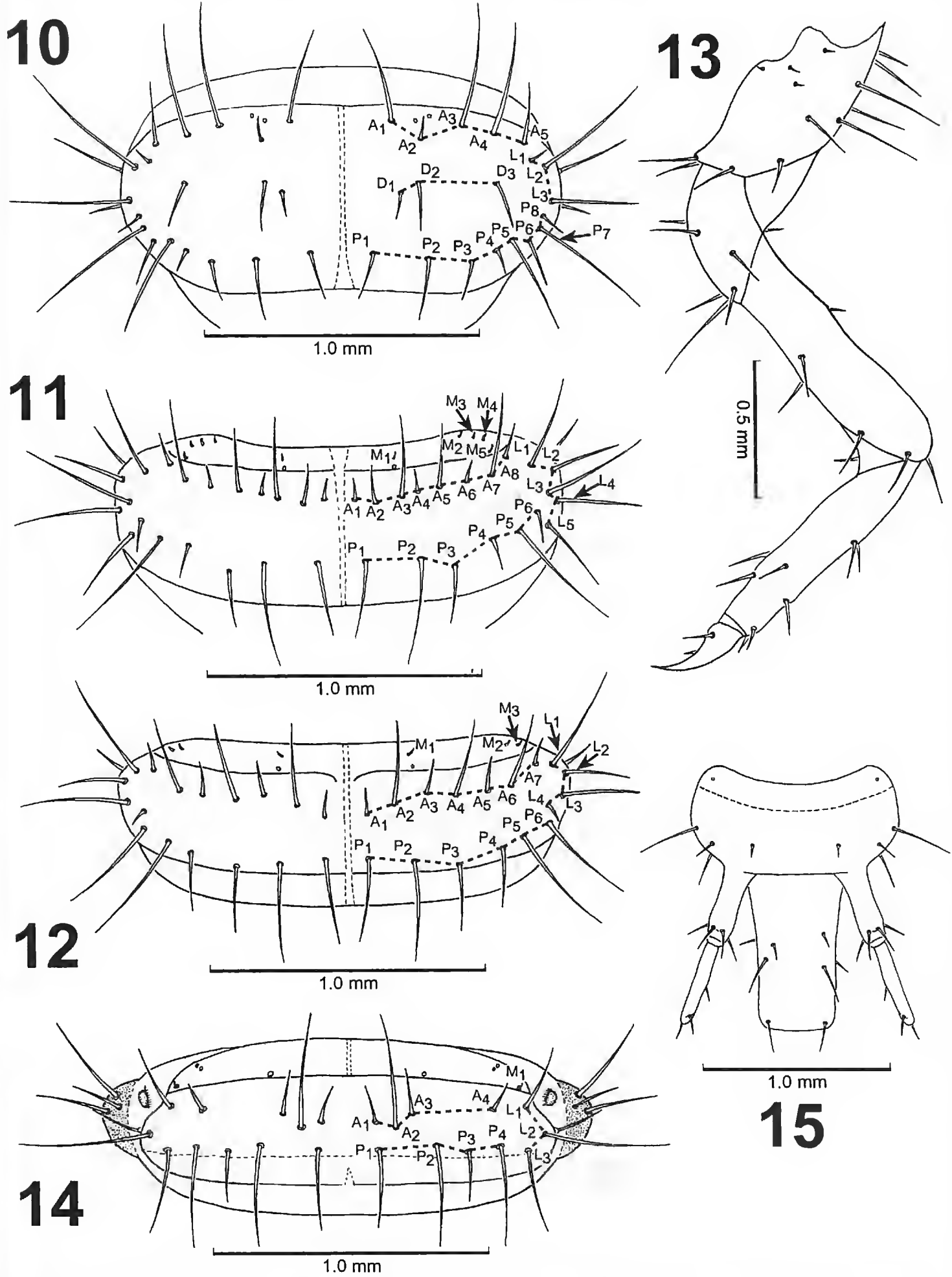
IMMATURE STAGES OF *OXYPORUS JAPONICUS*

Description of Egg.—Length 1.2–1.7 mm; white, darkening with age; cylindrical without distinct sculpture; mouthparts and appendages visible through chorion in more mature eggs.

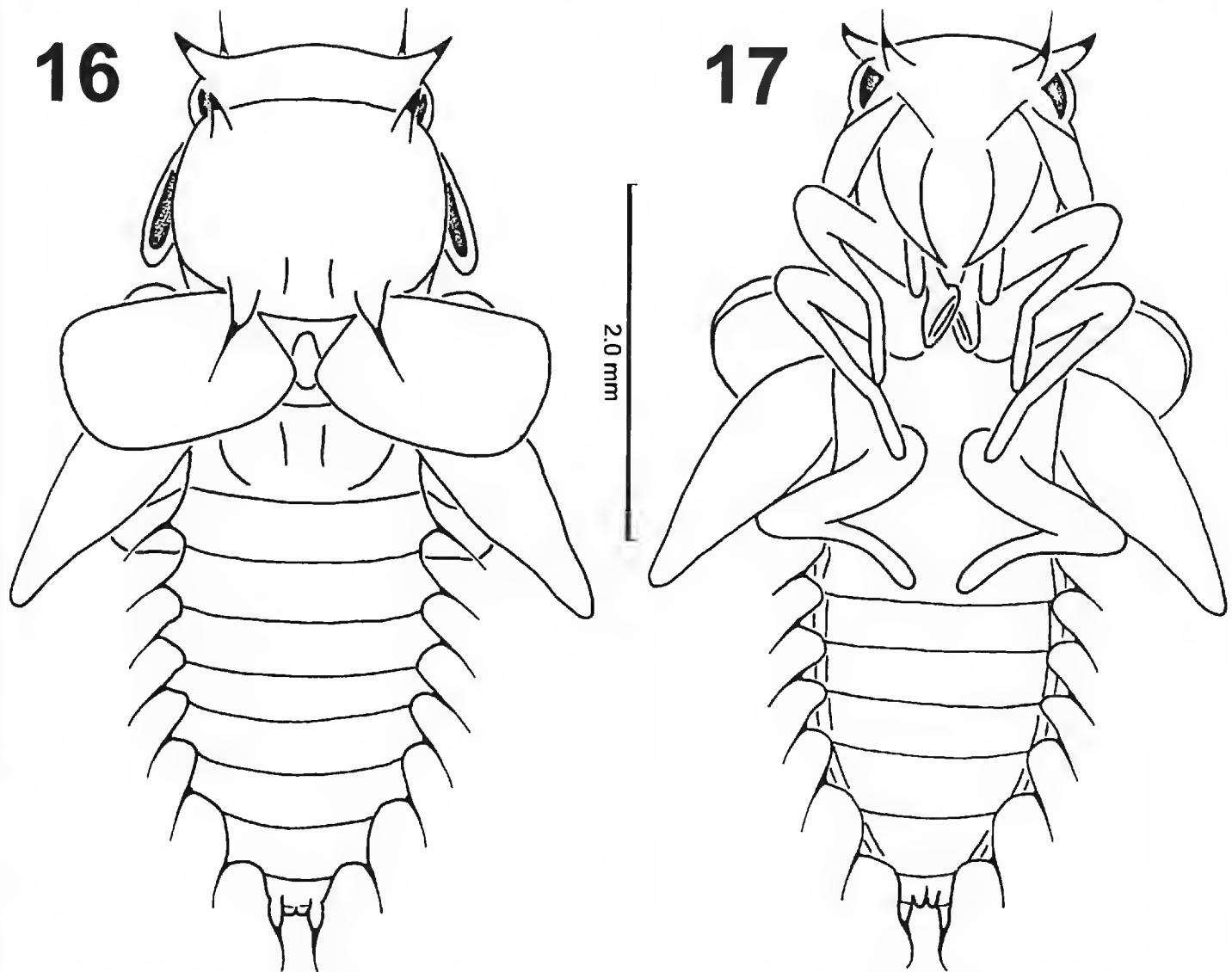
Description of Larval Instar III.—Length 8.8–12.0 mm. Body elongate, gently curved, parallel-sided, slightly flattened dorsoventrally. White with thoracic and abdominal terga brown; head dark yellow to brown. Vestiture length variable, setae simple. Head cylindrical to oval; ecdysial lines distinct, lateral arms forked, complete from back of head to bases of antennae; six pigmented stemmata in two vertical rows on each side (Fig. 2); setal arrangement as in Figs. 2–4. Antenna 3-segmented and inserted anterodorsally near ocelli in membranous socket; segment I elongate, narrowed toward middle, aetose, length $5\times$ width; segment II trisetose, $0.6\times$ length of segment I, bearing tubercle-like sensory appendage with distinct basal collar, single narrower, conical sensory appendage also present; segment III $0.6\times$ length of segment II, bearing inner circle of 3 small, subequal setae at apex, surrounded by outer circle of 3 longer setae (Fig. 5). Labrum fused to frons with anterior margin serrate; chaetotaxy with labral marginal and labral lateral rows of 2 setae each (L_1 , positioned near Fl_2), labral dorsal row of 1 seta (Fig. 6). Adoral surface of labrum (epipharynx) with numerous branched microtrichia and a large median furrow. Mandibles broad, flat, bifid apically, stout basally; margins finely serrate with many fine teeth, lateral margin with 2 small setae, protheca absent (Fig. 7). Maxilla with cardo triangular, fused to stipes and mala, with 1 small seta; mala short, stout, trilobed, inner lobe with 2 non-articulated and 2 articulated spines, middle lobe with 2 non-articulated spines and no articulated spines, outer lobe with 1 non-articulated and 2 articulated spines dorsally (Fig. 8). Maxillary palpus 3 segmented; segment I aetose, about as long as wide; segment II bisetose, segment III conical, aetose, length $1.3\times$ length of segment II, minute sensory structures at apex (Fig. 8). Labium of diamond-shaped submentum and trapezoidal mentum, ligula absent; labial palpus 2 segmented, directed ventrally; segment I subequal to length of segment II; segment II elongate and conical with 3 very minute setae at apex; palpigers fused to form ventral premental sclerite, bearing 1 pair setae, no campaniform sensilla present (Fig. 9). Thorax. Pronotum transverse, broadly oval, moderately sclerotized; chaetotaxy with anterior row of 7 setae, discal row with 3 setae, lateral row of 4 setae each, posterior row of 5 setae (Fig. 10). Mesonotum transverse, moderately sclerotized; chaetotaxy with anterior row of 8 setae, posterior row of 6 setae, lateral row of 5 setae, membrane with 5 setae (Fig. 11). Metanotum transverse; chaetotaxy similar to mesonotum, except anterior row of 7 setae, and membrane with 3 setae (Fig. 12). Legs long, each similar in size and configuration; chaetotaxy with 14 setae on coxa, 7 setae on trochanter, 7 setae on femur, 8 setae on tibia, 2 setae on tarsus (Fig. 13). Abdomen. Tergum I transverse, chaetotaxy with anterior and posterior rows of 4 setae each, lateral row of 3 setae, laterotergite with 3 setae each, 1 minute marginal seta present (Fig. 14); tergites and sternites of segments II–VIII similar in setation. Tergite IX with 4 pairs of setae, 1 pair minute campaniform sensilla on disc (Fig. 15). Urogomphi 2 segmented; basal segment fused to tergum IX, with 4 setae on apical half; segment II with 1 small ventral seta



Figures 2-9. *Oxyporus japonicus* Sharp, larval instar III. 2. Head, dorsal aspect. 3. Head, lateral aspect. 4. Head, ventral aspect. 5. Antenna, ventral aspect. 6. Labrum, dorsal aspect. 7. Mandible, dorsal view. 8. Maxilla, dorsal view. 9. Labium, ventral view. Abbreviations: Ed, epicranial dorsal setae; El, epicranial lateral setae; Fd, frontal dorsal setae; Fl, frontal lateral setae; P, posterior epicranial suture; Sa, sensory appendages; T, temporal setae; L, lateral setae; V, ventral setae; VI, ventral lateral setae.



Figures 10–15. *Oxyporus japonicus* Sharp, larval instar III. 10. Pronotum. 11. Mesonotum. 12. Metanotum. 13. Prothoracic leg, anterior aspect. 14. Abdominal tergum I. 15. Abdominal terga IX–X. Abbreviations: A, anterior setae; L, lateral setae; M, marginal setae; P, posterior setae.



Figures 16–17. *Oxyporus japonicus* Sharp, pupa. 16. Dorsal aspect. 17. Ventral aspect.

and 2 small apical setae (Fig. 15). Abdominal segment X slightly tapered from base to apex, setation composed of 8 setae (Fig. 15).

Variation in Larval Instars.—Overall body lengths of each instar are as follows: instar I, 1.5–2.5 mm; instar II, 3.5–6.0 mm; instar III, 8.5–12.0 mm. Structurally, the first instar differs from the second and third as follows: antennae much shorter and more robust, general reduction in setation over entire body, urogomphi and abdominal segment X much shorter and more robust. The second instar differs from the third as follows: antennae much shorter and more robust, a short Ed_3 seta is present on the dorsal surface of the head, general reduction in the number of setae on the dorsal surface of the thorax, legs shorter and more robust, urogomphi shorter and more robust.

Description of Pupa.—Length 5.5–10.0 mm, white, exarate; with 12 pairs non-articulated projections on head, prothorax, and abdominal areas. Head positioned ventrally, not completely visible in dorsal view, bearing 2 pairs projections above each eye and no setae on the eyes. Pronotum bearing 2 prominent setae on anterior angles, and 2 large setae off midline along posterior margin. Abdominal segments II–VIII bearing elongate projections along lateral margins; segment IX tapered apically; segment X bearing 2 elongate projections and 2 cylindrical inner lobes (Figs. 16 and 17).

Material Examined.—JAPAN. Kyoto, Asyû, 15 Oct 1993 and 19 Oct 1993. K. Setsuda, from *Lampteromyces japonicus* on dead *Fagus crenata* (51 eggs, 36 first

instar larvae, 52 second instar larvae, and 28 third instar larvae). JAPAN. *Kyoto*, Miyama, Asyû, 30 Oct 1995, K. Setsuda, from *L. japonicus* (2 pupae). Total number examined, 169 specimens.

Comments.—The mature larva of *O. japonicus* is similar to that of other described species of *Oxyporus*, including *O. vittatus* Gravenhorst (Leschen & Allen 1988), *O. stygicus* (Hanley & Goodrich 1994a), and *O. major* (Goodrich & Hanley, 1995). Larval instar III of *O. japonicus* can be differentiated from the previous species through the combination of the following: 2 setae in epicranial dorsal (Ed) row on head, 5 setae in anterior (A) row on pronotum, 8 setae in anterior (A) row on mesonotum.

DISCUSSION

Immature Stages.—Larval instar III of *O. japonicus* differs from *O. stygicus* in the following ways:

<i>Oxyporus japonicus</i>	<i>Oxyporus stygicus</i>
Lateral head seta L ₄ absent.	Lateral head seta L ₄ present.
2 setae in epicranial dorsal (Ed) row on head.	3 setae in epicranial dorsal (Ed) row on head.
3 setae in temporal (T) row on head.	4 setae in temporal (T) row on head.
3 setae in lateral (L) row on head.	4 setae in lateral (L) row on head.
5 setae in anterior (A) row on pronotum.	3 setae in anterior (A) row on pronotum.
8 setae in posterior (P) row on pronotum.	3 setae in posterior (P) row on pronotum.
8 setae in anterior (A) row on mesonotum.	5 setae in anterior (A) row on mesonotum.

Host Relationships.—Hanley & Goodrich (1995) reported five patterns of host usage in New World *Oxyporus* based primarily on distributions of adults among available host mushrooms: 1) overall host selection broad (7 or more families) with a moderately broad subset of preference (majority of specimens are taken from about half of the total number of genera), 2) overall host selection moderately broad (many genera from 4–6 families) with a relatively narrow subset of preference (majority of specimens are taken from less than one third of the total number of genera), 3) overall host selection relatively narrow (few genera from 2–4 families) with a well defined subset of preference (1–2 genera), 4) overall host selection relatively narrow (few genera from 2–4 families) with no defined subset of preference, and 5) host selection is species specific. Based on the available host records, we hypothesize that *O. japonicus* fits into pattern 3. Adults are found on few genera of fungi, typically two to four families with a noticeable preference towards one or two genera. For *O. japonicus*, 1125 specimens were collected from 5 genera in 2 families of fungi. The vast majority of those specimens, 1106 (98%), were collected from the genus *Lampteromyces*. New World species of *Oxyporus* that exhibit this pattern are *O. quinquemaculatus* LeConte, *O. balli* Campbell, *O. bierigi* Campbell, *O. lateralis* Gravenhorst, *O. lawrencei*

Campbell, *O. mexicanus* Fauvel, *O. rufipennis* LeConte, and *O. stygicus* (Hanley & Goodrich 1995).

Few collection records for species of *Oxyporus* include fungal hosts for larvae. From the host data available for the genus, larvae appear to be specialized on one or two species of related fungi within a small portion of the subset of preferences exhibited by adults. Large numbers of larvae of *O. japonicus* were collected from only one species of fungus, which further supports this pattern. The reasons for this apparent host specificity are unknown; however, Hanley & Goodrich (1995) hypothesized that mushrooms within an adult's subset of fungal preferences that exhibit fleshy-fibrous context allow more efficient internal feeding while being fibrous enough to maintain overall shape of the mushroom.

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REDEFINITION OF THE GENUS *CHELANOPS* GERVAIS (PSEUDOSCORPIONIDA: CHERNETIDAE)

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Abstract.—The type material of *Chelifer (Chelanops) coecus* Gervais, type species of the genus *Chelanops* Gervais, is lost, and the diagnostic characters of the genus are uncertain. A neotype series from near the original type locality in southern Chile has been studied, and new descriptions of the species and genus are presented.

Key Words.—Arachnida, Pseudoscorpionida, Chernetidae, *Chelanops*, emended diagnosis, *Chelanops coecus*, neotype designation, redescription.

The genus *Chelanops* was established originally as a separate section of *Chelifer*, with *Chelifer coecus* as type species (Gervais 1849: 13). The description of *C. coecus* was very sketchy by modern standards, and the diagnosis of the section *Chelanops* was exceedingly brief. Tömösváry (1882), without comment, placed *Chelanops* in the synonymy of *Chernes*. In a series of papers from 1890 to 1914, Banks, using a very broad (unwritten) definition of the genus, described 28 species of *Chelanops* from North and South America (see Hoff 1947). However, such careful workers as Tullgren (1907), With (1908), and Ellingsen (1910) did not recognize the species or genus in the South American fauna. Joseph (1927) made some observations on the life history of a species which he identified as *Chelanops coecus*, but he included no taxonomic data.

Beier (1932: 177, 1933: 538) recognized *Chelifer (Chelanops) coecus* as the type species of the genus *Chelanops*, but he evidently did not see the type specimens, as he reported the species as an “unsichere Art” and gave no description of it. This did not, however, deter him from giving a diagnosis of *Chelanops*, based apparently on four other species, namely *Chelifer (Trachychernes) rotundimanus* Ellingsen, *Chelifer (Trachychernes) altimanus* Ellingsen, *Chelanops chilensis* Beier, and *Chelanops costaricensis* Beier. Also, he did not include *coecus*, the type species, in the key to species of *Chelanops* because of insufficient description (“ungenügenden Beschreibung”). As a result, Beier’s working concept of the genus *Chelanops* was based not on the type species but on several other species which he believed were congeneric with *coecus* (as it turns out, two of the four species he recognized in 1932–33, *altimanus* and *costaricensis*, belong in other genera—see below).

The true nature of *Chelifer (Chelanops) coecus* Gervais has never been established. Beier (1964b: 307) stated that the original material of Gervais’ Chilean species had been lost. The present whereabouts of the types are indeed unknown; they are not in the Muséum national d’Histoire naturelle, Paris, where they might be expected (J. Heurtault, in litt.) or in any other museum I have contacted, and may be presumed lost.

Fortunately, there are available several series of specimens from near the type locality which Beier identified as *Chelanops coecus* (1964b: 367–368) and which generally conform to the description given by Gervais. I have mounted and stud-

ied a few of these specimens and from them have selected a neotype. On the basis of this new type and conspecific specimens, I have prepared a redescription of the species *Chelanops coecus* and a redefinition of the genus *Chelanops*.

MATERIALS AND METHODS

The specimens examined here were collected and preserved in alcohol. Many were dissected, cleared, and mounted on slides for detailed study under a compound microscope.

Some abbreviations are used in the text, as follows: L = length; L/B = ratio, length/breadth; L/D = ratio, length/depth; T = tactile seta.

All material dealt with in this study is from the collection of the California Academy of Sciences, San Francisco, California.

SYSTEMATICS

Family Chernetidae Menge

Chernetidae Menge: Muchmore 1982: 101; Harvey 1991: 534 (complete synonymy to 1989); Harvey 1992: 1427.

Genus *Chelanops* Gervais

Chelifer (*Chelanops*) Gervais, 1849: 13. Type species: *Chelifer* (*Chelanops*) *coecus* Gervais.

Chelanops Gervais: Beier 1932: 177; Beier 1933: 538; Hoff 1947: 503; Hoff 1949: 455, 460; Beier 1964b: 370; Harvey 1991: 553.

Stigmachernes Beier 1957: 457; Harvey 1991: 634. NEW SYNONYMY (see below).

Diagnosis (emended).—A representative of the family Chernetidae (see Harvey 1992: 1427). With the characters of the type species, *Chelanops coecus*, particularly the following. Well sclerotized and generally dark in color. Carapace with surface lightly granulate; 2 transverse furrows; 2 faint eyespots; numerous narrow, clavodentate setae. Abdominal tergites with 25–30 setae. Male genitalia typical of the family (see Harvey 1992: 1394). Spermathecae of female delicate and easily broken, but apparently consisting of 2 slender tubes of uniform diameter. Cheliceral hand usually with 7 setae, rarely with 8 or 9; flagellum of 4 setae; galea moderate in size, with several small rami. Palp robust, more so in male than in female; surfaces finely to moderately granulate; setae clavodentate to acuminate; each chelal finger with 45–50 marginal teeth and 7–13 external and internal accessory teeth; venom apparatus present only in movable finger of chela. Trichobothria as shown in Fig. 4: on fixed finger, *ist* lies proximad of *est*; on movable finger *st* is closer to *t* than to *sb*. Legs typical of the family, moderately slender; tarsus of leg IV with a long, erect tactile seta distad of middle.

Remarks.—In the possession of four setae in the flagellum of the chelicera, *Chelanops* is allied with some 30 other genera in the Chernetidae (tribe Hesperochernetini Beier 1932 ?). Of these, it appears most closely related to *Stigmachernes* Beier (1957), from the Juan Fernandez Islands, Chile. In most particulars the two genera are very similar, though the spermathecae of *Stigmachernes skottsbergi* Beier, the only known species of *Stigmachernes*, have not yet been described. *Stigmachernes*, undoubtedly, is a synonym of *Chelanops*.

Chelanops is similar to *Epactiochernes* Muchmore (1974b) and *Epichernes* Muchmore (in Muchmore & Hentschel 1982) in general habitus, nature of the spermathecae, and nature and placement of the tactile seta on the tarsus of leg IV. *Chelanops* differs most notably from those two genera in body size, placement of trichobothria *est* and *ist* on the fixed chelal finger, and the number of setae on the hand of the chelicera.

Semeiochernes Beier (1932) seems to be closely related to *Chelanops*. Beier (1954) noted this and decided that the holotype of *Chelanops costaricensis*, one of his original *Chelanops* species, is actually the female of *Semeiochernes militaris* Beier (1932). Mahnert (1987) also mentioned the similarity of the two genera. Though *Semeiochernes* has unique processes on the palpal chela of the male and lacks a tactile seta on the tarsus of leg IV, it is much like *Chelanops* in most other respects, including the spermathecae and the placement of trichobothria *ist* and *est*.

Chelanops strongly resembles *Dinocheirus* Chamberlin (1929) (and see Muchmore 1974a) in body size and shape, but it differs fundamentally from that genus in the nature of the spermathecae and the relative positions of trichobothria *ist* and *est* on the fixed chelal finger.

Neochelanops Beier (1964b: 370) should no longer be considered a subgenus of *Chelanops*. It appears unlikely that *Chelifer (Chelanops) patagonicus* Tullgren, type species of the subgenus, is congeneric with *Chelanops coecus*. In addition to the differences mentioned by Beier, the two species differ in the size and location of the tactile seta on the tarsus of leg IV: that of *coecus* is long and erect, and located just distad of the middle of the tarsus, but that of *patagonicus* is small, "pseudotactile," and near the end of the segment. The actual status of *Neochelanops* must await restudy of the type material of *Chelifer (Chelanops) patagonicus* (if available). The other species presently assigned to *Neochelanops* also need to be reevaluated.

Chelanops coecus (Gervais)

(Figs. 1–7)

Chelifer (Chelanops) coecus Gervais, 1849: 13. Type locality: southern Chile, near Calbuco.

Chelifer coecus Gervais: With 1908: 327.

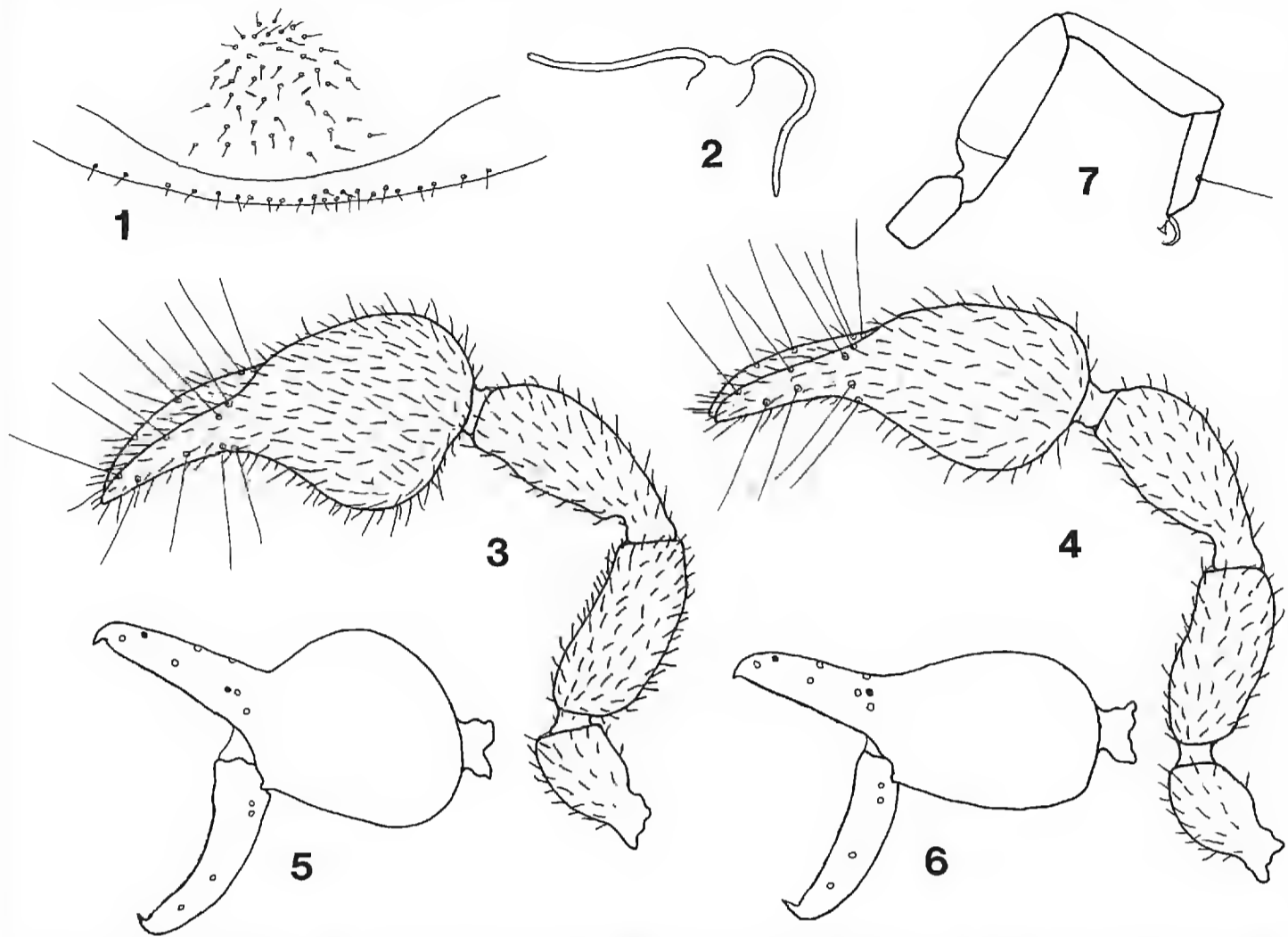
Chelifer (Trachychernes) rotundimanus Ellingsen, 1910: 379 (synonymized by Beier 1959: 215).

Chelanops (?) coecus (Gervais): Beier 1932: 179.

Chelanops (Chelanops) coecus (Gervais): Beier 1964b: 367; Harvey 1991: 554 (complete synonymy to 1989).

Chelanops chilensis Beier 1932: 178, fig. 186; Beier 1933: 538, fig. 10; Harvey 1991: 554. NEW SYNONYMY.

Redescription of adults.—Males and females similar, but palpal chelae of males more robust. Carapace and tergites light brown, palps dark reddish brown, other parts tan. Carapace longer than broad; surface lightly granulate, with 2 shallow, transverse furrows; no eyes; about 200 narrow clavodentate setae, 6–10 at anterior and 14–18 at posterior margin. Abdominal tergites 1–11 and sternites 4–10 divided; surfaces of tergites transversely reticulated to scaly, of sternites nearly smooth; interscutal membranes papillose to scaly; pleural membranes longitudinally papillose; most dorsal setae narrow clavodentate, ventral setae acuminate to denticulate; sternites with numerous "sense spots" scattered



Figures 1–7. *Chelanops coecus* (Gervais). Figure 1. Setae on 2nd and 3rd sternites of allotype female (spiracular setae omitted). Figure 2. Spermathecae of allotype female. Figure 3. Right palp of neotype male, dorsal view. Figure 4. Right palp of allotype female, dorsal view. Figure 5. Left chela of neotype male, lateral view (setae omitted; darkened areoles are underneath). Figure 6. Left chela of allotype female, lateral view. Figure 7. Leg IV of neotype male (most setae omitted).

over surfaces. Tergal chaetotaxy of neotype (male) 24:24:27:31:31:30:33:31:29:28:T18T:2, others, both males and females, similar. Sternal chaetotaxy of neotype (male) 37:[6-5):(3)35(3):(1)17(1):34:43:40:34:35:31:T15T:2, other males similar. Sternites 2–6 of females with about 45:(3)25(3):(1)20(1):27:35; setae on sternite 2 are close-set in a triangular group (Fig. 1). Though the tactile setae on tergite 11 and sternite 11 of the neotype are missing from their areoles, these are clearly present in many other specimens, both male and female. Internal genitalia of male typical of the Chernetidae, moderate in size and sclerotization. Spermathecae of female delicate and often destroyed in these preparations, but occasionally seen as 2 slender tubes of uniform diameter (Fig. 2). Chelicera 0.35–0.4 as long as carapace; hand usually with 7 setae (rarely 8 or 9), *is* and *ls* long, acuminate, *es* short, acuminate, *bs* usually acuminate, others denticulate; flagellum of 4 setae, denticulate distally; serrula of about 26 blades; galea of female long, slender, with 5–6 small rami, that of male a little smaller and with shorter rami. Palp robust, more so in male than in female (Figs. 3 and 4); L/B of trochanter 1.85–2.0, femur 2.85–3.0, patella 2.4–2.65, and chela (without pedicel) 2.05–2.3; L/D of hand (without pedicel) 1.01–1.15; movable finger 0.97–1.03× as long as hand. Surfaces finely to moderately granulate; most setae on medial sides of trochanter, femur, and patella narrow clavodentate, on lateral sides somewhat longer and more pointed, those on chela quite long, finely denticulate to acuminate; setae on chelal hand densely set in male, less so in female. Trichobothriotaxy as shown in Figs. 5 and 6; one paratype male has an extra trichobothrium *eb* on fixed finger. Each finger with 45–50 cusped marginal teeth and 9–13 external and 7–11 internal accessory teeth. Venom apparatus well developed only in movable finger, nodus ramosus between trichobothria *t* and *st*. Legs moderately slender: leg IV with L/D of femur+patella 3.25–3.55, tibia 4.45–4.8, tarsus 4.45–4.95. Tarsus of leg IV with a long, erect, tactile seta about 2/3 length of segment from proximal end (Fig. 7).

Tritonymph.—Much like adults but smaller and more robust. Chelicera with 6 setae on hand; flagellum of 4 setae. Palp with L/B of femur 2.65–2.7; patella 2.15–2.25; chela (without pedicel) 2.6;

L/D of hand (without pedicel) 1.4–1.45; movable finger 0.90 as long as hand. Fixed chelal finger with 7 trichobothria, movable finger with 3. Leg IV with L/D of femur+patella 3.25–3.4; tibia 3.9–4.1; tarsus 3.7–4.0; tactile seta on tarsus as in adult.

Deutonymph.—Like tritonymph but smaller. Chelicera with 5 setae on hand; flagellum of 4 setae. Palp with L/B of femur 2.45; patella 2.3; chela (without pedicel) 2.7; L/D of hand (without pedicel) 1.55; movable finger 0.88 as long as hand. Fixed chelal finger with 6 trichobothria, movable finger with 2. Leg IV with L/D of femur+patella 3.35; tibia 3.75; tarsus 3.6; tactile seta on tarsus as in adult.

Measurements (mm), Male.—Figures given first for neotype, followed in parentheses by ranges for 4 paratypes. Body L 4.85 (3.94–4.55). Carapace L 1.48 (1.27–1.40). Chelicera L 0.525 (0.48–0.52). Palp: trochanter 0.83 (0.74–0.83)/0.43 (0.39–0.415); femur 1.41 (1.33–1.37)/0.495 (0.45–0.48); patella 1.41 (1.26–1.36)/0.55 (0.49–0.52); chela (without pedicel) 2.33 (2.11–2.18)/1.06 (0.94–1.06); hand (without pedicel) 1.22 (1.11–1.15)/1.21 (0.96–1.13); pedicel L 0.19 (0.16–0.18); movable finger L 1.26 (1.11–1.19). Leg I: femur 0.415 (0.42–0.445)/0.30 (0.265–0.29); patella 0.64 (0.605–0.635)/0.265 (0.245–0.255); tibia 0.755 (0.69–0.725)/0.185 (0.17–0.18); tarsus 0.63 (0.57–0.635)/0.13 (0.12–0.125). Leg IV: femur+patella 1.26 (1.13–1.21)/0.355 (0.325–0.355); tibia 1.07 (0.94–1.03)/0.22 (0.205–0.215); tarsus 0.725 (0.69–0.725)/0.155 (0.14–0.155).

Female.—Ranges for 3 paratypes. Body L 5.29–5.66. Carapace L 1.41–1.52. Chelicera L 0.50–0.55. Palp: trochanter 0.77–0.83/0.41–0.43; femur 1.33–1.44/0.45–0.495; patella 1.30–1.37/0.495–0.55; chela (without pedicel) 2.12–2.22/0.85–0.955; hand (without pedicel) 1.17–1.26/0.83–0.895; pedicel L 0.18–0.19; movable finger L 1.11–1.19. Leg I: femur 0.40–0.45/0.28–0.30; patella 0.635–0.665/0.245–0.26; tibia 0.69–0.74/0.17–0.185; tarsus 0.59–0.62/0.125–0.13. Leg IV: femur+patella 1.19–1.27/0.355–0.38; tibia 0.96–1.04/0.20–0.215; tarsus 0.67–0.725/0.15–0.16.

Tritonymph.—Ranges for 3 paratypes. Body L 3.77–4.13. Carapace L 1.05–1.13. Chelicera L 0.38–0.40. Palp: trochanter 0.525–0.55/0.28–0.30; femur 0.87–0.95/0.325–0.35; patella 0.805–0.85/0.36–0.39; chela (without pedicel) 1.41–1.47/0.54–0.56; hand (without pedicel) 0.785–0.815/0.55–0.585; pedicel L 0.18–0.19; movable finger L 0.70–0.74. Leg IV: femur+patella 0.83–0.88/0.25–0.27; tibia 0.63–0.68/0.16–0.175; tarsus 0.49–0.50/0.125–0.14.

Deutonymph.—One specimen. Body L 2.84. Carapace L 0.80. Chelicera L 0.31. Palp: trochanter 0.39/0.215; femur 0.60/0.245; patella 0.57/0.25; chela (without pedicel) 1.00/0.37; hand (without pedicel) 0.56/0.36; pedicel L 0.075; movable finger L 0.495. Leg IV: femur+patella 0.62/0.185; tibia 0.47/0.125; tarsus 0.38/0.105.

Types Examined.—CHILE: [DE LOS LAGOS], Los Muermos, forest, 19 Jan 1951, E. S. Ross and A. E. Michelbacher, 9 males, 5 females, 3 tritonymphs, in 2 vials; this material was at some time studied by Beier, and a label was inserted, reading "*Chelanops rotundimanus* (Ell.) det. Beier ♂ ♀"; 5 males, 3 females, 3 tritonymphs have been mounted on slides. One of the mounted males, (WM7883.01002), is hereby designated the NEOTYPE; the others are paratypes.

Other Material Examined.—CHILE: [BIO-BIO], Nuble, 18 km E of San Carlos, 24 Dec 1950, Ross and Michelbacher, 1 male, 1 female, 1 deutonymph, in alcohol; [DE LA ARAUCANIA], 20 km E of Temuco, 8 Jan 1951, Ross and Michelbacher, 1 male, 1 tritonymph, in alcohol; [DE LA ARAUCANIA], 16 km NE of Pucón, 12 Jan 1951, Ross and Michelbacher, 1 male, 4 females, 1 deutonymph, mounted on slides; "Osorno Prov." [DE LOS LAGOS], valley forest, 18 km W of Purrangué, 16 Jan 1951, Ross and Michelbacher, 8 males 2 females, 1 tritonymph, in alcohol.

Chelanops skottsbergi (Beier), NEW COMBINATION

Stigmachernes skottsbergi Beier 1957: 457, fig. 3; Harvey 1991: 634.

Type locality. Juan Fernandez Islands, Chile.

According to Beier's (1957) description and figure, this species has all of the important characters of the genus *Chelanops* as defined above, even though the

palps are not as robust as those of *C. coecus*. Because *S. skottsbergi* is the type species of *Stigmachernes*, that genus becomes a synonym of *Chelanops*.

DISCUSSION

It is worth noting that although the neotype series was labelled "*Chelanops rotundimanus* (Ell.)," Beier (1959) synonymized *rotundimanus* with *coecus*, and in 1964b he treated these very specimens as *coecus*.

The original type locality of *Chelifer (Chelanops) coecus*, as given by Gervais, was near Calbuco, De los Lagos, Chile. The neotype series is from Los Muermos, also in De los Lagos, less than 40 km NW of Calbuco. The type locality of *Chelifer (Trachychernes) rotundimanus* is Philipi, De los Lagos, about the same distance NE of Los Muermos. The other specimens studied here are from Temuco, Pucón, and Nuble, some 2–300 km farther north. *Chelanops coecus* has also been reported from several other places in Chile and in Argentina (Beier 1959, 1962, 1964a, b, c; Cekalovic 1976), but the status of these records is uncertain.

Chelanops costaricensis, described by Beier in 1932 and one of the four species of *Chelanops* recognized by him at that time, was later declared to be a synonym of *Semeiochernes militaris* Beier (Beier 1954: 139, Harvey 1991: 632).

Altogether, about 70 species of pseudoscorpions have been assigned to the genus *Chelanops* at one time or another. Most have been reassigned subsequently to other genera, so that at the present time Harvey's Catalogue (1991: 554–555) lists 9 species in addition to *coecus* in the nominate subgenus of *Chelanops*. The structure of the spermathecae is not known for any of these species; but, on other grounds, most of them do not appear to belong in *Chelanops* as redefined above.

Chelanops chilensis Beier 1932, from Villarica, De la Araucania, southern Chile.

Relying on Beier's descriptions, figures and keys (1932: 178, fig. 186; 1933: 538, fig. 10), it appears certain that this is a synonym of *Chelanops coecus*. The major difference, in Beier's opinion, seems to have been the absence of tactile setae from the 11th tergite of *chilensis* compared to *rotundimanus* (= *coecus*); however, as mentioned above, the tactile setae of both the 11th tergites and 11th sternites may be lost from their areoles in preserved specimens. All other features of the two taxa appear to be identical, within the limits described above.

Chelanops affinis Banks 1894, from Florida, USA.

This species certainly belongs in another genus, according to observations I have made on the types (in the Museum of Comparative Zoology, Cambridge, Massachusetts) and numerous other specimens. It will be treated in detail in a later publication.

Chelanops altimanus (Ellingsen 1910), from the Virgin Islands, West Indies.

This species has recently been shown to be a representative of the genus *Dinocheirus* (Muchmore 1997).

Chelanops nigrimanus Banks 1902, from the Galapagos Islands, Pacific Ocean.

This inadequately described species was not mentioned by Beier in 1932 or 1933. It was listed, without comment, as *Parachernes (Argentochnes) nigrimanus* (Banks) by Chamberlin (1934) and as *Parachernes nigrimanus* (Banks)

by Beier (1940); these actions have not been noted by any other author, even by Harvey (1991), who retained the species in *Chelanops*. In a footnote in his paper on "The species of the pseudoscorpion genus *Chelanops* described by Banks," Hoff stated that *C. nigrimanus* Banks is a "*Species incertae sedis*; deposition of type individuals uncertain, perhaps in the National Museum. Dr. Chapin as yet has not located the type specimens." (1947: 473). This information may also have been known to Beier, who in 1948 (p. 472) described a species from Costa Rica as *Parachernes (Argentochernes) nigrimanus*. Further, Beier (1977, 1978) described three species and one subspecies of *Parachernes* from the Galapagos Islands, two from Isabela (= Albemarle), the type locality of *C. nigrimanus* Banks, without mention of the latter species. Recently, the holotype of *Chelanops nigrimanus* has been found by M. S. Harvey in the J. C. Chamberlin Collection of Pseudoscorpions, now housed in the Entomology Department of the California Academy of Sciences; it is a female, mounted on a microscope slide by Chamberlin (JC-799.01001; CAS Type No. 17500), and is in good condition. I have examined the specimen and find that it is, as Chamberlin determined, a representative of the genus *Parachernes* Chamberlin. Therefore, *Parachernes nigrimanus* Beier, 1948 becomes a junior primary homonym of *Parachernes nigrimanus* (Banks, 1902); for that Costa Rican species I propose the replacement name, *Parachernes beieri*.

The following species require further study before their status can be known:

Chelanops atlanticus Beier 1955a, from Tristan da Cunha, South Atlantic Ocean.

Chelanops insularis Beier 1955b, from the Juan Fernandez Islands, Pacific Ocean west of Chile.

Chelanops kuscheli Beier 1955b, from the Juan Fernandez Islands, Pacific Ocean west of Chile.

Chelanops occultus Beier 1964b, from central Chile.

Chelanops pugil Beier 1964a, from San Ambrosio Island, Pacific Ocean west of Chile.

They appear to differ in various ways: in the presence or absence of tactile setae on the 11th tergite, the presence or absence and size and location of a tactile seta on the 4th tarsus, and the relative positions of trichobothria *est* and *ist* on the palpal chela; and, as mentioned, the spermathecae are not known for any of them. Reexamination of the types, or of material which is certainly conspecific, is needed to place these species properly.

The status of the several species presently placed in the subgenus *Neochelanops* Beier 1964 (Harvey 1991: 555–556) is uncertain. If the descriptions by Tullgren (1900) and Beier (1964b) can be relied on, the type species *Chelifer (Chelanops) patagonicus* Tullgren is not congeneric with *Chelifer (Chelanops) coecus* Gervais. Only restudy of the types can resolve these problems.

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**A NEW SPECIES OF *CAPITONIUS*
(HYMENOPTERA: BRACONIDAE) FROM COSTA RICA
WITH REARING RECORDS**

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Abstract.—*Capitonius tricolorvalvus*, NEW SPECIES is described from Costa Rica. The species was reared from a stem gall of *Cissus verticillata* (L.) Nicholson & C. E. Jarvis and from leaf petioles of *Cecropia* spp.

Key Words.—Insecta, Braconidae, Cenocoeliini, *Capitonius*, Costa Rica, rearing records.

In the past 10 years much effort has been made to sample the insect fauna in Costa Rica. At least 30 Malaise traps have been operating throughout Costa Rica to collect specimens used to develop the book "The Hymenoptera of Costa Rica" (Hanson & Gauld 1995). At the same time, INBio (Instituto Nacional de Biodiversidad; see Janzen 1991, Gámez & Gauld 1993) started sampling insects by hand collecting, Malaise traps, light traps and other trapping devices. As a result, hundreds of specimens of Cenocoeliini were collected, of which most belong to undescribed species (van der Ent & Shaw 1998). Most Cenocoeliini were collected by Malaise traps and, therefore, host records are lacking. In temperate regions, Cenocoeliini parasitize wood-boring and bark-boring beetle larvae, mostly belonging to the families Cerambycidae and (less commonly) Scolytidae and Buprestidae (Saffer 1982). The only published host record for Cenocoeliini in Costa Rica is that of *Capitonius andirae* (Saffer), NEW COMBINATION, parasitizing seed-infesting curculionid beetle larvae (Saffer 1977). Recently an undescribed species of Cenocoeliini has been reared from a cerambycid larva which lived in an epiphytic species of Solanaceae (Quesada, INBio, unpublished data). The species described below is commonly encountered in Costa Rica and was reared from a stem gall and from leaf petioles. These are the first records of a species of Cenocoeliini from these types of plant substrates. It supports the expectation (van der Ent & Shaw 1998) that neotropical Cenocoeliini will display a wider variety of host habitat adaptations than their counterparts in temperate regions.

Capitonius can be identified as member of the tribe Cenocoeliini or subfamily Cenocoeliinae using the keys of van Achterberg (1993), Sharkey (1997) or Shaw (1995). The tribe Cenocoeliini is a monophyletic group which traditionally has been placed within the subfamily Helconinae, but more recently was considered to form the main tribe in a separate subfamily Cenocoeliinae (Achterberg 1994). Cenocoeliini are easily recognizable by the high insertion of the metasoma on the propodeum, a unique character among the non-cyclostome Braconidae. Van Achterberg provided generic keys to the world Cenocoeliinae (1994) and to the New World Cenocoeliinae (1997). The morphological terminology mostly follows that used by Sharkey and Wharton (1997) with some additional characters defined by van Achterberg (1994, 1997). Authorship of this new species is attributed to the senior author (LJE).



Figure 1. Lateral habitus of *Capitonius tricolorvalvus*.

CAPITONIUS TRICOLORVALVUS ENT, NEW SPECIES
(Figs. 1–10)

Types.—Holotype, female: COSTA RICA, *HEREDIA*: 3 km S of Puerto Viejo, OTS, La Selva, 100 m el, Dec 1992, P. Hanson, Malaise trap; deposited: Insect Museum, University of Wyoming, Laramie, U.S.A. Paratypes: 2♀ same data as holotype; 2♀ same data except Sep 1992; 1♀ same data except Oct 1992; 1♀ same data except Nov 1992; 2♀ same data except Jan–Feb 1993; 6♀ same data except Feb–Mar 1993; 3♀ same data except Feb–Apr 1993, huertos plots; *ALAJUELA*, 2♀ Est. Biol. San Ramón, 900 m el, Jul–Aug 1995; 2♂ same data except Jul–Aug 1998 (reared); *GUANACASTE*, 1♀ N. P. Guanacaste, Est. Pitilla, 9 km S of Santa Cecilia, 700 m el, Sep 1993; 1♂ same data except Jun 1994; *LIMÓN*, 1♀ 4 km NE of Bribri, 50 m el, Sep–Nov 1989; 1♀ same data except Dec 1989–Mar 1990; 1♀ same data except Apr–Jun 1990; 1♀ same data except Jul–Sep 1990; 1♀ 16 km W of Guapiles, 400 m el, Jul–Sep 1990; 1♂ sector Cocori, 30 km N de Cariari, Finca E. Rojas, 100 m el, Mar 1994, 1♀ same data except 15 Dec 1994 (hand collected); 1♂, 1♀ Teleférico (Aerial Tram), 500 m el, May 1997 (reared); *PUNTARENAS*, 2♀ R. F. Golfo Dulce, 3 km SW of Rincón, 10 m el, Oct–Dec 1990; 2♀ same data except Mar–May 1991; 1♀ same data except Aug

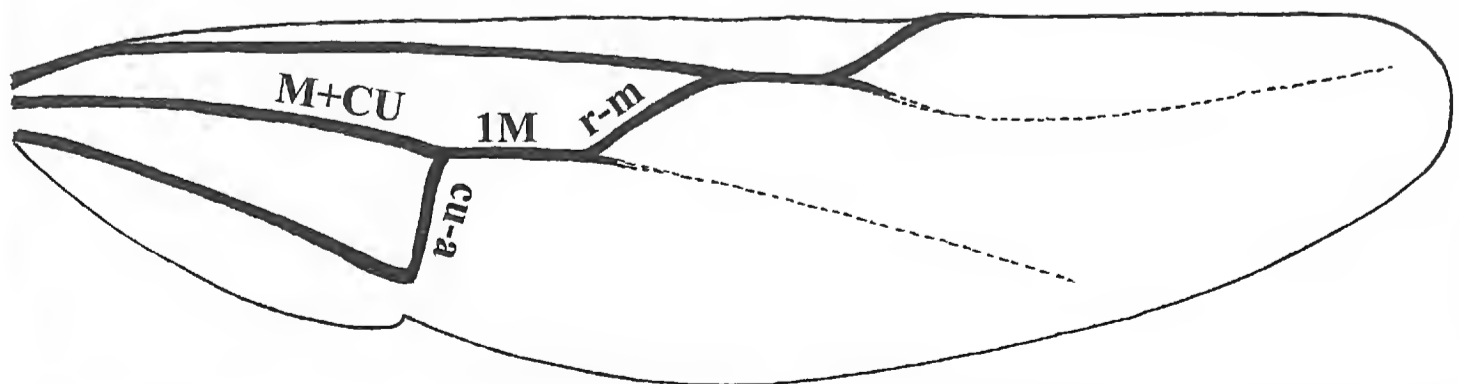


Figure 2. *Capitonius tricolorvalvus*. Hind wing.

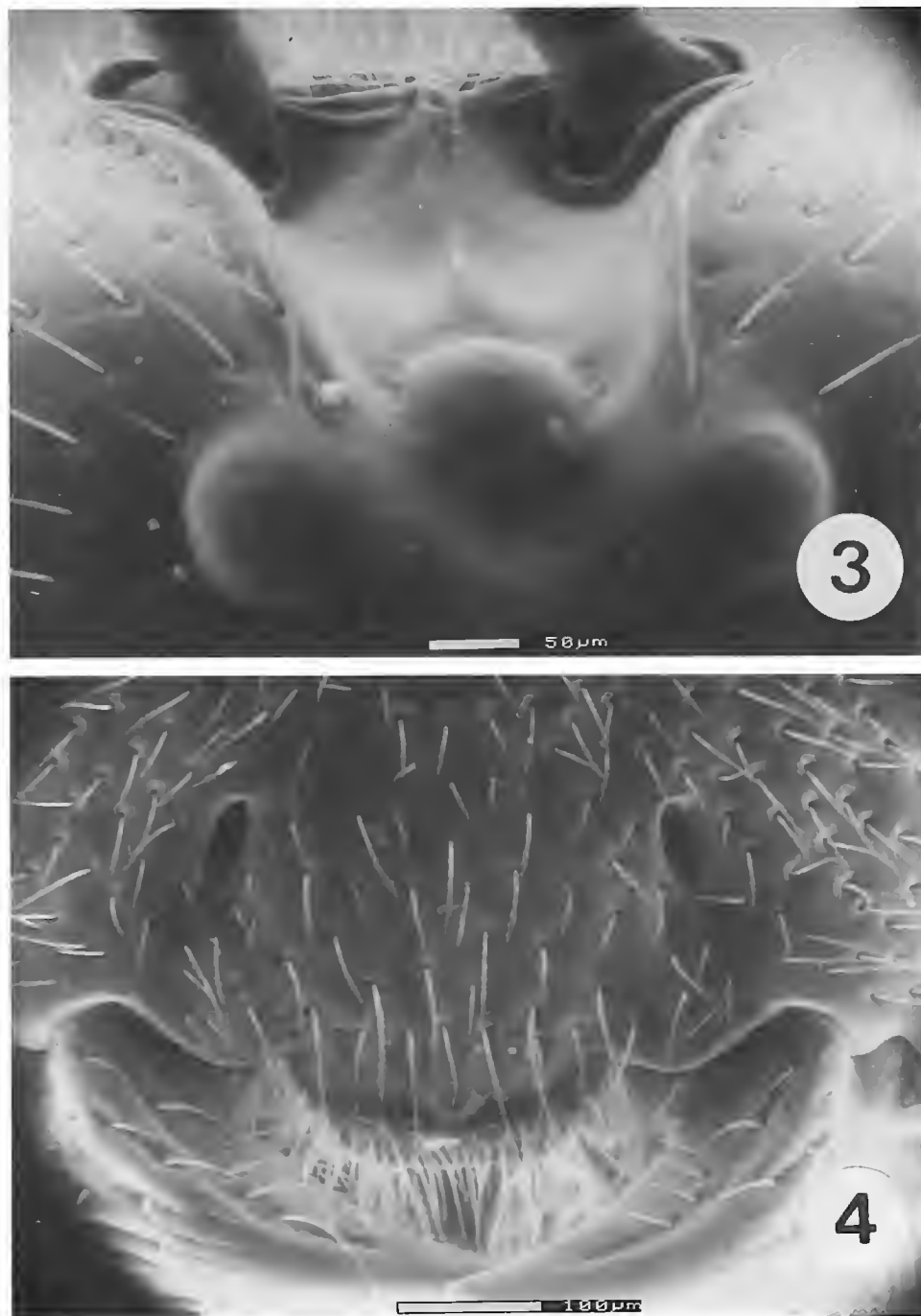


Figure 3–4. Head of *Capitonius tricolorvalvus*. Figure 3. Frontal cavity. Postero-dorsal view. Figure 4. Lower face and clypeus. Anterior view.

1991; 1 ♀ same data except Sep 1991; 1 ♀ same data except Apr 1993; 1 ♂ Cerro de Oro, Rio Rincón, 100 m el, 1–15 May 1995; 1 ♀ R. F. Golfo Dulce, 24 km W of Piedras Blancas, 200 m el, Dec 1989–Mar 1990; 1 ♀ same data except Nov 1991; 1 ♀ same data except June–Aug 1991; 1 ♀ R. F. Golfo Dulce, 5 km W of Piedras Blancas, 100 m el, Aug–Sep 1991; 2 ♀ Peninsula Osa, Rancho Quernado, Rio Riyitio, 200 m el, Sep–Oct 1992; 1 ♀ Peninsula Osa, 8 km S Rio Rincon Coopemarti, 30 m el, Feb 1991; 1 ♀ P. N. Corcovado, Est. Sirena, 50 m el, Apr–Aug 1989; 1 ♀ same except Mar–Jun 1991; 1 ♀ San Vito de Coto Brus, Las Cruces, 1200 m el, 9 Jul–7 Aug 1982; 1 ♀ SAN JOSE, Res. Biol. Carara, Est. Bijagual, 500 m el, Jan 1990. Paratypes are deposited at the location of the holotype, at the Museum de Insectos, Universidad de Costa Rica, Ciudad Universitaria, San Pedro de Montes de Oca, Costa Rica, at INBio, Santo Domingo de Heredia, Costa Rica and at the Nationaal Natuurhistorisch Museum, Leiden, The Netherlands.

Description of Holotype Female.—Body length 3.8 mm; forewing length 3.1 mm (Fig. 1).

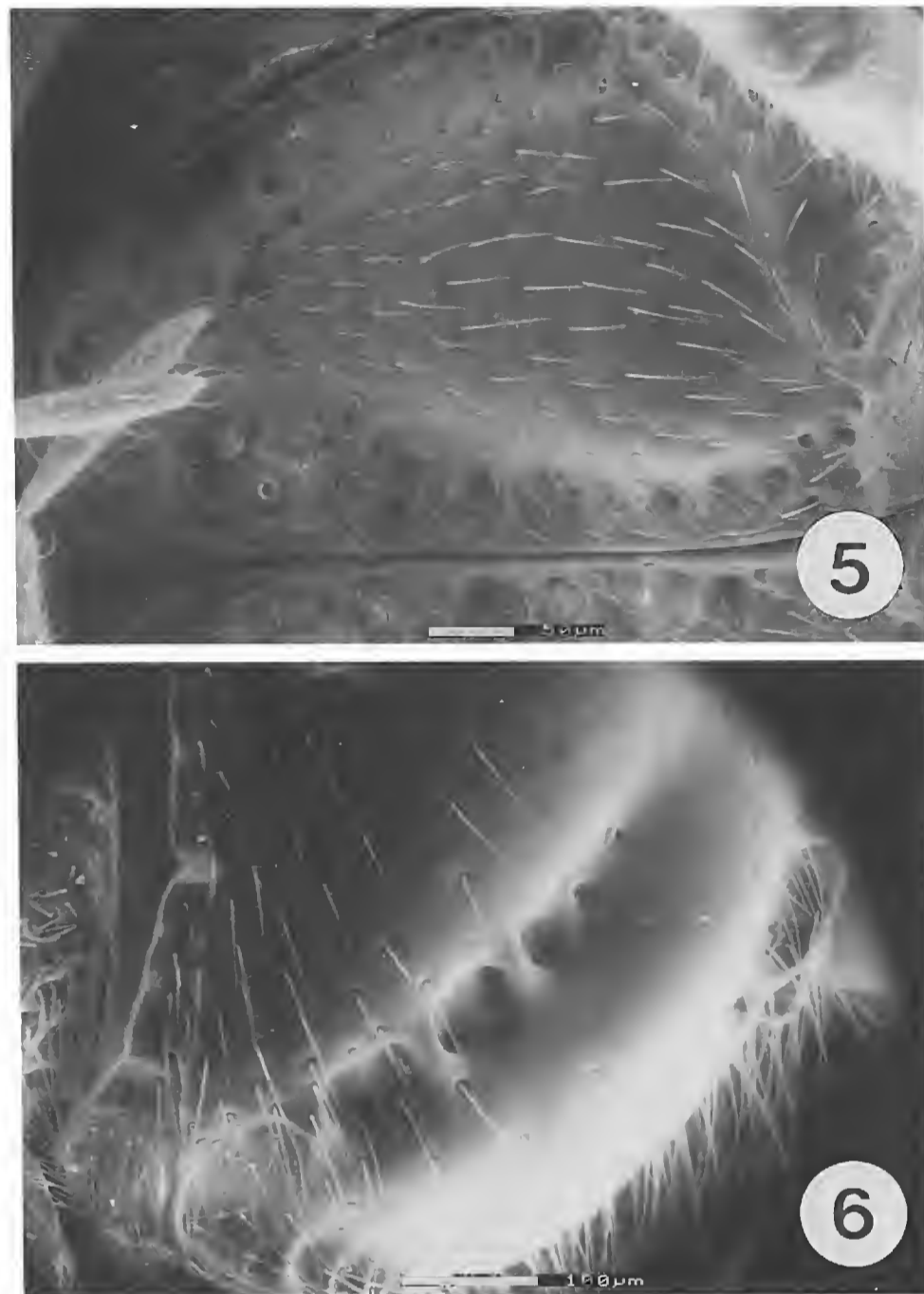


Figure 5–6. Sculpture patterns on mesosoma of *Capitonius tricolorvalvus*. Figure 5. Left lobe propodeum. Ventral view. Figure 6. Sternaulus. Lateral view.

Head: antenna with 26 flagellomeres; scapus $3.8\times$ longer than its maximum width; first, middle and penultimate flagellomere $5.5\times$, $2.0\times$, $1.3\times$ longer than wide respectively; vertex sparsely punctate and setose, area behind frontal cavity slightly convex, smooth and bare; distance between lateral ocelli to diameter of lateral ocellus $3.5\times$, distance between lateral and median ocellus $2.5\times$, and distance between lateral ocellus and eye $0.8\times$; frontal cavity with strong lateral carinae reaching lateral ocelli (Fig. 3), median carina of frontal cavity protruding anteriorly (Fig. 3); temple in lateral view $0.35\times$ eye width; eye ovoid with straight antero-ventral margin, $1.2\times$ taller than wide; face densely punctate and setose; clypeus less densely punctate than face, medio-ventrally of clypeus a distinct tooth (Fig. 4); malar space $0.7\times$ eye height; ventral lobe of mandible less protruding than dorsal lobe.

Mesosoma: mesosoma $1.4\times$ longer than high; propleuron moderately punctate and setose, lateral carina foveate and complete, median carina with foveae decreasing in size posteriorly (Fig. 5); pronotum smooth to weakly punctate, dorsal margin with a row of round foveae extending ventrally at posterior margin; mesopleuron sparsely punctate with a smooth and bare median area, sternaulus with large rectangular-oval foveae which are ventrally not carinate and absent in anterior $\frac{1}{3}$ of mesopleuron (Fig. 6), postpectal and epicnemial carina apparent but not distinctly foveate; mesoscutum sparsely punctate and setaceous, $1.1\times$ broader than long, notauli with large and irregular rectangular foveae, fusing medio-posteriorly on mesoscutum into a longitudinal carina (Fig. 7), lateral carina on dorsal part mesoscutum strongly protruding medio-anteriorly to each notaulus; scutellar sulcus with 2 large foveae; scutellum smooth; metapleuron and propodeum with large irregular aerolate sculpturing (Fig.

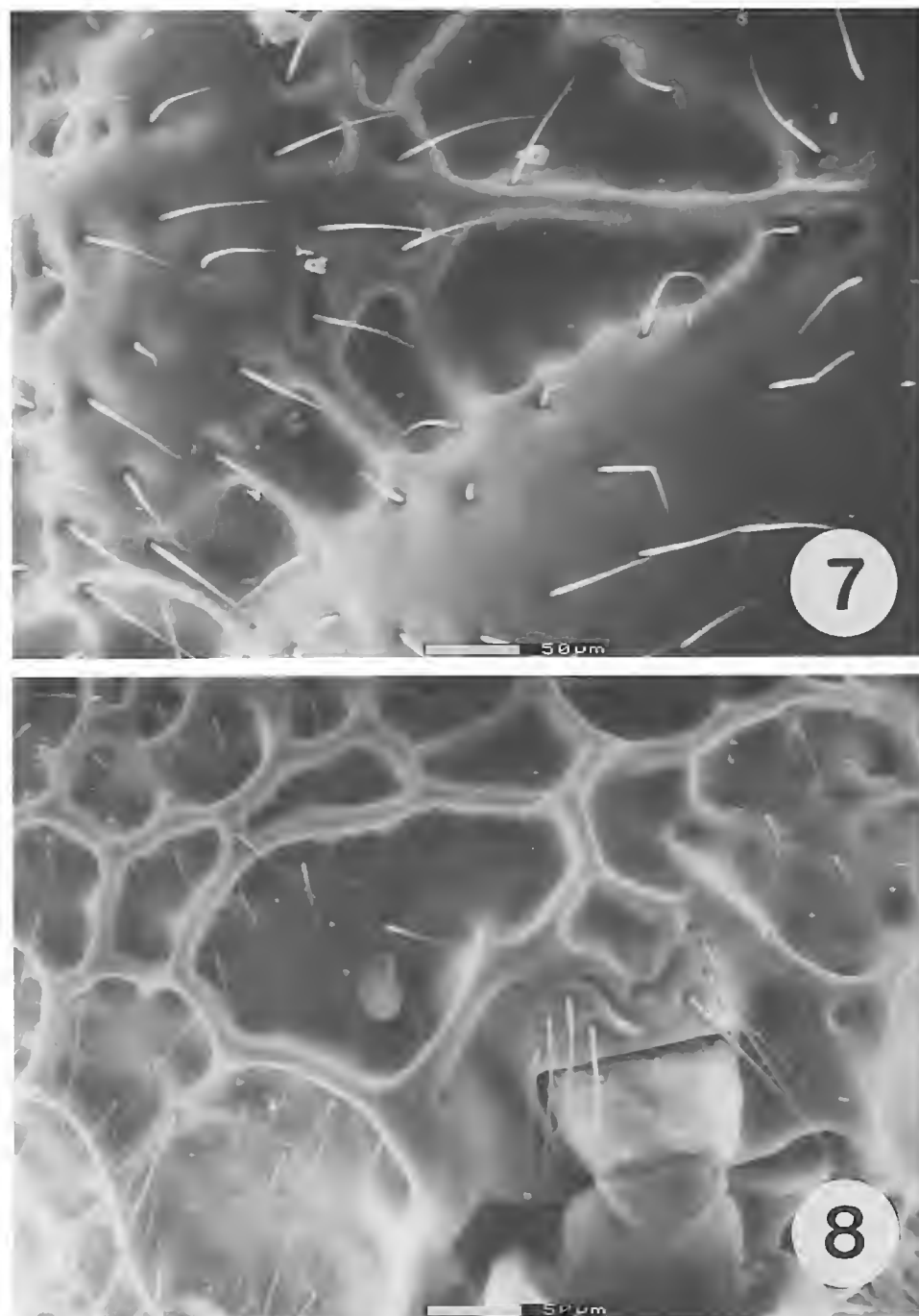


Figure 7–8. Sculpture patterns on mesosoma of *Capitonius tricolorvalvus*. Figure 7. Notauli, in part. Dorsal view. Figure 8. Propodeum, in part. Dorsal view.

8); hind femur $3.2\times$ longer than its maximum width; hind tibia $5.4\times$ longer than its maximum width, hind basitarsus $5.5\times$ longer than its maximum width; lateral spur of hind tibial $0.4\times$ longer than basitarsus; tarsal claw with a lobe protruding distally in a tooth; inner side hind coxa with a depression parallel to anterior margin ending ventrally in $\frac{1}{4}$ of a circular area (Fig. 9), circular area in ventral view forms basal $\frac{1}{3}$ of length of ventral area (Fig. 10).

Wings: forewing; pterostigma $2.5\times$ as long as its maximum width, vein M slightly curved, vein m-cu interstitial (no Rs+Mb) second submarginal cell $0.45\times$ length of pterostigma; hind wing vein M+CU $2.7\times$ longer than IM (Fig. 2); vein IM $1.3\times$ longer than r-m; vein IM $1.1\times$ longer than cu-a.

Metasoma: metasoma $2.5\times$ longer than its maximum width; tergum 1 smooth, $1.5\times$ longer than its apical width, dorsal carinae parallel and apparent in basal half; dorsope and laterope weakly developed; terga 2 and 3 smooth; tergum 3 medially $1.3\times$ longer than tergum 2; ovipositor length 4.1 mm, ovipositor sheath $1.3\times$ longer than forewing.

Color: head black, ventral half of clypeus brown, clypeal tooth black, mandible yellow-brown with dark brown apex, scapus and pedicel light yellow; antenna dull red-brown, darker towards apex; mesosoma dull red-brown; legs yellow-brown, slightly darker on apex of middle and hind tibia; tarsi yellow-white with apical 2 tarsomeres darkened; wings clear, pterostigma dark brown; metasoma dorsally black and ventrally brown, basal $\frac{3}{5}$ of ovipositor sheath light red-brown, darker basally, remainder black with a long (15–20 \times longer than wide) yellow-white apex.

Variation in Females.—Body length 3.2–4.9 mm; forewing length 2.7–3.9 mm; antenna with 23–

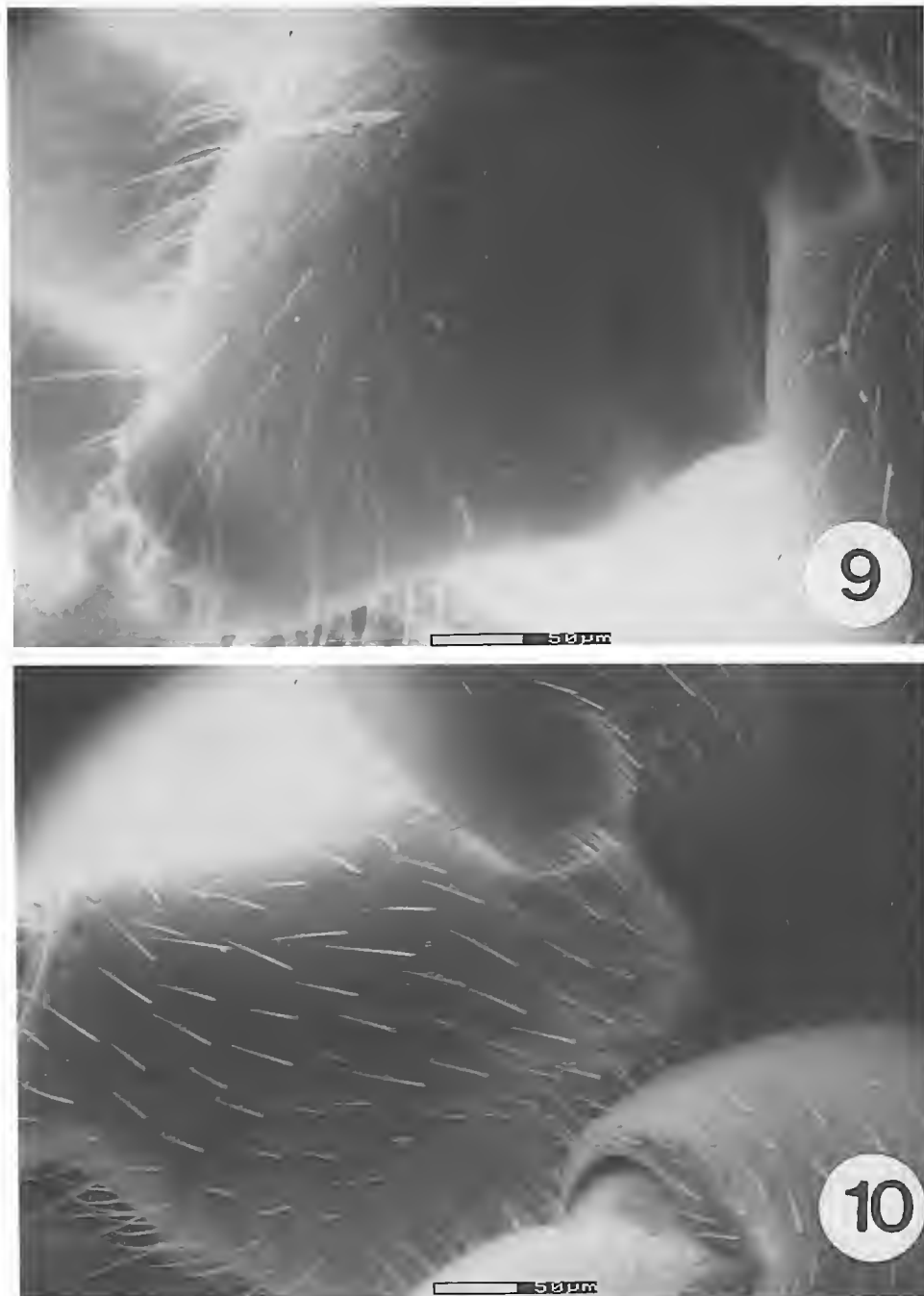


Figure 9–10. Hind coxa of *Capitonius tricolorvalvus*. Figure 9. Postero-lateral view with anterior at inner side a depression. Figure 10. Ventral view with endings depression of inner sides forming circular area.

28 flagellomeres; dorsal row of foveae on pronotum apparent to weakly developed; antero-medial lobe on mesoscutum smooth to weakly rugose; notaulus and sternaulus clearly defined to weakly defined by lacking of carinae, sternaulus equally sized to decreasing in size anteriorly; scutellar sulcus with 2 or 4 (in larger specimens) foveae; pterostigma 2.3–2.7 \times longer than its maximum width; hind wing vein M+CU 2.4–3.1 \times length of vein 1M; vein 1M 1.0–1.2 \times longer than cu-a and 1.1–1.4 \times longer than r-m; dorsal carinae on tergum 1 apparent from base to midlength; ovipositor length 3.2–5.3 mm; ovipositor sheaths 1.2–1.4 \times longer than forewing; ventral half of clypeus brown to black; hind tarsus with last 2–4 tarsomeres darkened.

Description of Males.—Similar to holotype female; body length 4.1–4.7 mm, forewing length 3.3–3.6 mm; antenna with 25–28 flagellomeres, more slender and longer than in female; first, middle and penultimate flagellomere 5.5 \times , 3.5 \times , 2 \times longer than wide respectively; hind coxa lacking depression at inner side.

Remarks.—The key to North American and Mexican Cenocoeliini by Saffer (1982) identifies *C. tricolorvalvus* at couplet 18, which includes a group of species with clear wings, mostly red mesosoma, lack of transverse carinae on the propleuron, regularly punctate face and clypeus, and ovipositor less than 1.5 \times longer than forewing. However, these species are distinctly larger (forewing length >5.0

mm) than *C. tricolorvalvus* and have 29 or more flagellomeres, a red metasoma, sometimes a red head, and uniformly colored ovipositor sheaths. *Capitonus tricolorvalvus* can be distinguished from similarly sized and colored Costa Rican species that are undescribed by the combination of the following characters: vertex behind frontal cavity smooth and bare, lobes of propleuron lacking carina or rugose sculpturing, sternaulus not apparent on anterior $\frac{1}{3}$ of mesopleuron, hind wing vein M+CU 2.4–3.1 \times longer than vein 1M, tricolored ovipositor sheaths (light red-brown, black, yellow-white), and ovipositor sheaths distinctly longer than forewing length.

Taxonomy.—The generic position of *C. tricolorvalvus* is somewhat ambiguous. *Capitonus tricolorvalvus* best fits into *Promachus* in the generic key of van Achterberg (1994) because the hind wing vein M+CU is between 2.1 \times and 4.7 \times longer than vein 1M. The New World genus *Promachus* was later found to be pre-occupied by a robberfly genus, and also because intermediates between *Promachus* and the Old World genus *Cenocoelius* were found in a Costa Rican sample of Cenocoeliini, van Achterberg (1995) decided to combine both genera using the older genus name *Cenocoelius*. Therefore, *C. tricolorvalvus* fits into the redefined *Cenocoelius* in the generic key to the New World Cenocoeliinae by van Achterberg (1997). However, several characters of *C. tricolorvalvus* other than the size of hind wing vein M+CU relative to 1M do not fit into the genus description of *Cenocoelius* including *Promachus*. In *C. tricolorvalvus* the notauli fuse medio-posteriorly, not posteriorly as in *Cenocoelius*; the sternaulus is incomplete versus complete; hind wing vein 1M is equal to slightly longer than r-m and cu-a versus shorter to sometimes equal; and the depression at the inner side of the hind coxa ends about the middle of the coxa versus distad as in several (perhaps all) formerly *Promachus* species. These characters do fit into the genus description of *Capitonus* but described species of *Capitonus* (van Achterberg, 1994) are larger in size than *C. tricolorvalvus* and have a concave vertex behind the frontal cavity. Recently, we found a morphospecies of Cenocoeliini from Costa Rica with specimens ranging in size of hind wing vein M+CU relative to 1M including both *Capitonus* and *Cenocoelius* character states *sensu* van Achterberg (1997). Therefore, the size of hind wing vein M+CU relative to 1M should not be used solely to distinguish between *Capitonus* and *Cenocoelius*. When the size is 2.1 \times or less, the wasp likely belongs to *Capitonus* but with a higher size up to at least 4.0 \times it could belong to either of the genera and other characters should be taken in consideration. Because the generic position of *C. tricolorvalvus* is ambiguous at present, it was decided to take a parsimonious approach and place it in *Capitonus* based on a majority of characters in the generic descriptions of van Achterberg (1994).

Distribution.—*Capitonus tricolorvalvus* occurs in Costa Rica from sea-level up to 1200 m elevation. They are most frequently encountered in tropical lowlands with moist and wet rain forest types below 500 m altitude. To date, they have not been collected in the tropical dry forest in NW Costa Rica.

Biology.—A male and a female *C. tricolorvalvus* have been reared from a stem gall of the vine *Cissus verticillata* (L.) Nicholson and C. E. Jarvis, found at Teleférico (aerial tram). The stem gall was hand collected at ground level and reared at the University of Costa Rica, San Pedro. It was probably formed by Cecidomyiidae and several cecidomyiid parasitoids were reared from it. Such stem

galls are often infested by beetles (a more likely host for *Cenocoeliini*). No traces were found of which beetle *C. tricolorvalvus* had parasitized (P. E. Hanson, personal communication).

Two males *C. tricolorvalvus* were reared by the senior author from leaf petioles of *Cecropia* spp. at the biological field station San Ramón. Also reared from these leaf petioles were numerous Scolytidae (many species), several Curculionidae (4 spp. of zygotine weevils: *Lechriops disparilis* Champion, *L. rufomaculatus* Champion, 2 undescribed spp. of *Pseudolechriops*; Hespenheide, personal communication) and the leaf petioles contained a few larval Cerambycidae (probably a *Lasiolepturges* sp.; Hespenheide, personal communication). All adult scolytids were small (<3 mm) and, therefore, unlikely to be attacked by *C. tricolorvalvus*. Moreover, most scolytids emerged a few weeks earlier from the leaf petioles than the parasitoids, the zygotine weevils and the cerambycids. Most likely, based on size and weight comparisons, *C. tricolorvalvus* attacked the cerambycid species inside the leaf petiole of *Cecropia* spp.

Etymology.—The species was named for its apparent tricolored ovipositor sheaths.

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Obituary: Vincent D. Roth (1924–1997)

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Figure 1. Vincent D. Roth in 1979 at the Southwestern Research Station, Arizona.

Abstract.—A chronology of the life of Vincent D. Roth, one of the founding members of the American Arachnological Society and member of the Pacific Coast Entomological Society from 10 December 1965 until his retirement in 1986, is presented along with a list of his publications and taxa named in his honor.

It is with sadness that I report the death of Vince Roth, after an illness, on 27 July 1997 at his home in Portal, Arizona. To me, Vince was a mentor and friend for many years; as he was to numerous others in the Arachnological community. If the value of a person is to be measured in terms of the vacancy left behind,

then Vince's passing is indeed a great loss. No more his myriad notes and specimens scattered to numerous biologists around the globe; nor his newsletters describing travels to exotic places.

Vince was born as Vincent Daniel Roth on 12 February 1924 in Portland, Oregon, where he grew up with one sibling, his younger sister, Wilma (Willie). His father, Frank Xavier Roth, worked for the railroads, was born in Winböring, Altötting, Bavaria (as Francis Seraph Rott), of Bavarian and Bohemian ancestry, and immigrated to the United States as a child, in 1893. His mother, Mary Wiedmeyer, was from Richfield, Wisconsin, born to a German father and a Menomonee Indian mother. The earliest indication of Vince's entomological bent is from a photo, showing him at two or three years old dressed as a bumble bee. He attended the local elementary schools and was a good student but, in response to the illness and premature death of his mother, failed and had to repeat the 7th grade. From 1938 he attended Benson Polytechnical High School and completed 2.5 years of automotive and trade courses.

In 1941 Vince joined the U.S. Navy and was in Pearl Harbor on 7 December 1941 during the Japanese bombing. He remained in the Navy until the end of the war, completing machinist school and studying steam and diesel engines, eventually attaining the rank of Machinist Mate 1st Class. The Navy gave him an opportunity to travel throughout the Pacific and he visited ports from Korea to the Ryukyus, Philippines, New Guinea, New Caledonia, Galapagos, and Hawaii. This, no doubt, catalyzed his love of travel (despite the fact that Vince never overcame seasickness) which remained with him for the rest of his life. This was also the time that he read a book, E. W. Teale's *Grassroot Jungles*, which triggered his interest in entomology.

After the war, in 1946, he enrolled in Oregon State College, Corvallis, Oregon, and received a B.S. (1949) and M.S. (1951) in Entomology. From the onset he gravitated to entomology and soon became Curator of the insect collection; a job he kept throughout his stay at the college. In the summers he took employment in agricultural entomology, working on cranberry insects (under Dr. J. B. Rosenstiel) and surveying mosquitos (under Dr. A. Lindquist). Among his social activities, he was elected to the Phi Sigma Biological Society and the Sigma Xi Honor Society, joined the Entomological Society of America and the Society of Systematic Zoology, served as secretary of the Oregon Entomological Society, and became the president of the Square Dance Club on campus.

During this period Vince became interested in spiders. Unable to identify what turned out to be a black widow, he contacted Dr. Willis J. Gertsch of the American Museum of Natural History, who suggested he study Comstock's *The Spider Book* and possibly introduced him to Dr. Harriet Exline (Frizzell) of the University of Washington. Years later he spoke to me of his appreciation of her generosity, not only in the sharing of information and providing literature but, as was important to Vince, teaching him the pronunciation of the many elusive names in arachnology. Her influence is reflected in the fact that he followed up her studies of the western Agelenidae (s. l.). He collected avidly in Oregon, finding many new species, some of which he described in his thesis (on the Oregon species of *Cybaeus*) and in other papers. From that point on, agelenoid spiders became Vince's primary arachnological interest.

In 1952 Vince married Jean Louise Lamb in Milwauke, Oregon, and the fol-



Figures 2–7. Vincent D. Roth. Figure 2. With parents and sister in Oregon in 1935; Figure 3. Dressed as bumble bee in 1928; Figure 4. With wife, Jean, and daughter, Susan, at Salem, Oregon, during 1954–1955; Figure 5. With wife, Bobbie, and daughters, Kristin and Kim, at the Southwestern Research Station, Arizona, in 1969; Figure 6. With Willis Gertsch and Darrell Ubick at Tucson, Arizona, in 1996; Figure 7. With wife, Barbara, in front of “El Ghosto Blanco” at Portal, Arizona, in 1996.

lowing year they moved to Berkeley, California, where he enrolled at the University of California with the goal of continuing his graduate studies. These were curtailed shortly after the birth of their daughter, Susan Elizabeth (in 1954), when the family moved back to Salem, Oregon. Here Vince started employment with the Oregon State Department of Agriculture as a Survey Entomologist, where he sampled for insect pests, assembled collections, and promoted 4-H programs in entomology. The following year, however, a better position became available at the University of Arizona Experiment Station. Leaving his family in Salem, Vince moved to Yuma and, as Assistant Entomologist, worked on the "Yellow Clover Aphid Problem" to develop a control for the Spotted Alfalfa Aphid. Although he regularly visited his family in Oregon, the arrangement proved unsatisfactory and the following year Vince and Jean were divorced.

In 1956 Vince began his long field association with Dr. Willis J. Gertsch, of the American Museum of Natural History, by assisting him on a collecting trip through the western United States and Mexico. As Vince was a keen collector, he kept a steady stream of interesting spiders flowing to Willis; on one occasion donating a particularly large collection of Oregon spiders, for which he received Life Membership to the AMNH. He also accompanied Willis on three expeditions to California, in 1958, 1959, and 1960 (the last joined by Wilton Ivie), which probably represent the first major collection of spiders from this region.

A major turning point in Vince's career came in 1962, when he became the Resident Director of the Southwestern Research Station. The station, or SWRS, located in the scenic and biologically rich Chiricahua Mountains of southeastern Arizona, was founded in 1955 and directed by Dr. Mont Cazier for the AMNH. Cazier's sudden retirement in mid-1962 left a vacancy which was temporarily filled by Willis Gertsch, who in turn encouraged Vince to take the post. This he did eagerly, taking up residence at the station's "Log Cabin" in 1963 with his wife, Dorothea "Bobbie" Ann Thompson from El Centro, California, whom he married in 1961. They had a daughter, Kristin Ann, and some years later (1970) adopted Kim Lee (who was born as Hai Sook Jin in Seoul, Korea; in 1964, the same year as Kristin). After Vince's second marriage dissolved (1972), the girls continued living at the station until they moved to Tucson to attend high school (1975).

Apart from running SWRS, Vince continued to spend much time exploring the desert, and took numerous trips throughout the Chiricahuas and Sonora, Mexico, keeping detailed field notes of the places visited. Most of the time it was in his old white pick-up, which he named "El Ghosto Blanco", and which he (miraculously) maintained in working order. El Ghosto was always kept well stocked with survival and collecting gear to be available for field work at a moment's notice, which was often the case. Although spiders were his main love, Vince maintained a generalist's interest in biology and created the synoptic collection of the local fauna and flora at SWRS. He enjoyed inventing and created a miniature herbarium and plant press to facilitate plant identification in the field (Roth 1972). His passion for solving biological puzzles is well illustrated in "the case of the lost lizard", as he called it (1997). The horned lizard, *Phrynosoma ditmarsii* Stejneger, was known from only a few museum specimens, all collected at the turn of the century at an unknown locality in Sonora. Vince eventually discovered the locality by closely examining those parts of it that the lizards themselves had

collected, that is, ingested (Roth 1971, Lowe et al. 1971). Vince was also an outspoken conservationist and expended much effort to preserve the natural environment in the Chiricahuas. He actively worked to stop overgrazing, much to the consternation of the local ranchers, and his battle against noxious weeds was equally legendary; he always carried a shovel in El Ghosto for eradicating the latest incursion of horehound or Johnsongrass.

In his spare time, he continued taxonomic work on spiders. In 1962 he received a National Science Foundation Grant for a taxonomic study of the South American Agelenidae, at the California Academy of Sciences. He published several additional papers on agelenids during this period, along with several lists, including Galapagos spiders (with P. R. Craig 1970), nearctic Gnaphosidae (with D. Ubick 1973), Chiricahua Mountain spiders (with A. K. S. Jung 1974), and Yuma Co., Arizona, jumping spiders (with D. Richman 1976). His discovery of a new species of intertidal spider in Sonora (Desidae: *Paratheuma interaesta* (Roth & Brown)) resulted in a series of papers on spiders from this unusual habitat, mostly with W. L. Brown from 1975–1980.

In 1968, his close friend and mentor, Willis Gertsch, retired from the AMNH and moved to the nearby village of Portal. Soon other arachnologists retired and moved to this area, as did Dr. Findley Russell and Dr. Martin H. Muma, and many more visited each summer to where the Chiricahuas became a veritable Mecca for Arachnologists. Appropriately, the first meeting of the American Arachnological Society, co-hosted by Willis and Vince in August 1972, was held there. Vince continued being active in the AAS throughout his life, serving as Vice President (from 1973–1975), Director (1980–1982), member of the Editorial Board (1985–1986), and Archivist (1986–1997). At the 1993 meeting he introduced the Auction, which immediately became a popular and entertaining way of raising money for the society, as well as redistributing literature (much of which was donated by Vince). In 1995 the AAS honored Vince with a commemorative plaque, in recognition of his contributions to Arachnology and to the Society, of which he was a charter member.

A most important trip for Vince was in the winter of 1975–1976 to Costa Rica, where he met Barbara Maria Emmanuela Schröpfer, a midwife from Cham, Bavaria. The following year they were married in an elaborate ceremony at SWRS. Barbara assisted Vince in running the station, was a hostess to the many visitors, and helped Vince in the field and laboratory. In 1977 Vince acquired some property in Portal from Willis. The following year he and Barbara, with the help of an elderly carpenter, built a large and attractive house (dubbed Number One Spider Lane), to which they retired in 1986. In October 1996, they had twins, Daniel and Taran, one month prior to Vince's death.

After Vince's retirement, they embarked upon an ambitious program of world travel, visiting the following: Spain-Morocco-Egypt-Israel-Germany (September 1986–July 1987); South America (March 1988–March 1989); India-SE Asia (October 1989–April 1990); southern Africa (October 1990–April 1991); Madagascar (March–September 1992); eastern Africa (October–November 1992); Ecuador (January–December 1994); Siberia (Kiril Islands) (July–September 1995); Hawaii (1977, 1982, 1984, 1990, 1996). These trips produced rich collections of spiders, now mostly at the California Academy of Sciences, some at the Museum of Comparative Zoology. In addition to collecting, Vince and Barbara volunteered

their services in a number of ways. In Ecuador they spent an entire year running a field station, Cabañas Aliñahui (now known as Butterfly Lodge), located on the Rio Napo; and in Madagascar, three months conducting a spider survey in Ranomafana National Park. They routinely curated spiders at the various museums visited around the globe. Vince was appointed Research Associate at both the California Academy of Sciences and the Bernice P. Bishop Museum.

During this period Vince's spider work was devoted largely to compiling keys to the Nearctic genera, an ambitious goal given our limited knowledge of many families, and which he published as *Handbook for Spider Identification* (1982) and later as *Spider Genera of North America* (1985, 1993). For this, he interacted with many colleagues, eagerly gathering the latest taxonomic information and corrections for the next edition. This project was typical Vince: a collaborative effort to produce a usable and up-to-date key, available at a modest cost to a broad audience, and with the profits going to support arachnological research.

Vince is survived by his wife Barbara, sons Taran and Daniel, daughters Kim, Kristin, and Suzie, grandchildren Ajelina and Dylan, and sister Wilma.

TAXA NAMED AFTER VINCENT AND BARBARA ROTH

ARANEAE

- Aphonopelma rothi* Smith, 1995 (Theraphosidae)
Callobius rothi Leech, 1972 (Amaurobiidae)
Castianeira rothi Reiskind, 1969 (Corinnidae)
Cesonia rothi Platnick & Shadab, 1980 (Gnaphosidae)
Euagrus rothi Coyle, 1988 (Dipluridae)
Hesperocranum rothi Ubick & Platnick 1991 (Liocranidae)
Indothele rothi Coyle, 1995 (Dipluridae)
Legendrena rothi Platnick, 1995 (Gallieniellidae)
Loxosceles barbara Gertsch & Ennik, 1983 (Sicariidae)
Loxosceles rothi Gertsch & Ennik, 1983 (Sicariidae)
Metazygia rothi Levi, 1995 (Araneidae)
Misumenops rothi Schick, 1965 (Thomisidae)
Neotama rothorum Baehr & Baehr, 1993 (Hersiliidae)
Rhoicinus rothi Exline, 1960 (Trechaleidae)
Theridion rothi Levi, 1959 (Theridiidae)
Tibellus rothi Schick, 1965 (Philodromidae)
Tricholathys rothi Chamberlin & Gertsch, 1958 (Dictynidae)
Zimiromus rothi Platnick & Shadab, 1981 (Gnaphosidae)

SOLIFUGAE

- Therobates rothi* Muma, 1962 (now *Eremochelis*, Eremobatidae)

CHELONETHIDA

- Diplotemnus rothi* Muchmore, 1975 (Miratemnidae)

OPILIONES

- Dalquestia rothorum* Cokendolpher & Stockwell, 1986 (Sclerosomatidae)

ISOPODA

Caucasonethes rothi Vandel, 1953 (Trichoniscidae)

DIPLOPODA

Bdellozonium rothi Chamberlin, 1950 (Polyzoniidae)

CHILOPODA

Stenophilus rothi Chamberlin, 1953 (Geophilidae)

COLLEMBOLA

Friesea rothi Christiansen & Bellinger, 1988 (Poduridae)

ORTHOPTERA

Grylloblatta rothi Gurney, 1953 (Grylloblattidae)

TRICHOPTERA

Limnephilus rothi Denning, 1966 (Limnephilidae)

Ochrotrichia rothi Denning & Blickle, 1972 (Hydroptilidae)

COLEOPTERA

Alaocybites rothi Gilbert, 1956 (Curculionidae)

Anilloferonia rothi Hatch, 1951 (Carabidae)

Bryothinusa rothi Moore & Legner, 1975 (Staphylinidae)

Catopocerus rothi Hatch, 1957 (Leiodidae)

Endeodes rothi Moore, 1975 (Melyridae)

Malthinus rothi Fender, 1972 (Cantharidae)

Pselaptrichus rothi Park in Hatch, 1962 (Pselaphidae)

Pseudohaida rothi Hatch, 1957 (Staphylinidae)

Rothium Moore & Legner, 1977 (Staphylinidae)

Scydmaenus rothi Marsh in Hatch, 1957 (Scydmaenidae)

Trigonoscuta rothi Pierce, 1975 (Curculionidae)

DIPTERA

Euparyphus rothi James, 1973 (Stratiomyidae)

HYMENOPTERA

Gryon rothi Masner, 1979 (Scelionidae)

Playaspalangia rothi Yoshimoto, 1976 (Pteromalidae)

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**AN ANALYSIS OF THE GENUS *SALAPIA* STÅL WITH
DESCRIPTION OF SIX NEW SPECIES, AND SOME
TAXONOMIC REARRANGEMENTS (HEMIPTERA:
HETEROPTERA: COREIDAE: ACANTHOCEPHALINI)**

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Abstract.—Six new species of *Salapia* Stål from Brazil, Ecuador, and Peru are described and illustrated. *Salapia humeralis* (Burmeister) is redescribed. *Salapia guttifer* (Stål) is transferred to the genus *Stenometapodus*, resulting in the new combination *Stenometapodus guttifer* (Stål). A key to the known species of *Salapia* is included.

Key Words.—Insecta, Hemiptera, Heteroptera, Coreidae, Acanthocephalini, *Salapia*, new species, Brazil, Ecuador, Peru.

Brailovsky (1992) revised the genus *Salapia* Stål, described four new species, and transferred *Laminiceps haenschi* Breddin (1901) to *Salapia*. In the same contribution he added new records for some species, and included a key to the known taxa, except *S. humeralis* (Burmeister) and *S. guttifer* (Stål) because the types were not located and the original description was too short to find good characters to separate from the other known species. However, the discovery of the types of *S. humeralis* and *S. guttifer* in the Museum der Humboldt Universität zu Berlin, six undescribed species, and some taxonomical problems made the present analysis, which includes a key to the known species necessary.

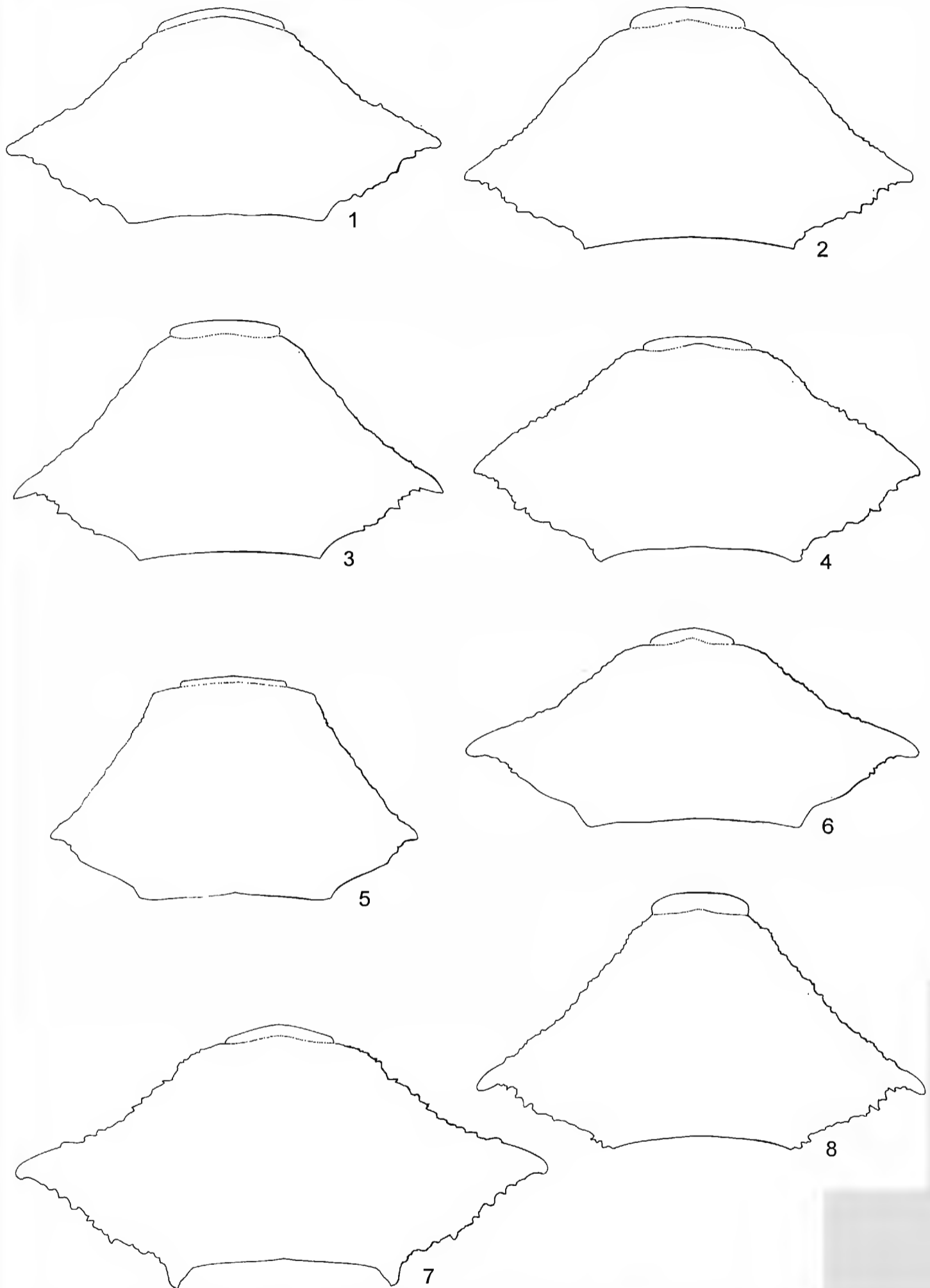
The genus *Salapia* is characterized by an elongate body; cylindrical hind tibiae that is not expanded; rostrum never extending to abdomen with segment IV the shortest, segment II the longest, and segment III longer than I; scutellum longer than wide, humeral angles acute, and metathoracic peritreme with two auricles. The closely related genus *Laminiceps* Costa is similar to *Salapia* except for the body robust, nearly oval, never parallel-sided, the scutellum wider than long, and the humeral angles obtuse, not acute.

Previously, twelve species of *Salapia* (*S. abdominalis* (Dallas), *S. baraquini* (Signoret), *S. dimidiata* (Dallas), *S. guttifer* (Stål), *S. haenschi* (Breddin), *S. humeralis* (Burmeister), *S. luteola* Brailovsky, *S. nigra* Brailovsky, *S. pallida* Brailovsky, *S. pretiosa* Blöte, *S. selecta* Brailovsky, and *S. signata* (Dallas)) were known. In this paper we add six new species collected in Brazil, Ecuador and Peru, and one species, *S. guttifer*, is transferred to the genus *Stenometapodus*, forming the new combination *Stenometapodus guttifer*.

With this contribution, the current number of species known in *Salapia* is 17.

***SALAPIA CAUCALANDIA* BRAILOVSKY AND BARRERA, NEW SPECIES
(Figs. 1, 9)**

Types.—Holotype: female; data: BRAZIL. Rondonia, vic. Caucalandia, 10°32'S–62°48'W, 160–350 m, 30 October 1991, J. MacDonald. Deposited in Mississippi Entomological Museum, Mississippi State. Paratype: 1 female: BRA-



Figures 1–8. Pronotum of *Salapia* spp. Figure 1. *S. caucalandia* Brailovsky and Barrera, NEW SPECIES. Figure 2. *S. deckerti* Brailovsky and Barrera, NEW SPECIES. Figure 3. *S. vanduzeei* Brailovsky and Barrera, NEW SPECIES. Figure 4. *S. egeri* Brailovsky and Barrera, NEW SPECIES. Figure 5. *S. humeralis* (Burmeister). Figure 6. *S. kondratieffi* Brailovsky and Barrera, NEW SPECIES. Figure 7. *S. onorei* Brailovsky and Barrera, NEW SPECIES. Figure 8. *S. signata* (Dallas).

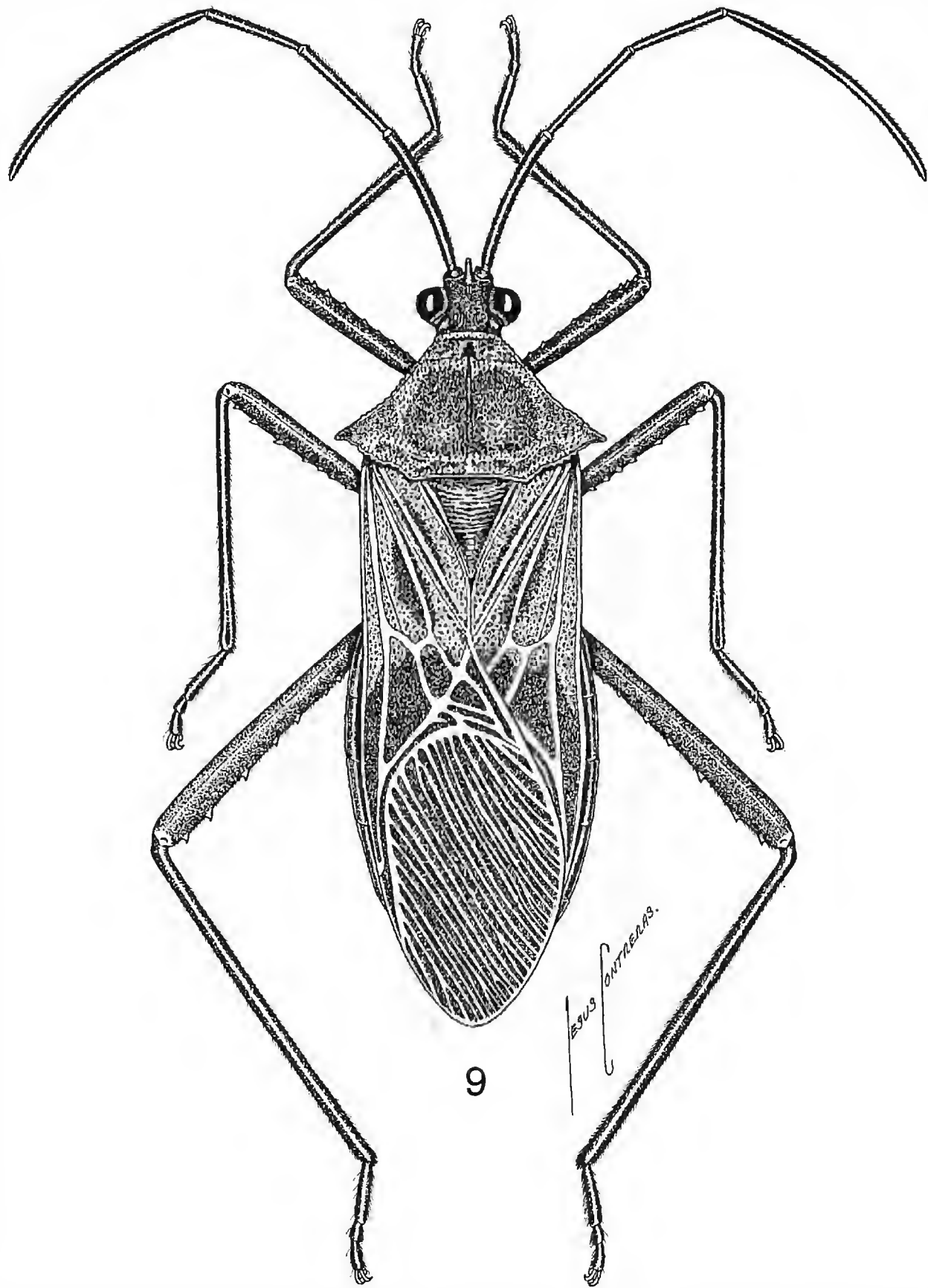


Figure 9. Dorsal view of *Salapia caucalandia* Brailovsky and Barrera, NEW SPECIES.

ZIL. Rondonia "Austin Trail" (linea C-13) off B-65, 2 km. N. Caucalandia, 21–23 March 1991, Kondratieff and Welch. Deposited in the "Colección Entomológica del Instituto de Biología, UNAM, México."

Description.—*Female (holotype). Dorsal coloration.* Head including antennal segments I to IV black; pronotum yellow with black discoidal spot on middle third; calli yellow with narrow black longitudinal stripe running on middle third; scutellum black with apex yellow; clavus and corium yellow with claval vein, apical margin of corium, and elongate stripe on endocorium black; hemelytral membrane black; connexival segments with upper margin orange, and inner margin black; abdominal

segments black. *Ventral coloration.* Head dull dark hazel with dirty yellow stripe contiguous to inner face of eye; buccula and rostral segments I to IV shiny black to reddish brown; thorax and legs dull dark hazel, tinged with orange, and following areas shiny reddish brown: acetabulae, anterior and posterior margin of propleura, and posterior margin of mesopleura and metapleura; anterior and posterior lobe of metathoracic peritreme black; abdominal sterna bright reddish brown with hazel reflections; pleural margin of abdominal sterna III to VIII and external face of gonocoxae I bright to dull orange. *Structure.* Head: Rostrum reaching anterior third of metasternum. Pronotum: Humeral angles expanded, apically acute; posterolateral margin denticulate; triangular process shorter (Fig. 1). *Measurements:* Head length including the tylus: 1.45 mm; width across eyes: 2.53 mm; interocular space: 1.00 mm; interocellar space: 0.42 mm; preocular distance: 0.88 mm; length of antennal segments: I, 3.64 mm; II, 3.00 mm; III, 2.44 mm; IV, 6.68 mm. Pronotal length: 4.10 mm; width across frontal angles: 1.80 mm; width across humeral angles: 6.60 mm. Scutellar length: 2.44 mm; width: 2.24 mm. Total body length: 19.10 mm.

Discussion.—Like *S. nigra* Brailovsky with antennal segments II and III, scutellum, buccula, and abdominal sterna (except pleural margins III to VII orange) black to reddish brown. *Salapia caucalandia*, can be easily distinguished by the antennal segment IV, and abdominal segments III to V entirely black, and the pronotum yellow with discoidal black spot near middle third. On *S. nigra* the antennal segment IV is black with discoidal ring yellow, the abdominal segments III to V orange, and the pronotum mostly black.

Distribution.—Only known from Brazil.

Etymology.—Named for its occurrence near Caucalandia.

SALAPIA DECKERTI BRAILOVSKY AND BARRERA, NEW SPECIES
(Figs. 2, 10)

Types.—Holotype: female; data: ECUADOR. Camelus, F. V. Feyer. Deposited in the Museum der Humboldt Universitat zu Berlin. Paratype: 1 female: same data as holotype. Deposited in the "Colección Entomológica del Instituto de Biología, UNAM, México."

Description.—*Female (holotype).* *Dorsal coloration:* Head, pronotum, and scutellum orange; antennal segment I reddish brown with inner face ochraceous to orange or entirely dirty orange; antennal segments II and III reddish brown and IV yellow with basal and apical third reddish brown; clavus orange to yellow with broad longitudinal stripe black; corium orange to yellow with 5 black maculae between veins; hemelytral membrane dark ambarine with basal angle, and inner veins darker; connexival segments III to VI reddish with upper border, posterior joint, and inner margin pale orange; connexival segments VII to IX, and dorsal abdominal segments II to IX pale orange. *Ventral coloration:* Head, buccula, thorax, coxae, trochanters, femora, and abdomen pale orange yellow; rostral segments reddish brown with apical third of segments I to III yellow; tibiae reddish brown with basal joint orange yellow; tarsi reddish brown; anterior and posterior lobe of metathoracic peritreme black. *Structure.* Head: Rostrum reaching anterior border of metasternum. Pronotum: Humeral angles expanded, apically acute; posterolateral margin denticulate; triangular process shorter (Fig. 2). *Measurements.* Head length including the tylus: 1.43 mm; width across eyes: 2.60 mm; interocular space: 1.04 mm; interocellar space: 0.44 mm; preocular distance: 0.90 mm; length of antennal segments: I, 4.08 mm; II, 3.16 mm; III, 2.48 mm; IV, 6.80 mm. Pronotal length: 3.96 mm; width across frontal angles: 1.68 mm; width across humeral angles: 6.80 mm. Scutellar length: 2.52 mm; width: 2.32 mm. Total body length: 18.80 mm.

Discussion.—Close to *S. luteola* Brailovsky with antennal segments II and III black to reddish brown, and pronotum and scutellum entirely yellow to orange. In *S. deckerti*, the clavus is black with margin yellow to orange, the corium is yellow to orange with 5 black maculae between veins, and ventrally entirely

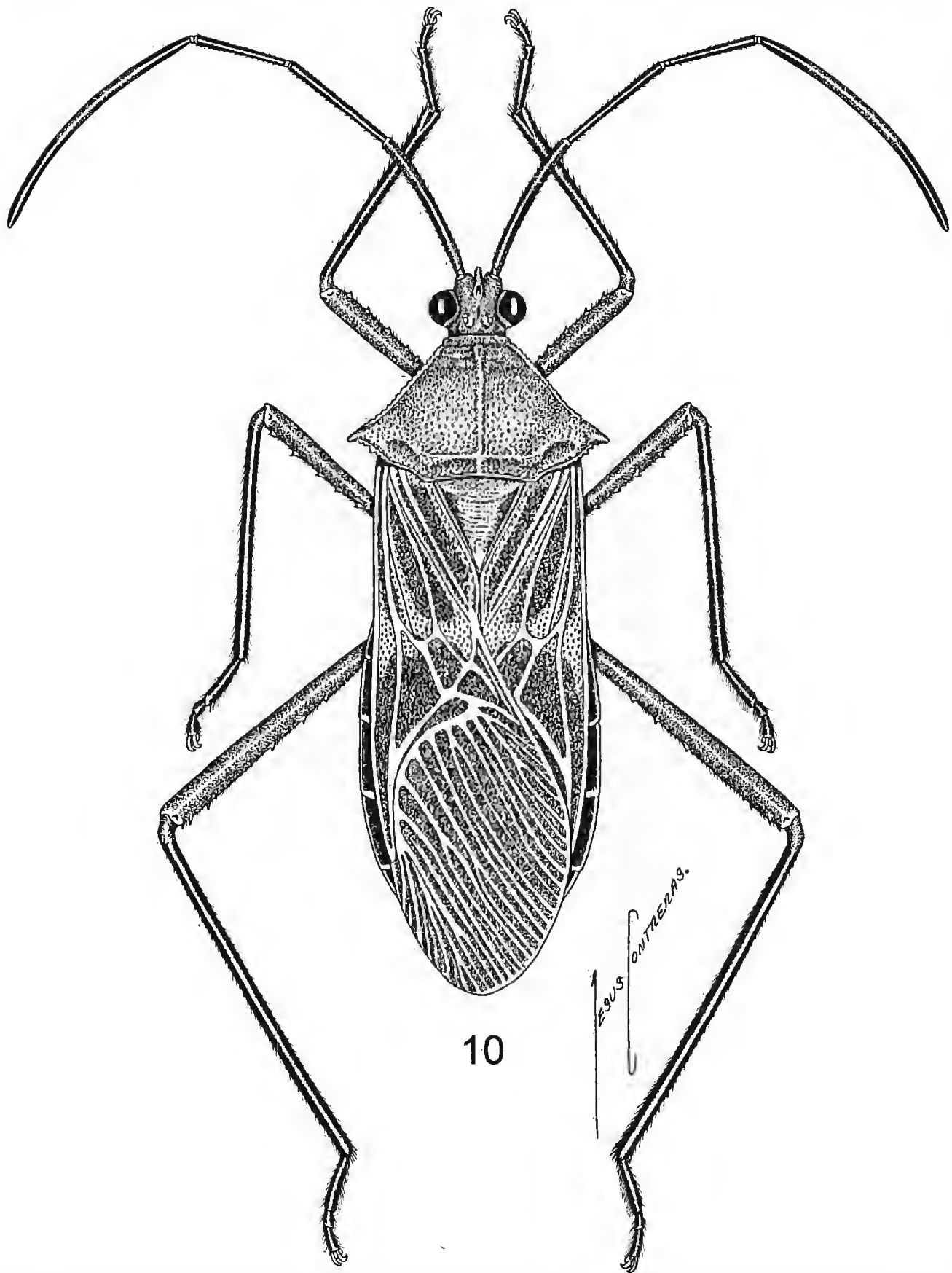


Figure 10. Dorsal view of *Salapia deckerti* Brailovsky and Barrera, NEW SPECIES.

yellow to orange. In *S. luteola* the clavus, corium, and ventral region are black to reddish brown, except the orange pleural margin of abdominal sterna III to VI.

Salapia pretiosa Blote also has the antennal segments II and III black to reddish brown, and the scutellum mostly yellow to orange (apical third black), but the clavus is entirely black, the corium black with transverse and straight orange to yellow stripe, and antennal segment IV black to reddish brown and not bicolorous like in *S. deckerti*.

Distribution.—Only known from Ecuador.

Etymology.—Named for Dr. Jurgen Deckert, distinguished German hemipterist.

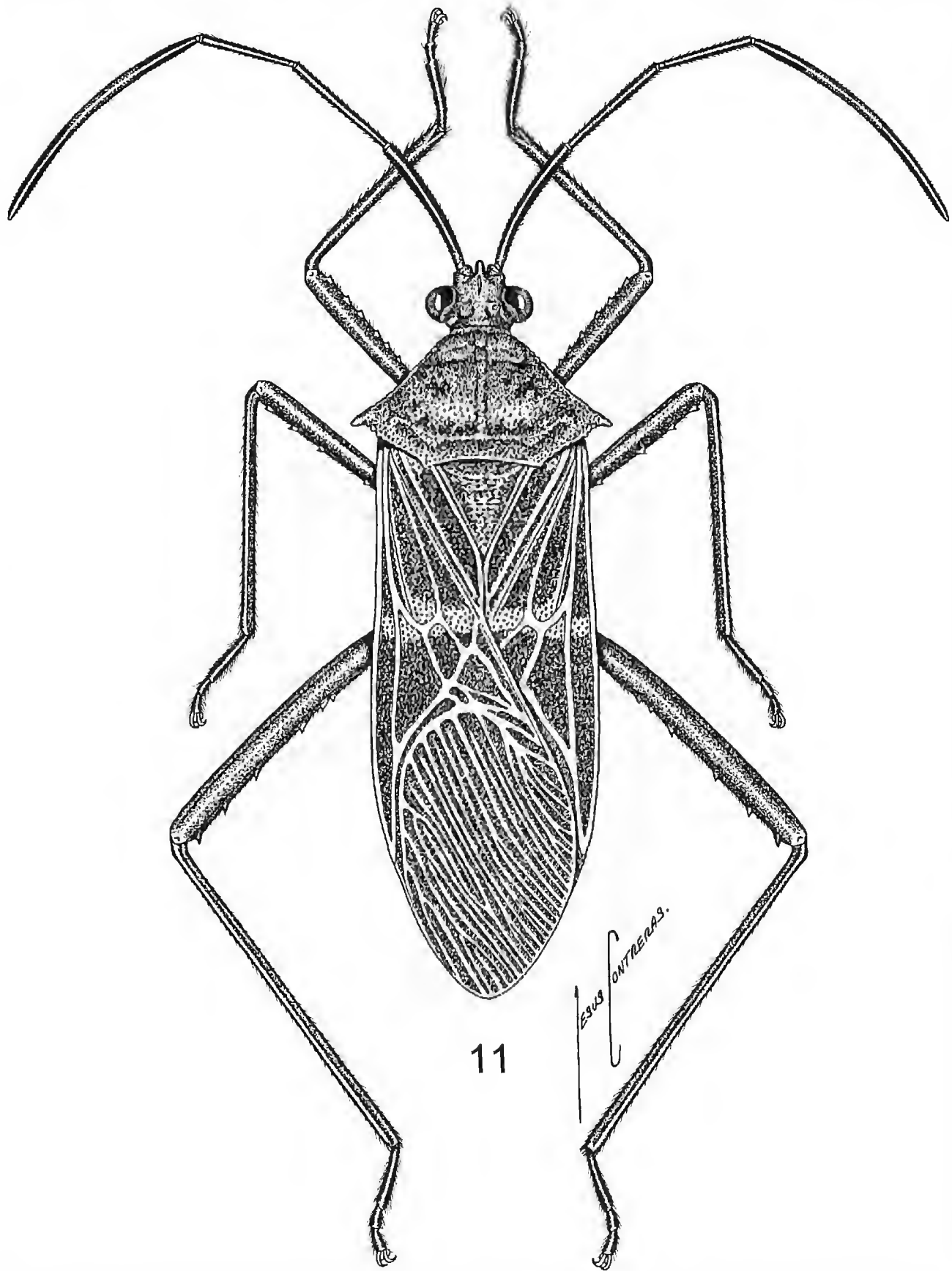


Figure 11. Dorsal view of *Salapia vanduzeei* Brailovsky and Barrera, NEW SPECIES.

SALAPIA VANDUZEEI BRAILOVSKY AND BARRERA, NEW SPECIES
(Figs. 3, 11)

Type.—Holotype: female; data: PERU. Putumayo District, El Encanto, 25 August 1920, Cornell Univ. Expedition, lot 569. Deposited in Cornell University, Insect Collection, Ithaca, New York.

Description.—*Female (holotype)*. *Dorsal coloration*: Head, pronotum, scutellum, connexival segments and abdominal segments orange; antennal segment I reddish brown with inner face dirty orange; segments II and III reddish brown and IV yellow with basal and apical third reddish brown; tylus reddish brown

with orange reflections; clavus black with basal angle orange; corium black with yellow irregular fascia; hemelytral membrane smoky black, with basal angle darker. *Ventral coloration*: Head, buccula, thorax, coxae, and abdominal sterna orange; rostral segments I to IV, trochanters, femora, tibiae, and tarsi reddish brown; anterior and posterior lobe of metathoracic peritreme black. *Structure*. Head: Rostrum reaching anterior border of metasternum. Pronotum: Humeral angles expanded, apically acute; posterolateral margin denticulate; triangular process shorter (Fig. 3). *Measurements*. Head length including the tylus: 1.45 mm; width across eyes: 2.60 mm; interocular space: 1.00 mm; interocellar space: 0.41 mm; preocular distance: 0.90 mm; length of antennal segments: I, 3.88 mm; II, 3.04 mm; III, 2.44 mm; IV, 6.92 mm. Pronotal length: 3.76 mm; width across frontal angles: 1.66 mm; width across humeral angles: 6.48 mm. Scutellar length: 2.44 mm; width: 2.36 mm. Total body length: 18.50 mm.

Discussion.—Related with *S. luteola* Brailovsky, in having antennal segments II and III and legs reddish brown to black, and pronotum and scutellum orange. *Salapia vanduzeei*, has the head, thorax, coxae and abdomen orange, in *S. luteola* these structures are reddish brown to black, except the connexival segments and pleural abdominal sterna are orange to yellow.

Distribution.—Only known from Peru.

Etymology.—Named for the late Dr. Edward P. Van Duzee, in recognition of his many fundamental contributions to hemipteran systematics.

SALAPIA EGERI BRAILOVSKY AND BARRERA, NEW SPECIES

(Figs. 4, 12)

Type.—Holotype: female; data: PERU. Sicuani. Deposited in the "Colección Entomológica del Instituto de Biología, UNAM, México."

Description.—*Female (holotype)*. *Dorsal coloration*: Head pale orange yellow; antennal segments I to III yellow with apical joint reddish brown; segment IV yellow with apical third reddish brown; pronotum pale orange yellow with elongate macula orange brown near to middle third; scutellum orange brown with basal discoidal spot, lateral margins, and apex yellow; clavus pale orange yellow with inner border reddish brown; corium pale orange yellow with 3 reddish brown maculae between veins; hemelytral membrane dark ambarine with basal angle darker; connexival segments III to VI orange brown and VII pale orange; abdominal segments black with creamy yellow longitudinal stripe running from II to posterior margin of segment VII. *Ventral coloration*: Head, buccula, rostral segments I to IV (apex of IV reddish brown), and legs (spines black to reddish brown) pale yellow to orange; thorax pale orange yellow with following areas orange brown: rectangular spot on propleura; outer margin of mesopleura, and posterior margin of metapleura; anterior and posterior lobe of metathoracic peritreme black; abdominal sterna shiny orange hazel, with creamy yellow discoidal spot lateral to middle line on sterna III to VI. *Structure*. Head: Rostrum reaching posterior border of mesosternum. Pronotum: Humeral angles expanded, broad, apically with short and broad, spine posterolateral margin denticulate; triangular process broad, well developed (Fig. 4). *Measurements*. Head length including the tylus: 2.00 mm; width across eyes: 2.52 mm; interocular space: 0.92 mm; interocellar space: 0.50 mm; preocular distance: 1.00 mm; length of antennal segments: I, 3.60 mm; II, 2.76 mm; III, 2.20 mm; IV, 6.28 mm. Pronotal length: 3.72 mm; width across frontal angles: 2.20 mm; width across humeral angles: 6.84 mm. Scutellar length: 2.28 mm; width: 2.20 mm. Total body length: 18.62 mm.

Discussion.—This species is similar in color and general appearance to *S. signata* (Dallas) in having the head orange yellow and antennal segments I to III yellow to orange with apical joint reddish brown to black. In *S. egeri*, the acetabulae are entirely orange, the pronotal disc, and scutellum without creamy yellow longitudinal stripe, the corium without transverse yellow fascia and humeral angles are broadened, and apically have a short broad spine (Fig. 4). In *S. signata* the acetabulae are creamy yellow, and contrast with the orange surface, the pron-

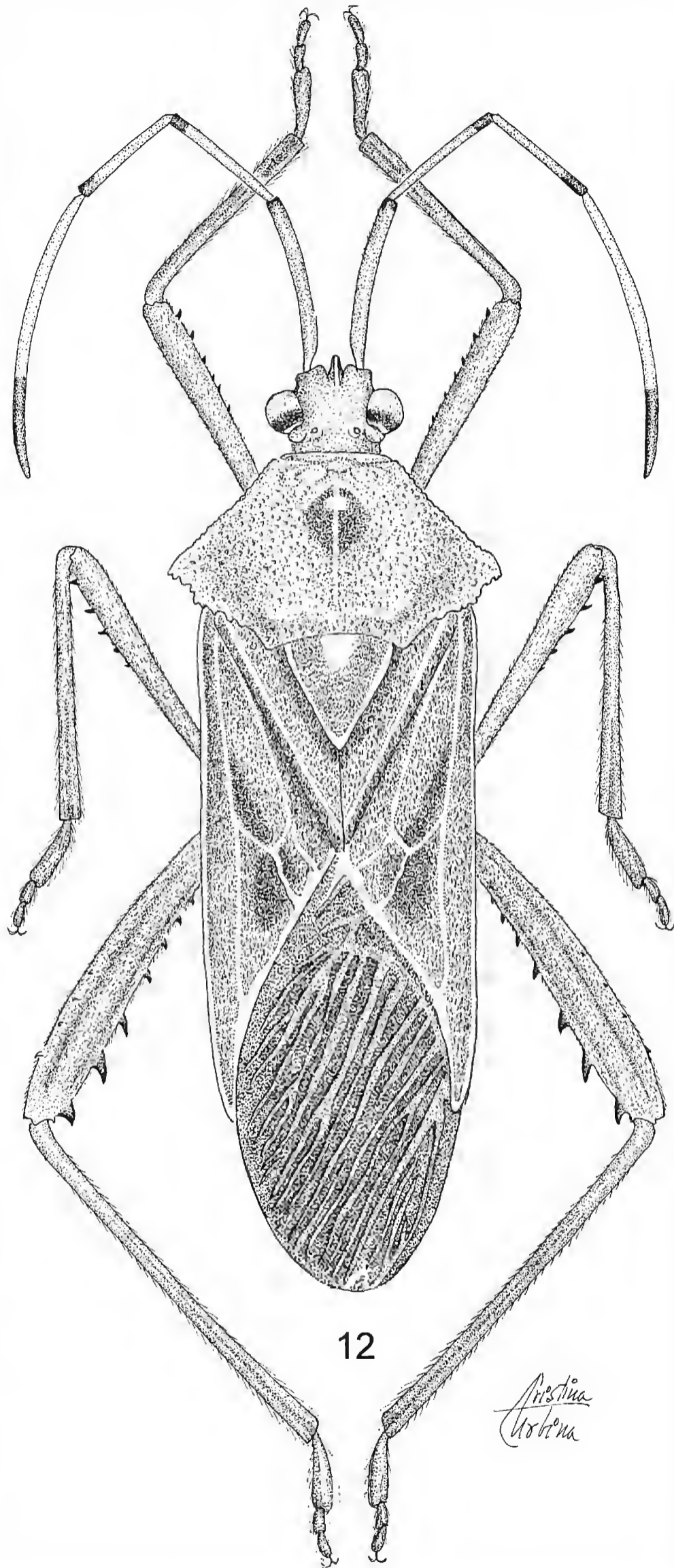


Figure 12. Dorsal view of *Salapia egeri* Brailovsky and Barrera, NEW SPECIES.

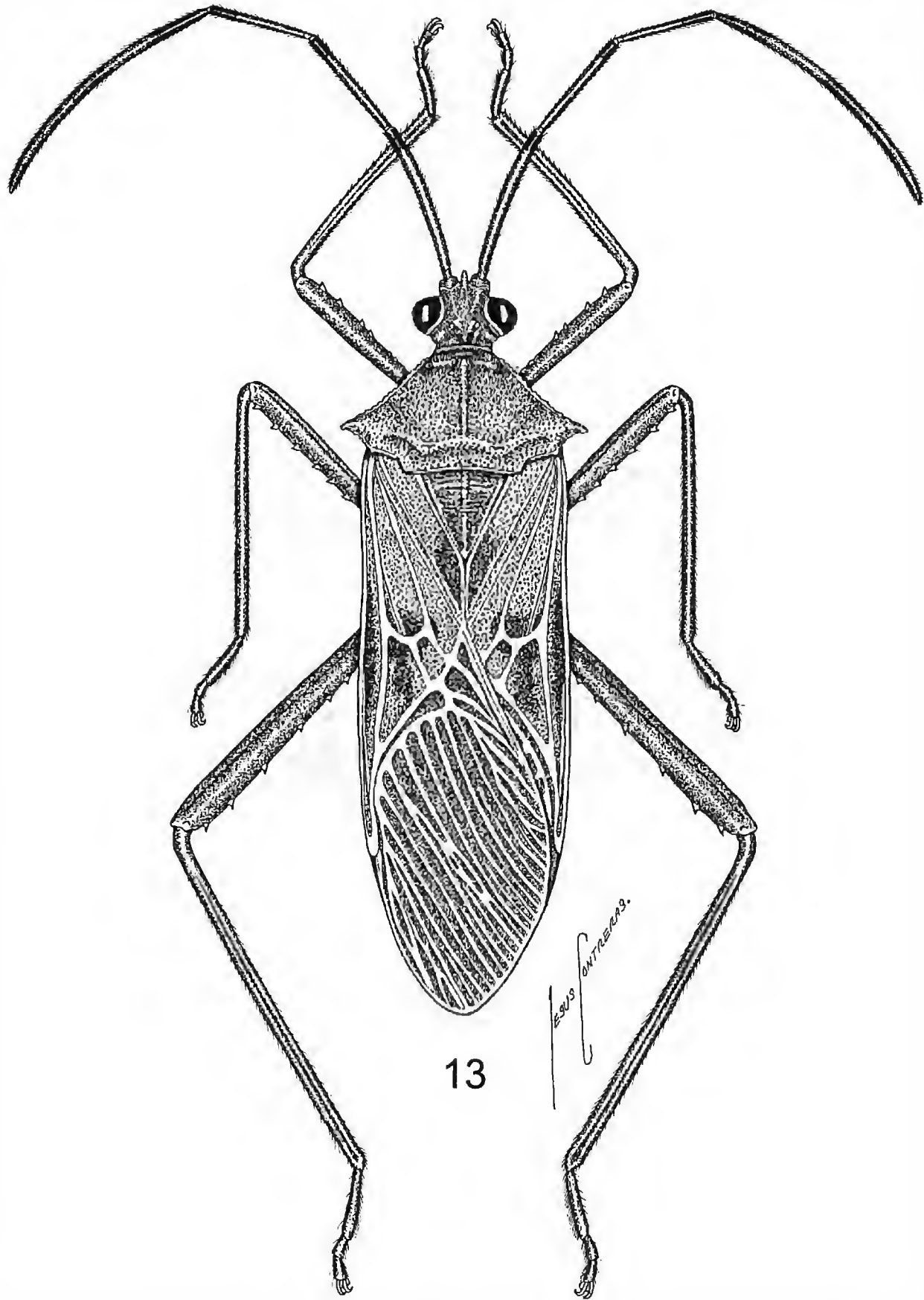


Figure 13. Dorsal view of *Salapia kondratieffi* Brailovsky and Barrera, NEW SPECIES.

otal disc, scutellum and corium with creamy yellow marks and humeral angles are narrowed, exposed, and apically with long, acute spine (Fig. 8).

Distribution.—Only known from Peru.

Etymology.—Named for Dr. J. E. Eger, distinguished American hemipterist.

SALAPIA KONDRATIEFFI BRAILOVSKY AND BARRERA, NEW SPECIES
(Figs. 6, 13)

Types.—Holotype: female; data: BRAZIL. Rondonia, 62 km. SW, Ariquemes, nr. Fazenda Rancho Grande, 6–15 December 1990, D. A. Rider and J. E. Eger.

Deposited in the "Colección Entomológica del Instituto de Biología, UNAM, México". Paratype: 1 female; data: BRAZIL. Rondonia, Linea C-2.5, off B-65, 12.5 km. S. Caucalandia, 17 March 1991, Kondratieff and Welch. Deposited in Colorado State University, Fort Collins, Colorado.

Description.—*Female (holotype).* *Dorsal coloration:* Head dark orange hazel; antennal segments I to III yellow orange with apical joint reddish brown; segment IV reddish brown with pale yellow ring near middle third; pronotum dark orange hazel with narrow longitudinal stripe pale yellow orange; scutellum reddish brown with narrow longitudinal stripe pale yellow orange; clavus dark orange with apical third black; corium dark orange with 5 to 6 black maculae between apical veins; hemelytral membrane yellow ambarine with basal angle and space between veins brown; connexival segments reddish brown with upper margin orange; abdominal segments orange. *Ventral coloration:* Head including buccula dirty yellow with middle third pale brown; rostral segments I and II dirty orange hazel with apical joint darker; segments III and IV reddish brown; thorax dark orange hazel with posterior margin of metapleura reddish brown; coxae and trochanters ochraceous to orange hazel with outer margin reddish brown; femora dark orange hazel; tibiae and tarsi pale orange yellow; anterior and posterior lobe of metathoracic peritreme black; abdominal sterna dark orange hazel. *Structure.* Head: Rostrum reaching anterior border of metasternum. Pronotum: Humeral angles expanded, apically acute; posterolateral margin denticulate; triangular process shorter (Fig. 6). *Measurements.* Head length including the tylus: 1.45 mm; width across eyes: 2.50 mm; interocular space: 0.98 mm; interocellar space: 0.44 mm; preocular distance: 0.88 mm; length of antennal segments: I, 3.68 mm; II, 2.96 mm; III, 2.44 mm; IV, 6.52 mm. Pronotal length: 3.60 mm; width across frontal angles: 1.68 mm; width across humeral angles: 6.00 mm. Scutellar length: 2.20 mm; width: 1.92 mm. Total body length: 17.70 mm.

Discussion.—Like *S. egeri* with antennal segments I to III yellow or orange and apically black to reddish brown, the pronotal disc, corium, and acetabulae without creamy yellow marks, and tibiae and tarsi pale yellow. *Salapia kondratieffi*, differs in having the abdominal sterna III to VI without pale yellow discoidal spots, humeral angles narrow with an acute longer spine (Fig. 6) and antennal segment IV black to reddish brown with yellow ring near middle third. In *S. egeri* the abdominal sterna III to VI have pale yellowish spots, the humeral angles are broadened with a short, broad apical spine (Fig. 4), and antennal segment IV is yellow with apical third black to reddish brown.

Distribution.—Known only from Brazil.

Etymology.—Named for Dr. Boris C. Kondratieff, distinguished American Plecopterist.

SALAPIA ONOREI BRAILOVSKY AND BARRERA, NEW SPECIES

(Figs. 7, 14)

Type.—Holotype: female; data: Ecuador. Sucumbios, San Pablo, Rio Aguarico, October 1995, F. Nischk. Deposited in the "Departamento de Entomología, Pontificia Universidad Católica del Ecuador."

Description.—*Female (holotype).* *Dorsal coloration:* Head and corium dark orange hazel; antennal segment I dark orange hazel, II and III yellow orange, and IV pale yellow; pronotum dark orange hazel with humeral angles reddish brown, and a black triangular spot on middle third with the base behind calli, and the apex close to posterior border; scutellum black to reddish brown; clavus dark orange hazel with claval commissure brown; hemelytral membrane ambarine, with basal angle and each margin dark brown; connexival segments dark orange hazel with anterior and posterior joint black; dorsal abdominal segments black with lateral margins and a longitudinal stripe running from II to VI segment yellow. *Ventral coloration:* Head pale orange hazel with middle third brown; rostral segment I, and basal third of II pale orange hazel, middle and posterior third of segment II and basal half of III reddish brown, and apical half of III and IV dark orange hazel; buccula pale orange hazel; thorax pale orange yellow with following areas reddish brown: acetabulae (outer edge pale orange

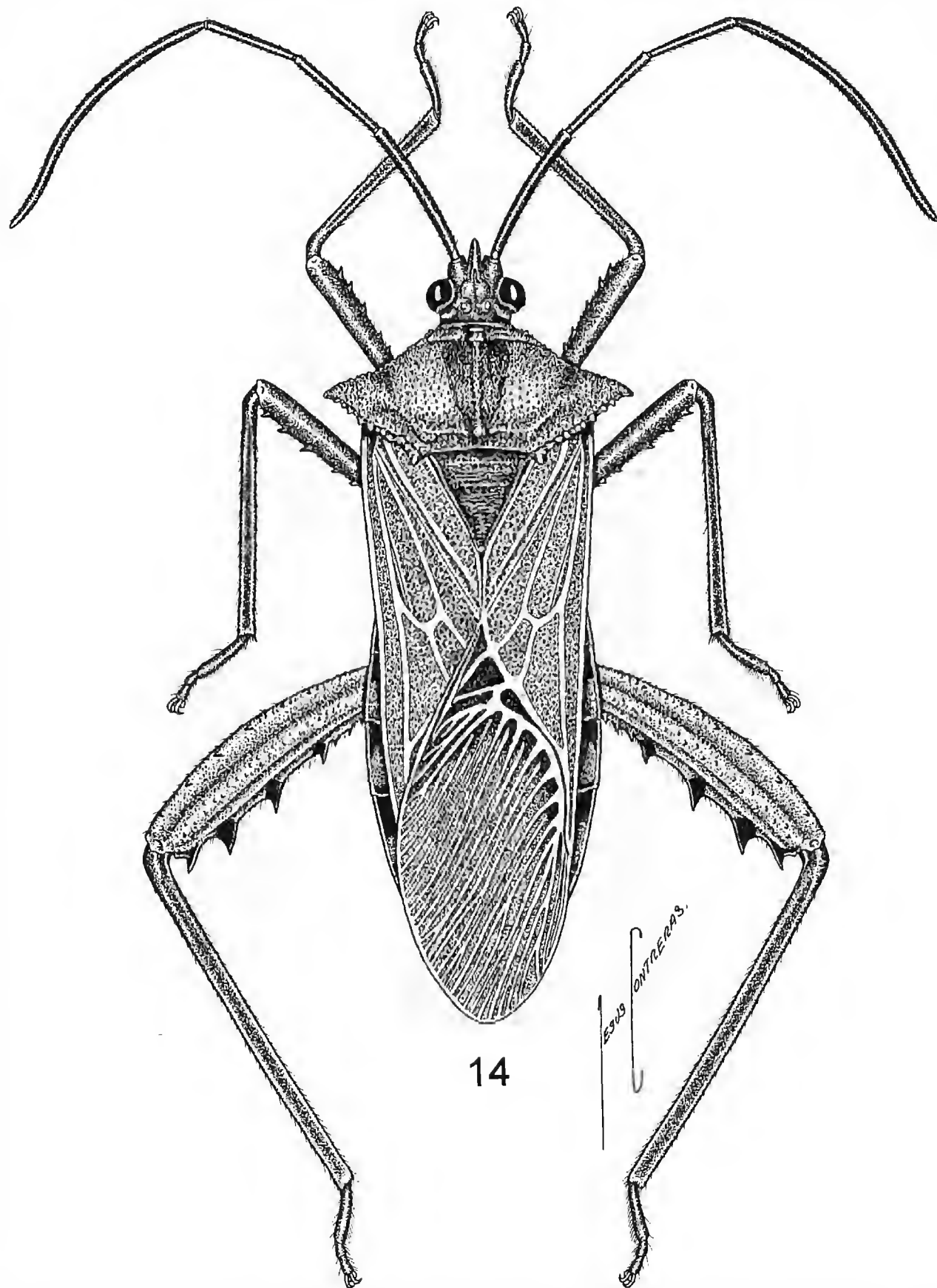


Figure 14. Dorsal view of *Salapia onorei* Brailovsky and Barrera, NEW SPECIES.

yellow), posterior and outer margin of propleura, mesopleura and metapleura, and prosternum, mesosternum, and metasternum; anterior and posterior lobe of metathoracic peritreme black; coxae dark orange hazel; trochanters, femora, tibiae, and tarsi pale yellow with femoral spines black (hind femora pale orange yellow); abdominal sterna dark orange hazel with posterior margin of sterna III to VII, anterior and posterior joint of pleural sterna III to VII, gonocoxae I (except external angle), and outer margin of paratergite VIII and IX black. *Structure*. Head: Rostrum reaching posterior border of mesosternum. Pronotum: Humeral angles markedly expanded, with the spine large and robust; posterolateral margin conspicuously denticulate; triangular process robust, well developed (Fig. 7). *Measurements*. Head length including the tylus: 2.12 mm; width across eyes: 2.64 mm; interocular space: 1.18 mm; interocellar space: 0.53 mm; preocular distance: 1.28 mm; length of antennal segments: I, 3.88

mm; II, 3.00 mm; III, 2.41 mm; IV, 7.64 mm. Pronotal length: 5.07 mm; width across frontal angles: 1.88 mm; width across humeral angles: 8.04 mm. Scutellar length: 2.60 mm; width: 2.54 mm. Total body length: 19.82 mm.

Discussion.—This new species superficially resembles *S. signata* (Dallas) in size and shape. *S. onorei* is, however, readily distinguishable by the humeral angles markedly expanded, posterolateral margins conspicuously denticulate, with triangular process well developed (Fig. 7), pronotal disc and scutellum without creamy yellow longitudinal stripe, and corium without transverse creamy yellow vitta, all of them present in *S. signata*.

Like *S. humeralis* (Burmeister), the antennal segments II and III are entirely yellow to orange. In *S. humeralis* the humeral angles are scarcely expanded, the spine shorter and the triangular process quite small (Fig. 5), the pronotal disc is shiny orange with humeral angles pale yellow, and the acetabulae and posterior margin of propleura, mesopleura, and metapleura creamy yellow. *S. onorei* differ in the shape of the humeral angles, the length of the triangular process (Fig. 7), and on the general coloration.

In *S. egeri*, the triangular process of the pronotum are broad, and markedly exposed, both the antennal segments II and III are yellow with apical third black, and the humeral angles are broadened, with the spine shorter and robust (Fig. 4).

Distribution.—Known only from Ecuador.

Etymology.—Named for Dr. Giovanni Onore, distinguished Ecuadorian entomologist.

SALAPIA HUMERALIS (BURMEISTER)
(Figs. 5, 15)

Paryphes humeralis Burmeister 1835: 336.

Salapia humeralis, Stål 1868: 50.

Types.—Lectotype (here designated): female; data: BRAZIL, Bahia, Gomez nr 1157. Deposited in Museum der Humboldt Universitat zu Berlin, Germany. Paratype: 1 female; data: same data as lectotype. Deposited in Museum der Humboldt Universitat zu Berlin, Germany.

Redescription.—*Female (lectotype).* *Dorsal coloration:* Head shiny orange hazel with tylus and antenniferous tubercles yellow; antennal segment I reddish orange with apical joint yellow; segments II and III yellow; segment IV mutilated; pronotum reddish orange with calli orange hazel, and humeral angles yellow; scutellum reddish orange with apex yellow; corium and clavus yellow; hemelytral membrane dark ambarine, with basal angle, veins, and external edge darker; connexival segments III to VI with upper margin yellow and inner margin reddish orange hazel, and segments VII to IX orange hazel; dorsal abdominal segments orange hazel with black longitudinal and irregular stripe running from segment II to VI. *Ventral coloration.* Head including the buccula and rostral segments I to IV shiny orange hazel; thorax shiny orange hazel with acetabulae, posterior margin of propleura, and small spot on posterior margin of mesopleura creamy yellow, with following areas shiny reddish brown: middle third of propleura, anterior angle of acetabulae, and great portion of mesopleura and metapleura; coxae shiny orange hazel with external face reddish brown; trochanters with outer face reddish brown, and inner face shiny orange hazel; femora reddish brown; tibiae with two reddish brown stripes and two yellow stripes; tarsi yellow; abdominal sterna shiny orange hazel with pleural margins III to VII, and a broad rectangular spot on posterior margin of each sterna and lateral to middle line orange; genital plates shiny orange hazel. *Structure.* Head: Rostrum reaching posterior border of mesosternum. Pronotum: Humeral angles slightly expanded, apically with short and robust spine; posterolateral margin scarcely denticulate; triangular process conspicuously reduced (Fig. 5). *Measurements.* Head length including the tylus: 2.00 mm; width across eyes: 2.80 mm; interocular

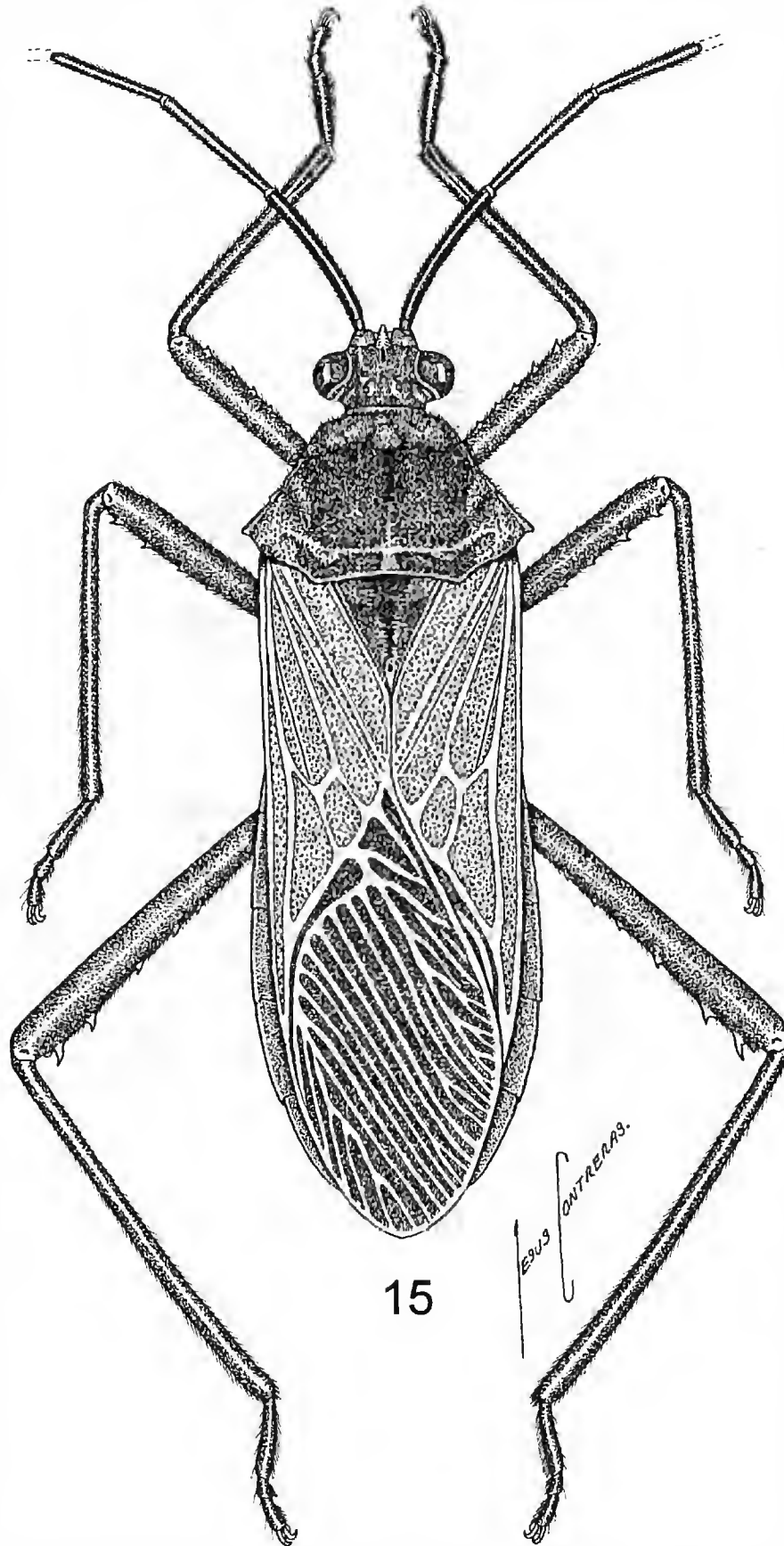


Figure 15. Dorsal view of *Salapia humeralis* (Burmeister).

space: 1.20 mm; interocellar space: 0.54 mm; preocular distance: 0.92 mm; length of antennal segments: I, 3.32 mm; II, 2.64 mm; III, 2.24 mm; IV, mutilated. Pronotal length: 3.36 mm; width across frontal angles: 1.80 mm; width across humeral angles: 5.60 mm. Scutellar length: 2.20 mm; width: 2.08 mm. Total body length: 17.96 mm.

Discussion.—*Paryphes humeralis* Burmeister (1835) is known only from the female lectotype and female paralectotype, here designated, which bears the labels “Brazil, Bahia, Gomez, nr. 1157” and deposited in the Museum der Humboldt Universitat zu Berlin, Germany. It was referred to the genus *Salapia* by Stål (1868).

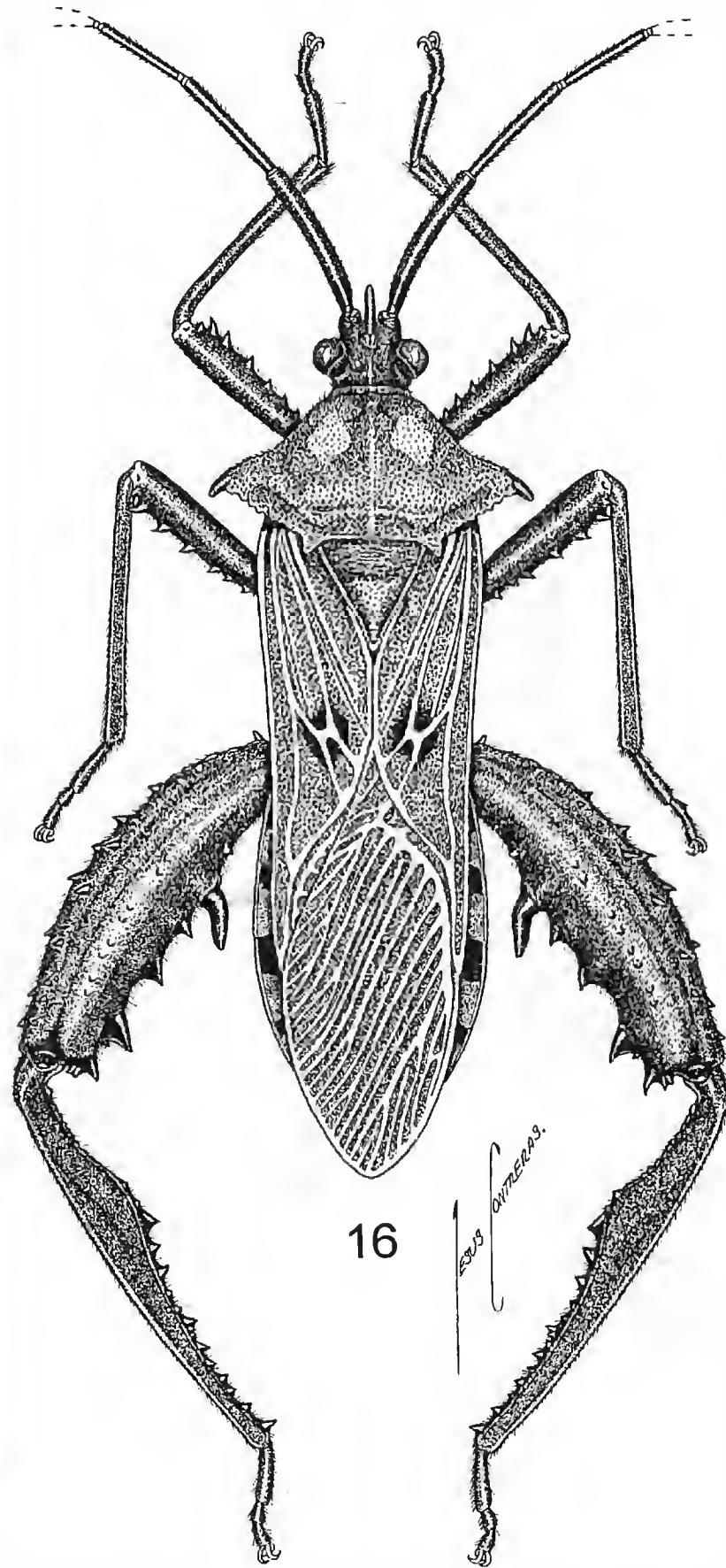


Figure 16. Dorsal view of *Stenometapodus guttifer* (Stål).

This species is distinguished from the other species of the genus by the following characters: antennal segments II and III plus clavus and corium entirely yellow; pronotal disc reddish orange with calli orange hazel and humeral angles yellow; abdominal sterna with broad rectangular spot orange yellow occupying the posterior margin of sterna III to VII and lateral to middle line; width across eyes conspicuously developed, longer than 2.70 mm; humeral angles of pronotum slightly expanded, and apically with short and robust spine (Fig. 5).

Distribution.—Only known from Brazil.

STENOMETAPODUS GUTTIFER (STÅL), NEW COMBINATION
(Fig. 16)

Petalops guttifer Stål 1859: 456–457.

Salapia guttifera, Stål 1868: 50.

Petalops guttifer Stål (1859) is known only from the male lectotype, here designated, which bears the labels "Brazil, Rio Janeiro, Berol, nr. 1476" and deposited in Museum der Humboldt Universität zu Berlin, Germany. It was referred to the genus *Salapia* by Stål (1868), and here transferred to the genus *Stenometa-podus* Breddin (1903) with the binomius *Stenometa-podus guttifer*, NEW COMBINATION.

This species clearly belongs in the widespread South American genus *Stenometa-podus* (Brailovsky 1984) by the following characters: hind tibiae expanded, and longer than abdomen, posterior angles of pronotum acute, scutellum usually with erect setae, and posterior angle of connexival segments V and VI spined. In *Salapia* the hind tibiae are simple and cylindrical, and never expanded.

KEY TO *SALAPIA* SPECIES

- | | |
|--|--|
| 1. Antennal segments II and III yellow to orange, with or without apical third black | 2 |
| 1'. Antennal segments II and III black to reddish brown | 6 |
| 2. Antennal segments II and III yellow to orange, with apical third black | 3 |
| 2'. Antennal segments II and III entirely yellow to orange | 5 |
| 3. Pronotal disc and scutellum pale orange hazel with wide longitudinal vitta creamy yellow; acetabulae pale creamy yellow | <i>S. signata</i> (Dallas) |
| 3'. Pronotal disc and scutellum pale or dark orange hazel without creamy yellow longitudinal vitta; acetabulae orange hazel, and unicolorous with thorax | 4 |
| 4. Abdominal sterna III to VI with large pale yellow discoidal spot, laterally to midline; humeral angles broad, with short, robust spine (Fig. 4); triangular process broad, well developed (Fig. 4) | <i>S. egeri</i> Brailovsky and Barrera, NEW SPECIES |
| 4'. Abdominal sterna III to VI without pale yellow discoidal spot; humeral angles narrowed, with acute, longer spine (Fig. 6); triangular process smaller, scarcely developed (Fig. 6) | <i>S. kondratieffi</i> Brailovsky and Barrera, NEW SPECIES |
| 5. Humeral angles markedly expanded, with the spine longer and acute (Fig. 7); triangular process of pronotum conspicuously developed (Fig. 7); acetabulae reddish brown; posterior margin of propleura, mesopleura and metapleura reddish brown | <i>S. onorei</i> Brailovsky and Barrera, NEW SPECIES |
| 5'. Humeral angles scarcely expanded, with the spine shorter (Fig. 5); triangular process of pronotum smaller (Fig. 5); acetabulae creamy yellow; posterior margin of propleura, mesopleura, and metapleura creamy yellow | <i>S. humeralis</i> (Burmeister) |
| 6. Scutellum yellow to orange, with or without apex black | 7 |
| 6'. Scutellum black to reddish brown | 10 |

7. Head and buccula black; thorax black to reddish brown 8
- 7'. Head and buccula yellow to orange; thorax pale orange 9
8. Femora black to reddish brown; pronotal disc entirely yellow
..... *S. luteola* Brailovsky
- 8'. Femora yellow to orange; pronotal disc not entirely yellow
..... *S. pretiosa* Blöte
9. Femora orange; clavus yellow to orange with broad longitudinal stripe
black; corium yellow to orange with five black maculae between veins
..... *S. deckerti* Brailovsky and Barrera, NEW SPECIES
- 9'. Femora reddish brown; clavus black with basal third orange; corium
black with yellow irregular transverse fascia
..... *S. vanduzeei* Brailovsky and Barrera, NEW SPECIES
10. Buccula black; thorax black to reddish brown 11
- 10'. Buccula yellow; thorax yellow to orange 15
11. Abdominal sterna black, with pleural margin yellow to orange 12
- 11'. Abdominal sterna yellow to orange 13
12. Antennal segment IV black; dorsal abdominal segments III to V black;
anterolateral margin and anterior lobe of pronotum yellow.
..... *S. caucalandia* Brailovsky and Barrera, NEW SPECIES
- 12'. Antennal segment IV yellow with basal and apical third reddish brown;
dorsal abdominal segments III to V orange; anterolateral margin and
anterior lobe of pronotum black *S. nigra* Brailovsky
13. Corium yellow to orange, with apical margin and elongate longitudinal
stripe on endocorium black *S. dimidiata* (Dallas)
- 13'. Corium black, with or without transverse vitta yellow to orange 14
14. Corium entirely black; antennal segment IV with small yellow ring ...
..... *S. abdominalis* (Dallas)
- 14'. Corium black with transversal vitta yellow to orange; antennal segment
IV with broad yellow ring. *S. baraquini* (Signoret)
15. Pleural margin of abdominal sterna IV to VII bicolorous; clavus black
to reddish brown with posterior third yellow; corium with yellow and
broad transverse vitta *S. selecta* Brailovsky
- 15'. Pleural margin of abdominal sterna IV to VII unicolorous; clavus black
or yellow, on the last condition with only the vein black; corium with
slender or without yellow transverse vitta 16
16. Clavus black or reddish brown; corium black, with ochre, slender and
irregular transversal vitta *S. haenschi* (Breddin)
- 16'. Clavus yellow with the vein black; corium yellow to orange with the
apical margin and elongate stripe on endocorium black
..... *S. pallida* Brailovsky

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**SUNLIGHT AVOIDANCE COMPARED BETWEEN
HESPEROPSIS GRACIELAE (MACNEILL) (LEPIDOPTERA:
HESPERIIDAE) AND *BREPHIDIUM EXILIS* (BOISDUVAL)
(LEPIDOPTERA: LYCAENIDAE)**

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Abstract.—Tolerance of solar radiation by the sympatric butterfly species, *Hesperopsis graciela* (MacNeill) and *Brephidium exilis* (Boisduval), was compared. Adults in varying air temperatures (30–40° C) were exposed to different intensities of direct sunlight (13.8–110 kilolux), and the elapsed response times were recorded when butterflies avoided continued exposure by flying to shade. Avoidance response times (transformed $\log [Y + 1]$) were shorter in *H. graciela* (re-transformed mean = 44 sec) than *B. exilis* (102 sec) across all air temperatures and light intensities. Air temperature (affecting the body-temperature increase needed to stimulate flight) and light intensity (affecting the rate of heating) independently influenced the species' tolerance of sunlight. Avoidance response times decreased linearly with increasing air temperature and hyperbolically with increasing light intensity. Rates of decrease did not differ between species. *Brephidium exilis*'s more prolonged exposure to sunlight contradicts its smaller size and larger ratio of body surface-area : volume (0.99) compared with *H. graciela* (0.78). *Hesperopsis graciela* appears physiologically less adapted than *B. exilis* to radiation exposure and more readily exploits shade from its hostplant to maintain a lower body temperature.

Key Words.—Insecta, Lepidoptera, comparative thermoregulation, HesperIIDae, *Hesperopsis graciela*, Lycaenidae, *Brephidium exilis*.

MacNeill's sootywing, *Hesperopsis graciela* (MacNeill), is a small (wing-spread \approx 23 mm) dark-brown butterfly (Lepidoptera: HesperIIDae) found along the lower Colorado River and near the river along its tributaries in southeastern California, western Arizona, southern Nevada, and southern Utah (Scott 1986). Two or three generations of *H. graciela* occur from April to October (Emmel & Emmel 1973, Austin & Austin 1980). Larvae of *H. graciela* feed only on *Atriplex lentiformis* (Torrey) (Chenopodiaceae), a shrub found in dense clumps along lower Colorado River drainages (Emmel & Emmel 1973). *Hesperopsis graciela* is more rare than the distribution of its hostplant (Austin & Austin 1980). In Nevada, the butterfly's rarity has afforded the species the conservation ranks of 'G?S1', signifying an unknown global (G) rarity and a state (S) rarity of critically imperiled (< 6 viable occurrences) (K. Goodwin, Nev. Nat. Heritage Program, Carson City, personal communication; also see Master 1991).

Hesperopsis graciela's distinctive, characteristic tendency of flying within riparian shrubs (MacNeill 1970) suggests the species may limit exposure to direct sunlight (solar radiation) to prevent overheating in the high insolation and summer air temperatures within its range (Wiesenborn 1998). The present study further tests this hypothesis by comparing *H. graciela*'s avoidance of sunlight with that of the pigmy blue, *Brephidium exilis* (Boisduval). *Brephidium exilis* (here ssp. *exilis*) is a smaller (wingspread \approx 16 mm) brown and white butterfly (Lepidoptera: Lycaenidae) sympatric with *H. graciela* (Scott 1986). Although *H. graciela* and *B. exilis* larvae both feed on *A. lentiformis* and are found along and near the lower

Colorado River, *B. exilis* is less specialized, occurring in other low-altitude, alkaline habitats and feeding on other Chenopodiaceae (Scott 1986).

MATERIALS AND METHODS

The study site was located on the eastern edge of the Muddy River floodplain at an elevation of 450 m near Bowman's Reservoir, Clark County, Nevada. Average daily maximum air temperatures at Logandale near the site during 1968–1992 in April, May, June, July, August, and September were 26.5, 31.8, 37.9, 40.7, 39.1, and 35.5° C, respectively (Nat. Oceanic & Atmospheric Admin., Western Regional Climate Center, Reno, Nevada). The site supported a narrow, linear band of *A. lentiformis* with a lesser amount of *Pluchea sericea* (Nuttall). Both *B. exilis* and *H. graciellae* were frequently observed flying among the *A. lentiformis* shrubs throughout the day.

The species' avoidance of direct sunlight was determined similar to the method used previously (Wiesenborn 1998). Insects were individually captured with an aerial net and placed into a shaded 31 cm × 31 cm × 31 cm aluminum-frame cage. The cage was covered on the bottom and on two sides with 13-mesh/cm plastic screen, on one side with aluminum, on the top with clear vinyl, and on one side with a cloth sleeve for inside access. The insect was allowed to acclimate for 5 min, and the cage was repositioned with its aluminum side shaded and direct sunlight transmitted through the top to illuminate one-half of the cage bottom. A 10-cm long *A. lentiformis* branch with 4–5 leaves was placed under the insect at the beginning of each observation. The insect was allowed to walk or fly onto the branch and placed in shade on the cage bottom for 1 min. Insects that flew from the branch before the 1-min shading period had elapsed were placed back onto the branch and the 1-min period repeated. The branch then was picked-up and the insect exposed to direct sunlight passing through 8-mesh/cm organdy cloth laid atop the cage. By using organdy cloth in layers (1, 2, 4, 8, or 16 layers), light intensity striking the insect was varied without altering the sunlight spectrum transmitted. Differences in basking posture required *B. exilis* to be exposed laterally and *H. graciellae* dorsally, and the former's walking required the branch to be continually moved to maintain a constant lateral exposure. The time was recorded when the exposure was begun and when the insect flew from the branch. Subtracting the former from the latter calculated the elapsed avoidance response time in seconds. Observations were stopped after 20 min if flight did not occur (2 of 70 observations, both of *B. exilis* shaded by the 16-layer treatment). Flights from the branch always were to shade.

Each trial consisted of each light-intensity treatment tested once in random order on an insect. Species were tested in random order with both species tested once on 22 April and twice on 23, 24, and 28 April 1998. Trials were performed under 0–5% cloud cover between 10:14 PDT and 15:35 PDT and lasted 15–68 min each. Relative humidity was 18–38% and wind speed 0–5 kmph. Light intensity (measured with a Sekonic L-398 light meter) inside the cage was 4.1–10 kilolux (klx) in shade and 103–120 klx in sunlight without shading by organdy cloth. Air temperature in shade and light intensity beneath the organdy cloth were measured inside the cage at the beginning of each observation.

Two *H. graciellae* and all seven *B. exilis* were collected after being tested. Thoracic and abdominal widths (at midpoints) and lengths were measured with

an ocular micrometer and used (assuming a cylindrical shape) to calculate thoracic and abdominal surface areas (excluding cylinder ends), volumes, and area : volume ratios. Ratios likely represent the effect of body size on heating rate, because surface area would affect the amount of radiation absorbed, and volume would affect the mass being heated. Collected specimens were verified as to species and deposited as vouchers (G. Austin, Nev. St. Mus., Las Vegas, personal communication).

Avoidance response times were transformed $\log(Y + 1)$ and analyzed by multiple regression with cage air temperature, light intensity, and species as independent variables (the latter as a categorical variable, Myers 1986). The regression was improved (r^2 maximized and residuals most-randomly scattered) by transforming light intensity $1/X$. Cage air temperature was not related ($F = 1.66$; $df = 1,68$; $P = 0.20$) to light intensity. The interactions species \times light intensity, species \times air temperature, and air temperature \times light intensity were individually added to the regression model and tested for significance ($P < 0.05$). For presentation, transformed avoidance response times were adjusted (Sokal & Rohlf 1981) for transformed light intensity, then retransformed and plotted on logarithmic scale against air temperature. Similarly, transformed avoidance response times were adjusted for air temperature, then retransformed and plotted on logarithmic scale against light intensity. Regression lines were fitted to transformed data for each species and plotted after retransformation.

RESULTS

Combined thoracic and abdominal surface areas were $22 \pm 2.5 \text{ mm}^2$ (mean \pm SD; $n = 7$) in *B. exilis* and $48 \pm 4.8 \text{ mm}^2$ ($n = 2$) in *H. graciellae*, and combined thoracic and abdominal volumes were $22 \pm 4.2 \text{ mm}^3$ in *B. exilis* and $61 \pm 7.2 \text{ mm}^3$ in *H. graciellae*. Area: volume ratios were 0.99 ± 0.096 in *B. exilis* and 0.78 ± 0.014 in *H. graciellae*, 1.3 times greater in *B. exilis* than in *H. graciellae*.

Avoidance response time was related to air temperature ($F = 34.4$; $df = 1,66$; $P < 0.001$), light intensity ($F = 99.2$; $df = 1,66$; $P < 0.001$), and species ($F = 30.0$; $df = 1,66$; $P < 0.001$). *Hesperopsis graciellae* sought shade earlier (retransformed mean = 44 sec) than *B. exilis* (retransformed mean = 102 sec), and both species sought shade earlier with increasing air temperature (Fig. 1A) and light intensity (Fig. 1B). After accounting for these variables, interactions were not evident between species and air temperature ($F = 0.327$; $df = 1,65$; $P = 0.57$) or species and light intensity ($F = 2.52$; $df = 1,65$; $P = 0.12$). The regression lines in each plot (Fig. 1) therefore do not statistically diverge from parallel; the two species did not differ in their rate of decrease in avoidance response time as air temperature or light intensity increased. Air temperature and light intensity also did not interact ($F = 0.26$; $df = 1,65$; $P = 0.61$), indicating independent effects on avoidance response time. Regression ($F = 46.3$; $df = 3,66$; $P < 0.001$; $r^2 = 0.68$) of avoidance response time on air temperature, light intensity, and species (*B. exilis* = 1, *H. graciellae* = 2) produced the following equation (coefficients \pm SEs):

$$\log(s + 1) = 4.9 \pm 0.5 - 0.086 \pm 0.015 (^\circ \text{C}) \\ + 29 \pm 3 (1/\text{klx}) - 0.44 \pm 0.08 (\text{species})$$

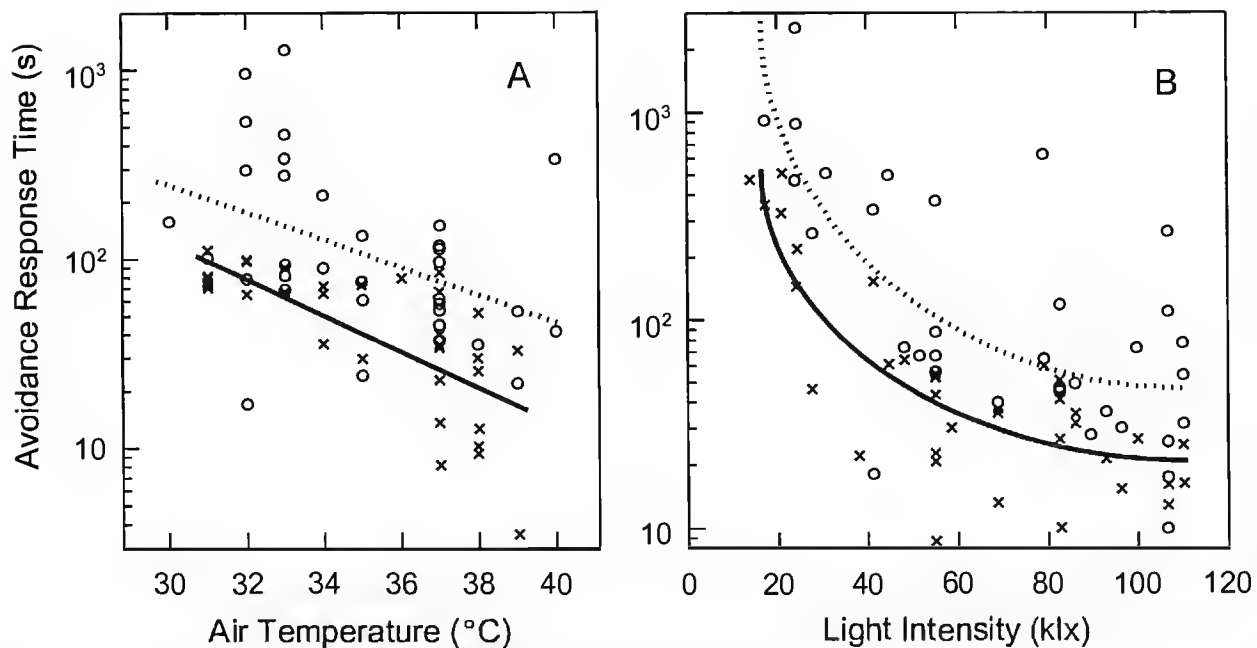


Figure 1. Avoidance of sunlight by *Brepidium exilis* (circles and broken lines) and *Hesperopsis graciellae* (X's and solid lines): avoidance response time in seconds elapsed (A) adjusted for light intensity (transformed $1/X$) and plotted against air temperature and (B) adjusted for air temperature and plotted against light intensity. Avoidance response times, plotted on logarithmic scales, were retransformed to original scale after adjusting transformed $\log(Y + 1)$.

DISCUSSION

Flight from sunlight to shade by *H. graciellae* and *B. exilis* likely was a behavioral response to prevent overheating (Wiesenborn 1998); continual exposure to sunlight elevated body temperatures until a threshold was reached stimulating flight to shade. Although body temperatures in butterflies increase as the time of exposure to sunlight increases, the rate of temperature increase diminishes as body temperatures asymptote near an upper limit (Heinrich 1972, 1986; Wasserthal 1975). The curvilinear, asymptotic relationship described in these studies suggests body temperature increases linearly with a proportional increase in exposure time, a function linearized by transforming exposure time $\log X$ (Sokal & Rohlf 1981). The $\log(Y + 1)$ transformation of avoidance response time (exposure time until flight to shade) in the present study therefore agrees with the diminishing rate of body temperature increase as previously determined.

The hyperbolic relationship between transformed avoidance response time and light intensity (Fig. 1B) likely resulted from the latter being a rate (quantity per time), equal to light energy per area illuminated per time. Rates frequently plot as hyperbolic curves that are straightened by reciprocal transformation (Sokal & Rohlf 1981).

The independent effects of air temperature and light intensity on avoidance response time indicate these variables acted on the butterflies by different mechanisms. Air temperature, approximating the initial body temperature prior to exposure to sunlight, contributed additively towards the body temperature increase required to reach the threshold to stimulate flight. Light intensity, approximating solar radiation, provided the sole energy influx driving body temperature upward. Within species, higher light intensity resulted in greater rate of energy absorbance and greater rate of temperature increase towards the flight threshold. Insect species with greater rates of radiation absorbance heat more quickly as radiation intensity increases (Digby 1955). *Hesperopsis graciellae* and *B. exilis* appear not to differ

in radiation absorbance, because their rates of decrease in avoidance response time did not differ with increasing radiation intensity.

Earlier flight to shade by *H. graciellae* due to greater energy absorbance and body heating rate also is contradictory to the species' larger body size, as larger insects exposed to radiation typically heat more slowly (Heinrich 1986). *Brephidium exilis*'s greater area: volume ratio expectedly would have caused it to heat 1.3 times faster than *H. graciellae*. Instead, *B. exilis* remained, while exposed to sunlight, 2.7 times longer than *H. graciellae*. Because heating rate does not appreciably differ between lateral and dorsal basking (Heinrich 1986), it is unlikely *B. exilis*'s greater tolerance of direct sunlight is due to this behavioral difference. *Hesperopsis graciellae*'s earlier flight to shade may have been due to its darker coloration, increasing radiation absorbance. However, coloration incompletely indicates the proportion of radiation absorbed, because visible light reflected off the insect does not include the near-infrared, part of the spectrum that can contribute significant warming (Heinrich 1972).

Equivalent heating rates between the two species would require *H. graciellae* to have a lower flight threshold, or temperature tolerance, compared with *B. exilis*. The difference between the species' flight-threshold temperatures can be estimated from the plot of avoidance response time against air temperature (Fig. 1A). The mean avoidance response time (retransformed = 67 sec) for both species corresponds to an air temperature of 33° C for *H. graciellae* and 38° C for *B. exilis*. The two species would have responded at the same time if subjected to these two air temperatures and exposed to the same light intensity. The 5° C air temperature difference between species therefore estimates the difference between flight-threshold temperatures; *B. exilis* tolerated body temperatures 5° C higher than *H. graciellae* assuming equivalent heating rates. *Brephidium exilis*'s tolerance of high body temperatures resembles that found in dragonflies, where desert species tolerate body temperatures 4–9° C higher than species found in cooler regions (Polcyn 1994).

Hesperopsis graciellae is less able to tolerate direct sunlight and therefore less adapted to the high insolation and air temperatures of its environment. Rather than tolerating high body temperatures, *H. graciellae* appears to maintain lower body temperatures by flying within the shade of its hostplant, *A. lentiformis*. Thus *H. graciellae*'s specialization on *A. lentiformis* may in part be due to its need for a foodplant providing adequate canopy cover. This concept is supported by considering *Hesperopsis alpheus* (Edwards), a species closely related to *H. graciellae* that is more widely-distributed and feeds on *Atriplex canescens* (Pursh) Nuttall (MacNeill 1970). Of the two insect species, only *H. graciellae* inhabits the lower Colorado River, while *H. alpheus* is limited to higher elevations (> 1500 m) and cooler climates (Emmel & Emmel 1973; G. Pratt, UC Riverside, personal communication). Both *Atriplex* species are found in the lower Colorado River habitats of *H. graciellae* (Turner et al. 1995). *Atriplex lentiformis* is up to 1 m taller than *A. canescens* and provides a more dome-shaped canopy (Turner et al. 1995); *H. graciellae*'s exploitation of *A. lentiformis*'s greater cover likely allows the insect to inhabit an otherwise inhospitable climate. Indeed, *H. alpheus* does not exhibit *H. graciellae*'s habit of flying for prolonged periods within shrubs (MacNeill 1970).

In contrast to *H. graciellae*, *B. exilis*'s wide host range does not allow it to

consistently utilize host shade as a means of thermoregulation, instead requiring the species to be physiologically better adapted to desert climate. For example, one of *B. exilis*'s most-used hosts is *Atriplex semibaccata* Robert Brown (Emmel & Emmel 1973), an exotic plant common at low elevations whose prostrate growth form (Munz 1974) would offer butterflies little protection from sunlight. Tolerance of direct sunlight expectedly also is required by *B. exilis*'s migratory behavior (Scott 1986), reducing the species' ability to remain sheltered within plants.

Conservation activities intended to benefit *H. graciellae* should consider the species' requirement for cover. In addition to furnishing its other life requisites, such as nectar sources for adults (Wiesenborn 1997), restored or preserved riparian habitat should provide *A. lentiformis* patches large enough, and contiguous enough, to allow prolonged flight within host canopies. It is unclear if neighboring, alternative plant species of adequate canopy would by themselves satisfy the insect's shade requirement, because oviposition behavior and plant cover may be interrelated. Regardless of larval suitability, *A. lentiformis* shrubs offering inadequate canopy may not be selected by ovipositing females.

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**DESCRIPTION OF IMMATURE STAGES OF
PHYLLOPHAGA (TRIODONYX) LALANZA SAYLOR
(COLEOPTERA: MELOLONTHIDAE, MELOLONTHINAE)**

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Abstract.—Three larval stages and pupa of *Phyllophaga (Triodonyx) lalanza* Saylor are described based on a large series of samples obtained in sugar cane fields from Tepic, Nayarit, Mexico, where the larvae cause severe damage to the root system. Fully developed third-stage larvae (58–64 mm length) of this species are some of the biggest root-feeding white grubs in Latin America. Illustrations of diagnostic structures of third-stage larva and pupa are included.

Key Words.—Insecta, white grubs, morphology, taxonomy, sugar cane.

Resumen.—Se describen los tres estados larvarios y la pupa de *Phyllophaga (Triodonyx) lalanza* Saylor, con base en series grandes de muestras obtenidas en los cañaverales de la región de Tepic, Nayarit, México, donde las larvas causan daños severos al sistema radicular. Las larvas de tercer estadio completamente desarrolladas alcanzan entre 58 y 64 mm de longitud, por lo cual representan una de las larvas edafícolas rizófagas más grandes descritas hasta el momento en América Latina. Se ilustran las estructuras diagnósticas para la identificación de la larva de tercer estado y la pupa.

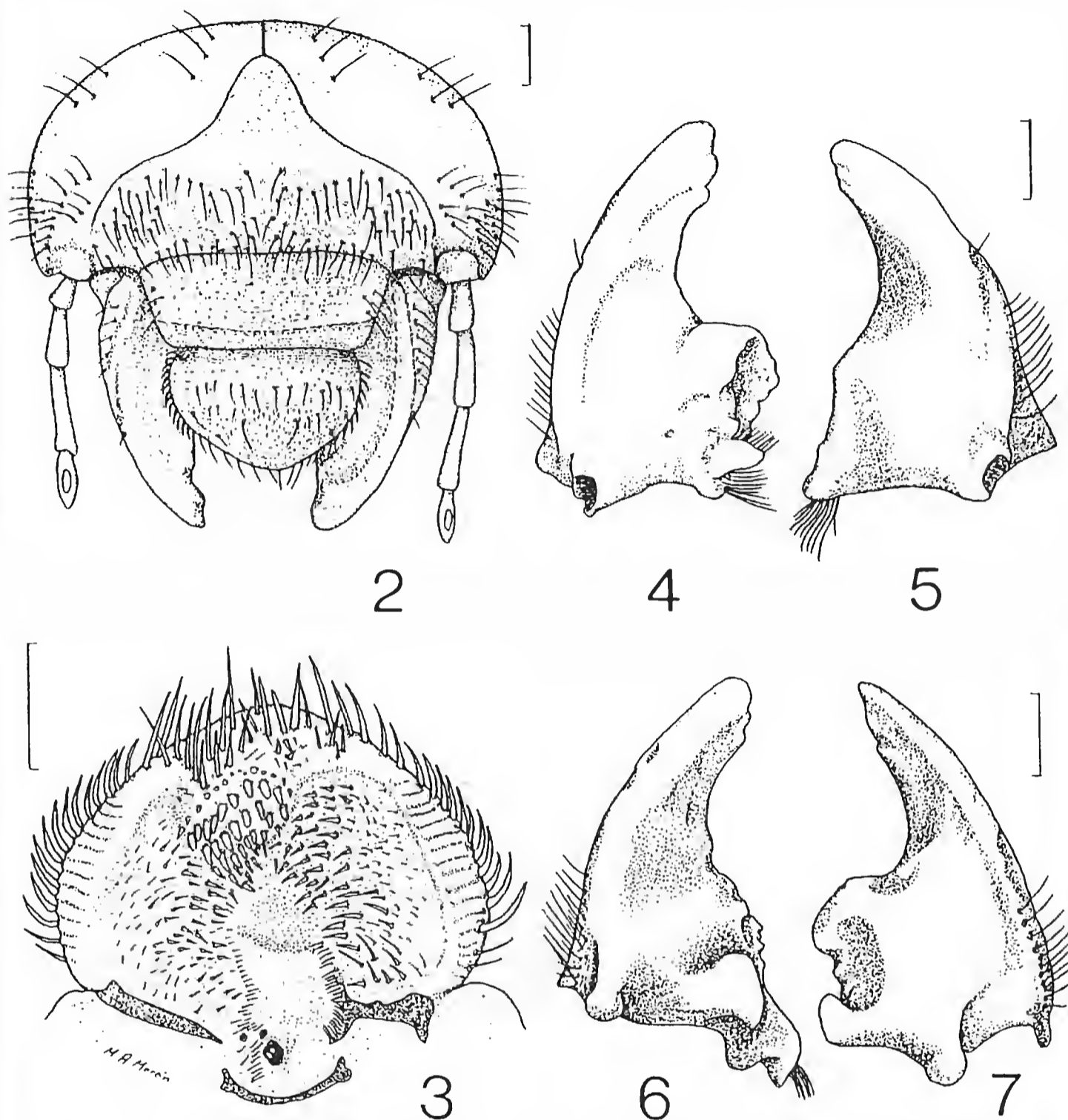
In recent years (1993–1996) reports of damage by white grubs in sugar cane fields, black bean, chili pepper, and corn crops have increased in the state of Nayarit, Mexico. Larvae have seriously damaged nearly 1000 ha of sugar cane around Tepic city. Nearly 90% of the samples of larvae and adults obtained and studied by the authors were determined as *Phyllophaga (Triodonyx) lalanza* Saylor (Morón et al. 1996). In this paper, the third instar larva and pupa of this species are described, including the taxonomic characters and measures of the first and second instar larvae, and the third instar larva is briefly compared with the larvae of other species of *Phyllophaga*. Technical terms used are those of Ritcher (1966) and Morón (1986). The descriptions are based on 160 third instar larvae, 64 second instar larvae, 16 first instar larvae, two cast skins of third instar larvae and 8 pupae, reared from eggs or directly collected in the field (see Material Examined). Specimens studied are deposited in the following Mexican collections: Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, SAGAR, Celaya, Guanajuato; Instituto de Biología, U.N.A.M. Mexico City; Departamento de Investigación en Ciencias Agrícolas, Benemérita Universidad Autónoma de Puebla, Puebla; Instituto de Ecología, A.C. Xalapa, Veracruz; Departamento Técnico de Campo, Ingenio de Puga, S.A. Tepic, Nayarit; the private collection of M.A. Morón, Xalapa, Veracruz; and in the collections of California Academy of Sciences, San Francisco; U.S. National Museum, Smithsonian Institution, Washington, D.C.; University of Nebraska State Museum, Lincoln; and Biosystematics Research Centre, Ottawa, Canada.



Figure 1. *Phyllophaga lalanza* third stage larva, lateral aspect. Chaetotaxy simplified. Scale line is 5 mm.

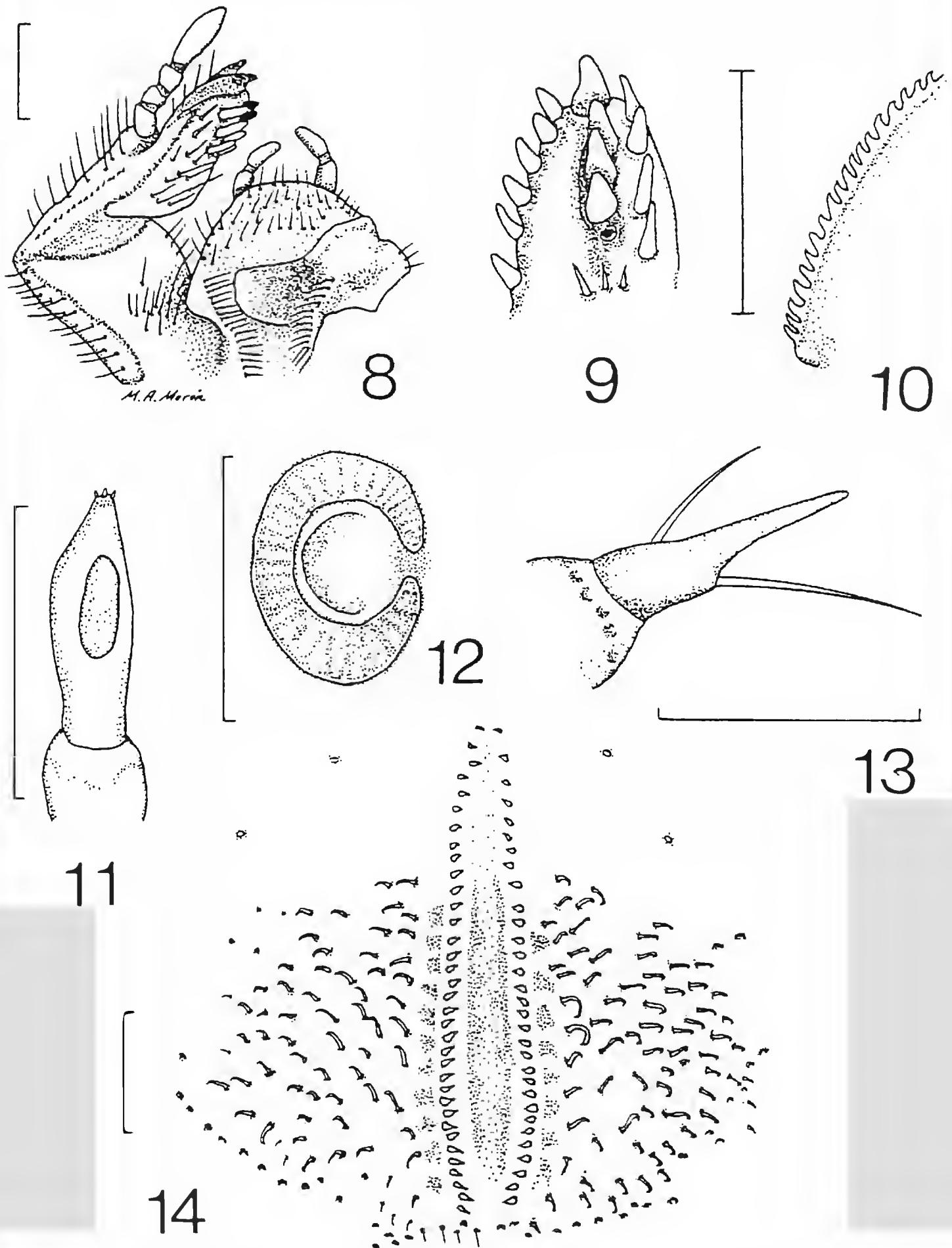
PHYLLOPHAGA (TRIODYNYX) LALANZA SAYLOR, 1941
(Figs. 1–15)

Third Instar Larva.—*Head.* Maximum width of head capsule 7.4–8.0 mm. Surface of cranium finely and densely rugopunctate, reddish yellow. Frons (Figs. 1 and 2) with only 1 exterior frontal seta on each side; 26–30 anterior frontal setae; 30–54 posterior frontal setae, laterally mixed with 8–12 exterior frontal setae on each side; each anterior angle of frons with 2 setae; remaining cranial surface with 3–4 dorso-epicranial setae, 3 epicranial setae, 18–20 para-ocellar setae on each side. Clypeus (Fig. 2) with 4 lateral setae. Labrum slightly asymmetrical, lateral margins rounded, 12 posterior setae, 5–7 central setae, and 2–3 lateral setae. Eye spots absent. Epipharynx (Fig. 3) without zygum and epizygum; haptomerum with group of 30–35 heli; each plegmatium with 13 to 18 short plegmata. Proplegmata absent. Dexiophoba and laeophoba large, extending forward from sense cone for more than one half distance between sense cone and heli. Laetorma with 2–3 anterior, short processes. Haptolachus with few microsensillae. Sclerotized plate not developed, but with 2 macrosensillae between sense cone and dexiortorma. Crepis well sclerotized with both ends bifurcated. Each acanthopariae with 14–16 curvate, spine-like setae. Chaetoparia moderately developed, with few microsensilla among the setae. Mandibles (Figs. 4–7) with ventral stridulatory areas absent. Scissorial area of left mandible with distal blade-like portion separated from proximal tooth by scissorial notch; inner margin without tooth; molar area with well developed distal lobe (M1); dorsomolar setae absent; acia long, slightly acute; brustia multisetose. Scissorial area of right mandible formed by 3 short teeth; inner margin without tooth; molar area with 2 irregular lobes; calx enlarged; brustia multisetose. Galea with 1 well developed uncus (Fig. 8); lacinia with 3 terminal unci in a longitudinal row, fused at bases, and each side with 4–6 stout heli in a longitudinal line (Fig. 9). Maxillary stridulatory area with 16–19 sharp-pointed, anteriorly directed teeth, without anterior process (Fig. 10). Hypopharyngeal sclerome asymmetrical, produced on right side into broadened process (Fig. 8). Dorsal surface of last antennal segment with 1 large, oval sensory spot (Fig. 11). *Thorax.* Thoracic spiracles 0.8–0.9 mm measured dorsoventrally; respiratory plate reddish yellow, regularly shaped as a closed “C”; distance between 2 lobes of respiratory plate less than dorsoventral diameter of bulla; spiracular bulla rounded, slightly



Figures 2–7. *Phyllophaga lalanza* Saylor third-stage larva. Figure 2. Frontal view of cranium. Figure 3. Epipharynx. Figures 4 and 5. Dorsal aspect of left and right mandibles, respectively. Figures 6 and 7. Ventral aspect of right and left mandibles, respectively. Scale lines are 1 mm.

prominent. Pronotum with 2 well-marked, yellowish, lateral scleromes at each side (Fig. 1). Dorsa of pro-, meso- and metathorax with sparse, slender setae, without short spinelike setae. Tarsal claws of prothoracic and mesothoracic legs similar, large, each claw bearing 2 setae (Fig. 1). Claws of metathoracic legs reduced in size (Fig. 1). *Abdomen*. Abdominal spiracles of segments 1 to 4 nearly similar in size, 0.8–0.9 mm measured dorsoventrally; respiratory plate reddish yellow, regularly shaped as a closed “C”; distance between 2 lobes of respiratory plate much less than dorso-ventral diameter of bulla; spiracular bulla rounded, slightly prominent (Fig. 12). Respiratory plate with a maximum of about 18 to 24 oval “holes” along any diameter; “holes” not in definite rows. Spiracles of segments 5 to 7 reduced in size, 0.65–0.70 mm; distance between 2 lobes of respiratory plate slightly less than dorso-ventral diameter of bulla. Spiracles of segment 8 noticeably smaller, 0.50–0.52 mm; distance between 2 lobes of respiratory plate equal to dorsoventral diameter of the bulla (Fig. 1). Dorsum of abdominal segments 2 to 7 with large number of spinelike setae and some sparse, long, slender setae; dorsum of segments 8 to 10 with some paired, sparse, long, slender setae (Fig. 1). Venter of segments 1 to 9 with paired, sparse, slender setae. Raster with pair of longitudinal palidia which are slightly



Figures 8–14. *Phyllophaga lalanza* third-stage larva. Figure 8. Dorsal aspect of left maxilla and labium. Figure 9. Apex of right lacinia, mesial view. Figure 10. Stridulatory area of right maxilla. Figure 11. Dorsal aspect of apical antennal segment. Figure 12. Fourth abdominal spiracle. Figure 13. Tarsal claw of fore leg. Figure 14. Palidia and teges. Scale lines are 1 mm.

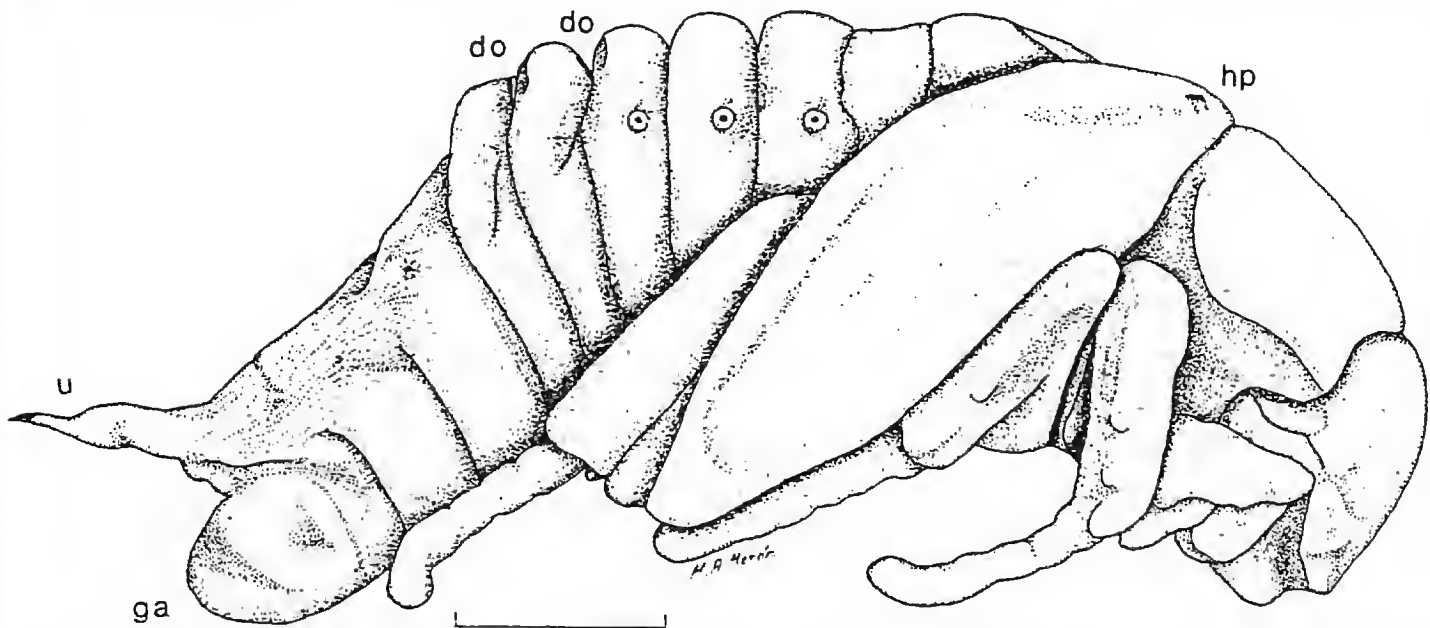


Figure 15. *Phyllophaga lalanza* male pupa, lateral aspect. Note the humeral peg-like projection on the elytral tectus (hp), the dioneiform organs (do) and genital ampulla (ga). Scale line is 5 mm.

convergent anteriorly and posteriorly; each palidium formed by 27 to 37 short, spinelike pali (Fig. 14). Teges formed by 65 to 75 hooked, short setae. Campus with 4 long, slender setae. Barbula dense, with long setae. Dorsal anal lobe with large number of short setae. Lower anal lobe divided by sagittal cleft, with some sparse short setae. Anal slit "Y"-shaped, stem of "Y" shorter than arms of "Y". Approximate total body length: 58–64 mm.

Second Instar Larva.—Similar to third instar except as follows: maximum width of head capsule: 4.70–5.25 mm; frons with 30–52 posterior frontal setae; dorso-ventral diameter of prothoracic spiracles 0.40–0.55 mm; length of metacoxae: 3.0–3.5 mm; each palidium with 29–38 pali.

First Instar Larva.—Similar to second instar except as follows: maximum width of head capsule: 2.9–3.3 mm; frons with 15–26 posterior frontal setae; respiratory plates of thoracic and abdominal spiracles kidney shaped; dorso-ventral diameter of prothoracic spiracles 0.25 mm; one thin eclosion spine at each side of metanotum; length of metacoxae 1.85–2.00 mm; each palidium with 27–39 pali.

Pupa.—*Head.* Glabrous, strongly reflexed downward; antennae and mouth parts clearly differentiated, labrum much exposed, ocular canthi wide, compound eyes sunken (Fig. 15). *Thorax.* Pronotum convex, with shallow depressions at sides and near middle, anterior lateral angles clearly projected. Meso- and metanotum well differentiated. Elytral tectae with shallow, longitudinal sulci and each humeral corner with short, tubercle-like, sclerotized callus. Wing tectae slightly longer than elytra. Protibiae with 3 short processes on external borders. Mesotibiae with vague keels. Metatibiae without keels and apical spurs well differentiated. *Abdomen.* Segments I–VI clearly wider than distal segments. Two pairs of poorly developed dioneiform organs between tergites IV–VI. Pleural lobes rounded and prominent. Spiracle I simple, ovate, with fine peritreme; spiracles II–IV rounded, with wide, prominent peritreme and adjacent sclerotized, small dorsal plate; spiracles V–VI closed, vague; spiracles VII–VIII closed, vague, and surrounded by longitudinal rugae (Fig. 15). Last abdominal tergite with 2 long, sharply pointed, divergent urogomphi. Last abdominal "sternite" in males with smooth, prominent genital ampulla; in females, flattened and deeply striated. Body length, 30–35 mm.

Remarks.—Except for its large size (58–64 mm length) and the high number of long frontal setae, third instars of *P. lalanza* do not have any definite taxonomic character that separates the larvae of the subgenus *Triodonyx* from the known larvae of other subgenera of continental American *Phyllophaga*. The high number of long frontal setae is useful to separate the first and second instars of this species from other small species that live in the Nayarit area. Using the key to species of *Phyllophaga* larvae from the U.S. (Ritcher 1966: 87), *P. lalanza* vaguely keyed to near *P. quercus* Knoch and *P. tristis* Fab. because of the absence of proplegmata in the epipharynx, but it has a raster with closely set palidia formed by more than 13 pali. Using the key to larvae from the Antillean and exotic Melo-

lonthini (Böving 1942: 173), the larvae of the Antillean subgenera *Clemora* Saylor or *Cnemarachis* Saylor show an irregular or dispersed arrangement of pali; *Clemora* does not have proplegmata, and *Cnemarachis* has numerous proplegmata. Some Asiatic species of *Ancylonycha* Dejean have regular pali and do not have proplegmata but have round, black spots on the dorsal side of the cardo, coxae, and near the spiracles. So, the possible relationships of larvae of *Phyllophaga* (*Triodonyx*) species remains obscure. One interesting character observed in the pupa of *P. lalanza* is the presence of humeral, sclerotized, spine-like, elytral calla, but, unfortunately, no other pupae of the genus are described in detail so that a comparison can be made.

Material Examined.—MEXICO: STATE OF NAYARIT, Tepic Municipality, Ejido F. I. Madero, 16 April 1994, S. Hernández & M. A. Morón, soil under sugar cane roots, 760 m, 2 cast skins of third instars associated with immature adults and 4 third instars; 14 third instars, same data except: 15 November 1994, S. Hernández & A. Ramírez; 12 third instars, same data except: Ejido Pochotitán, 10 December 1994, 910 m; 22 third instars, same data except: 18 January 95, 910 m; 63 third instars, same data except: Ejido El Refugio, 3 November 1994, 990 m; 10 third instars, same data except: 10 November 1994; 35 third instars, same data except: 5 December 1994. Two second instars reared from eggs deposited by females collected in Ejido F. I. Madero, 20 July 1994; 6 second instars from Ejido Pochotitán, 17 October 1994, A. Ramírez & S. Hernández, under sugar cane roots, 910 m; 31 second instars, same data except: Ejido El Refugio, 17 August 1994; 25 second instars, same data except: 14 September 1994. Five first instars reared from eggs deposited by females collected in Ejido F. I. Madero, 20 July 1994, 760 m, A. Ramírez; 11 first instars from Ejido El Refugio, 17 August 1994, A. Ramírez & S. Hernández, under sugar cane roots, 910 m. Four male and 4 female pupae collected in Ejido Pochotitán, Potrero La Mesa, 23 April 1994, S. Hernández, A. Ramírez & M. A. Morón, inside pupal chamber located under sugar cane roots, 910 m.

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**TWO NEW SPECIES OF *GIULIANIUM* MOORE FROM
THE PACIFIC COASTS OF ALASKA AND CALIFORNIA
(COLEOPTERA: STAPHYLINIDAE: OMALIINAE)**

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Abstract.—A systematic review of the omaliine genus *Giulanium* Moore is presented. Diagnosis of *Giulanium* is presented, and three species are recognized, two of which are described as new (*G. alaskanum*, NEW SPECIES, and *G. newtoni*, NEW SPECIES). Types and paratypes of the two new species are designated. A key is provided for separation of known species of *Giulanium* and illustrations of diagnostic features are provided.

Key Words.—Insecta, Coleoptera, Staphylinidae, Omaliinae, *Giulanium*, new species, intertidal.

While taking collecting trips to Alaska and Hokkaido (Japan) and studying Field Museum of Natural History (Chicago, Illinois) collections, we discovered two remarkable new species of intertidal staphylinid beetles. We concluded after detailed study of these specimens that these species represented two new species of Omaliine genus *Giulanium* Moore. This genus was first described and characterized by Moore (1976) based on the new species *G. campbelli* from California, U.S.A. He tentatively placed *Giulanium* in the subfamily Phloeocharinae. However, Newton & Thayer (1995) proposed that *Giulanium* should be placed in the Omaliinae (tribe Aphaenostemmini Peyerimhoff) because members of *Giulanium* lack the derived characters of the Phloeocharinae and have a well-developed Omaliine-type gland system (Thayer 1987). Their phylogenetic analysis indicated that *Giulanium* showed a sister group relationship with *Aphaenostemmus* Peyerimhoff (see Newton & Thayer 1995 for more detailed discussions).

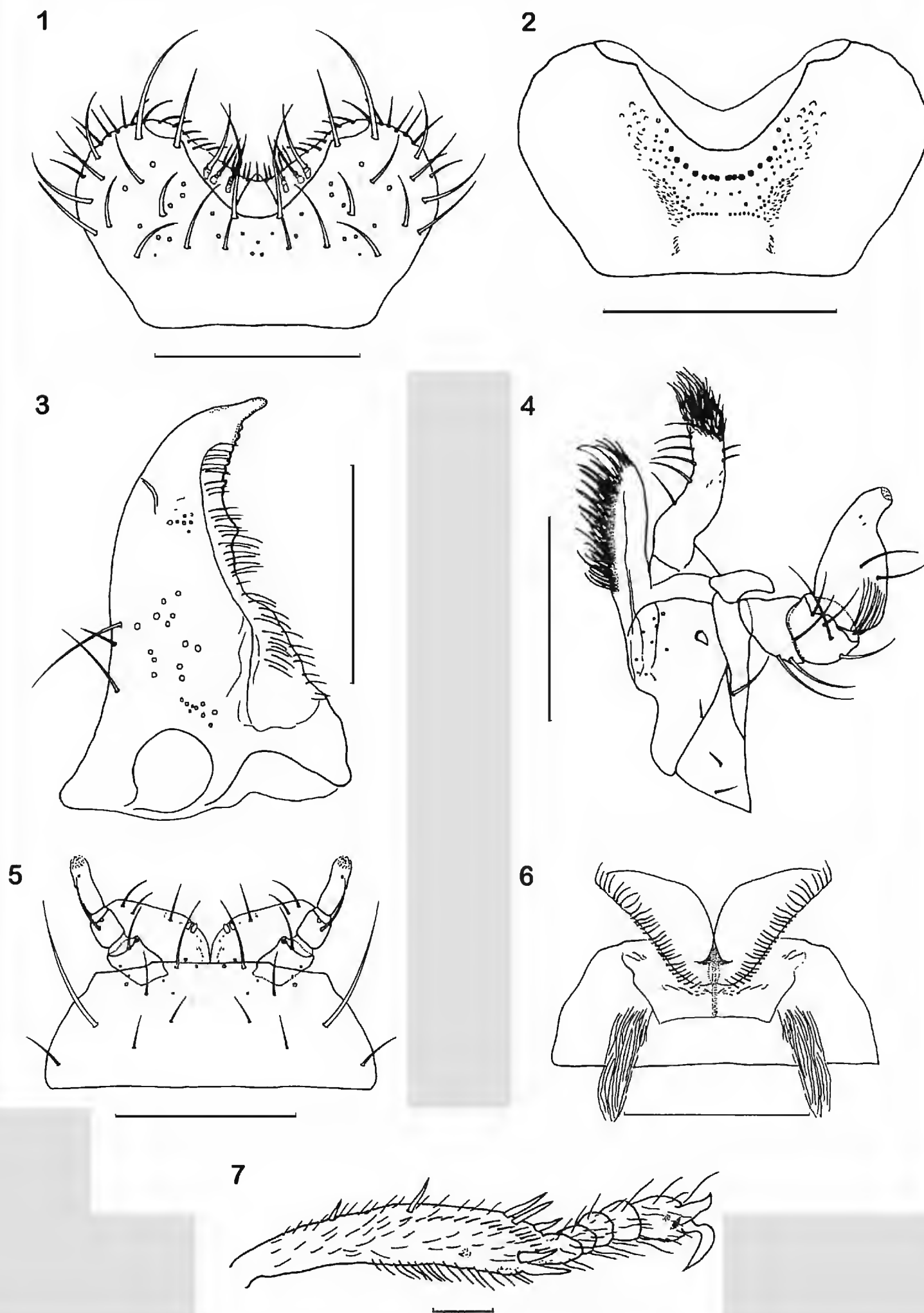
Our objectives in this paper are to redescribe *Giulanium*, to describe two new species (*G. alaskanum* and *G. newtoni*), and to provide a key for separation of known species.

GIULIANIUM MOORE

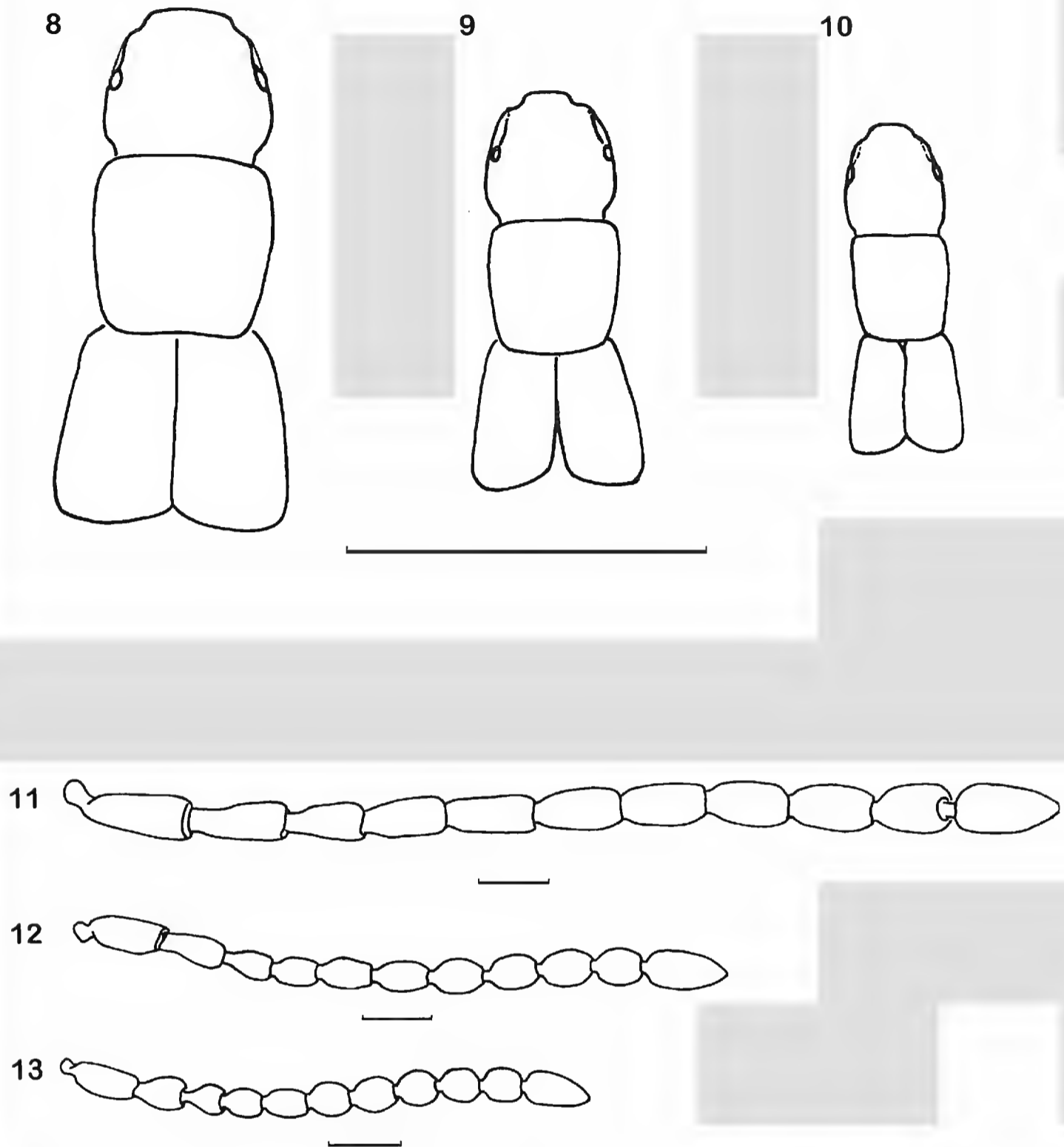
Giulanium Moore, 1976: 56.

Type Species.—*Giulanium campbelli* Moore 1976, by original designation.

Diagnosis.—Moore (1976) has provided a complete description of this genus. This diagnosis condenses and updates that description to include other species, corrects mistakes and adds characters not mentioned by Moore. Members of *Giulanium* can be recognized by the following combination of characteristics: small, length 2.1 mm–3.0 mm; body uniformly dark brown to light brown (teneral specimens often dark rufus with darker abdomens); body form slender, parallel-sided or abdomen slightly wider than very slender head thorax and elytra, flattened; body densely pubescent with very short and fine microsetae; integument moderately densely reticulate throughout. Head orbicular to slightly elongate (Figs. 8–10), narrowed at base to broad neck, nuchal constriction faint to absent dorsally. Gular sutures separated, diverged to base of head. Infraorbital carina absent. Eyes very small, several setae between facets. Tempora long. Antennae long, reaching to posterior fourth or to beyond apex of elytra when extended posteriorly, all antennomeres elongate (Figs. 11–13). Labrum (Fig. 1)



Figures 1–7. *G. alaskanum*. Figure 1. Labrum, dorsal aspect; Figure 2. Epipharynx, ventral aspect; Figure 3. Mandible, ventral aspect; Figure 4. Maxilla, dorsal aspect; Figure 5. Labium, dorsal aspect; Figure 6. Hypopharynx, dorsal aspect; Figure 7. Hind tarsus, lateral aspect. Scales 0.1 mm.



Figures 8–10. Body shape, dorsal aspect and Figs. 11–13. Antenna, lateral aspect. Figure 8. *G. campbelli*; Figure 9. *G. alaskanum*; Figure 10. *G. newtoni*; Figure 11. *G. campbelli*; Figure 12. *G. alaskanum*; Figure 13. *G. newtoni*. Scales 0.1 mm.

deeply and broadly emarginate anteriorly, appearing bilobed, anterior margin with diffuse fringe of fine setae. Epipharynx as in Fig. 2. Mandible (Fig. 3) with acute apex, and finely ciliate prosthema, without enlarged molar region. Maxilla as in Fig. 4; lacinia with 2 large spines apically and numerous spinose setae and smaller setae along inner margin; galea with numerous moderately long setae at apex, 4–6 widely separated large setae on inner margin and 1 large seta externally near base of densely setose area. Maxilla with palpomere 4 as long or longer than 2+3, somewhat bulbous at base and narrowed apically with a distinctive recurved apex (Fig. 4). Labium (Fig. 5) with 3-articled palpi, 2nd wider than 3rd, narrower than 1st, ligula very broad and divided to base into 2 broad lobes. Hypopharynx as in Fig. 6. Pronotum subquadrate to slightly elongate (Figs. 8–10). Tibiae (Fig. 7) with a few scattered spines, tarsal claws falcate. All tarsi 5-articled, tarsomere 1–4 short, subequal, article 5 longer. Hind wings absent. Abdominal sternite III very deeply sinuate anteriorly, more or less U-shaped. Abdomen III–VII without paratergites. Abdominal tergite VII slightly longer than VI, abdom-

inal tergites without transverse basal impressions. Anterior margin of abdominal sternite VIII modified into broad lobe in association with sternal gland and gland reservoir.

Intertidal, found under stones and boards (and probably other debris) below the high-tide mark on beaches of the Pacific Coast of North America from Northern California to Alaska and Hokkaido. Larvae unknown.

Distribution.—Pacific Coasts of California, Alaska, Hokkaido (Japan).

KEY FOR IDENTIFICATION OF KNOWN SPECIES OF *GIULIANIUM*

1. Larger species, 3.0 mm in length; antenna very elongate, nearly attaining apex of elytra when extended posteriorly, antennal articles 3–10 very elongate, 2.0–1.5 times longer than wide (Fig. 11); aedeagus as in Fig. 14 *G. campbelli*
- 1'. Smaller species, 2.1–2.7 mm in length; antenna less elongate, attaining middle to apical third of elytra when extended posteriorly, antennal articles 3–10 less elongate 1.7–1.1 times longer than wide (Figs. 12 and 13); aedeagus not as above 2
- 2(1'). Smaller species, 2.1–2.2 mm in length, mature specimens uniformly light brown; head distinctly elongate, 1.1–1.2 times longer than wide (Fig. 10); pronotum slightly, but distinctly elongate, about 1.1 times longer than wide (Fig. 10); aedeagus as in Fig. 16; known from northern California *G. newtoni*
- 2'. Larger species, 2.4–2.7 mm in length, mature specimens uniformly dark brown; head subquadrate, about as long as wide (Fig. 9); pronotum about as long as wide to slightly longer than wide (up to 1.05 times longer than wide) (Fig. 9); aedeagus as in Fig. 15.; known from Alaska and Japan *G. alaskanum*

GIULIANIUM CAMPBELLI MOORE 1976

(Figs. 8, 11, 14)

Giulianium campbelli Moore, 1976: 57.

Redescription.—Length 3.0 mm. Body uniformly dark brown throughout, uniformly covered with dense vestiture of very fine pubescence, slender, parallel-sided. Head slightly wider than long (1.1–1.2 times wider than long) (Fig. 8); antenna (Fig. 11) very long and slender, nearly attaining apex of elytra when extended posteriorly, all antennomeres very elongate, antennomere 3–10 about 2.0–1.5 times longer than wide, with apical articles relatively shorter than more basal articles. Pronotum (Fig. 8) about as wide as long (Moore 1976 says that the pronotum is $\frac{1}{7}$ longer than wide but our measurements of the holotype and one paratype did not confirm this). Aedeagus as in Fig. 14 (dorsal aspect only, lateral aspect of parameres not available because the aedeagus is permanently mounted in mounting medium and could not be reoriented).

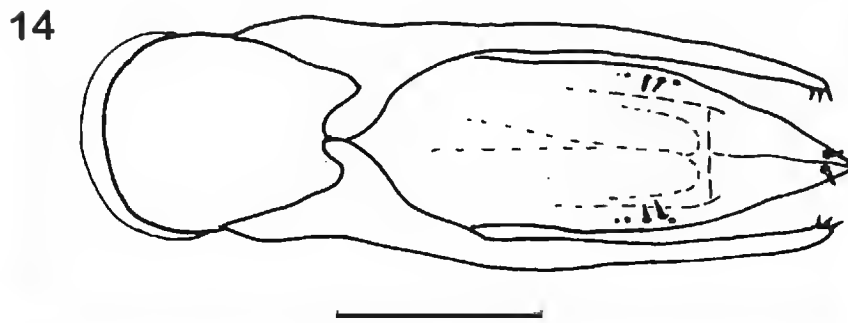
Distribution.—California.

Material Examined.—Holotype, labeled as follows: 'Bear Harbor, Humboldt County, California, June 1964, Derham Giuliani; Holotype, *Giulianium campbelli* Moore' deposited in the Entomological Research Institute, Ottawa, Canada. Paratype 1, same data as holotype.

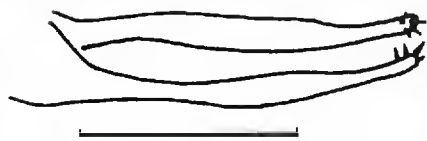
GIULIANIUM ALASKANUM, NEW SPECIES

(Figs. 9, 12, 15, 16)

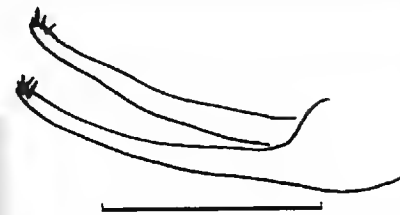
Types.—Holotype, labeled as follows: 'U.S.A.: Alaska. Seward, 24 V 1994, K. J. Ahn, ex., under boulder in low tide; Holotype, *Giulianium alaskanum* Ahn and



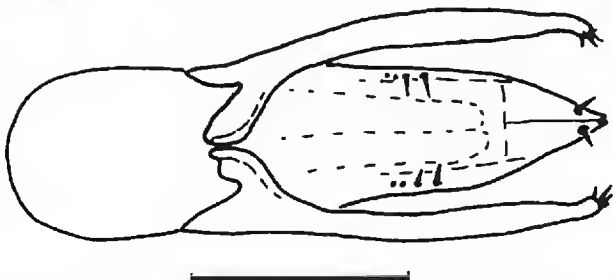
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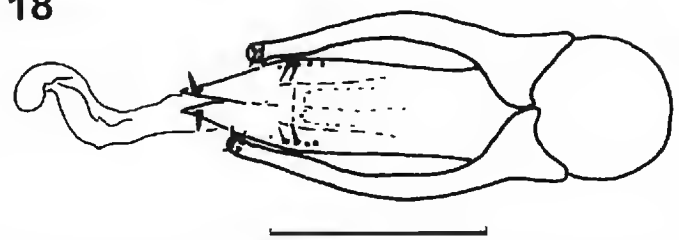
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Figures 14–18. Aedeagus. Figure 14. *G. campbelli*, dorsal aspect; Figure 15. *G. alaskanum*, lateral aspect; Figure 16. Dorsal aspect; Figure 17. *G. newtoni*, lateral aspect; Figure 18. Dorsal aspect. Scales 0.1 mm.

Ashe, Desig. K.-J. Ahn and J. S. Ashe 1998.' deposited in the Snow Entomological Museum, University of Kansas, Lawrence, Kansas. Paratypes, 28; 2 labeled as follows: 'Japan: Hokkaido. Akkeshi, Tokotan, 15 VI 1994, ex., under beach ground' 26 same data as type (18, Snow Entomological Museum; 8, Chungnam National University Insect Collection, Daejeon, Korea; 2, Field Museum of Natural History, Chicago, Illinois).

Description.—Length 2.4–2.7 mm. Body uniformly dark brown throughout, uniformly covered with dense vestiture of very fine pubescence, slender, parallel-sided. Head about as wide as long (Fig. 9); antenna (Fig. 11) long and slender, attaining apical third of elytra when extended posteriorly, all antennal articles elongate, articles 3–10 about 1.7–1.3 times longer than wide, with apical articles relatively shorter than more basal articles. Pronotum (Fig. 9) subquadrate to slightly longer than wide (less than 1.1 times longer than wide). Aedeagus as in Figs. 15 and 16; parameres more or less straight in lateral aspect, not bent upwards with respect to the medial lobe, lateral edge narrowed in apical fifth (Fig. 15), dorsal aspect more or less uniformly divergent from base to apex (Fig. 16).

Distribution.—Alaska and Japan (Hokkaido).

GIULIANIUM NEWTONI, NEW SPECIES

(Figs. 10, 13, 17, 18)

Types.—Holotype, labeled as follows: 'U.S.A.: California, San Mateo Co. Moss Beach, 27 II 1952, under boards below high tide, O. Bryant, Field Museum Nat

Hist; Holotype, *Giulianium newtoni* Ahn and Ashe, Desig. K.-J. Ahn and J. S. Ashe 1998.' deposited in the Field Museum of Natural History, Chicago. Paratypes, 5; same data as type (3, Field Museum of Natural History; 2, Snow Entomological Museum).

Description.—Length 2.1–2.2 mm. Body uniformly light brown throughout, uniformly covered with dense vestiture of very fine pubescence, very slender, parallel-sided. Head distinctly longer than wide (Fig. 10); antenna (Fig. 13) long and slender, attaining apical half of elytra when extended posteriorly, all antennomeres elongate, antennomeres 3–10 about 1.5–1.1 times longer than wide, with apical articles relatively shorter than more basal articles. Pronotum (Fig. 10) distinctly longer than wide, about 1.1 times longer than wide. Aedeagus as in Figs. 17 and 18; parameres distinctly bent upwards with respect to the median lobe, lateral edge not narrowed in apical fifth (Fig. 17), dorsal aspect with parameres diverging in basal half and converging toward midline from near middle to apex (Fig. 18).

Distribution.—California.

Discussion.—The three known species are superficially very similar, but they can be distinguished by the characters in the key, and by the slight, but consistent, differences in the parameres noted in the descriptions (see also Figs. 14–18). To facilitate comparisons between these similar species, the illustrations of comparable structures of all three species are drawn to the same scale. The differences in relative size and proportions of the head, pronotum and antennae, and the differences in the parameres of the aedeagi, are readily apparent in these illustrations.

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We extend special thanks to Dr. A. Smetana (Entomological Research Institute, Ottawa, Canada) and Dr. A. F. Newton, Jr. (Field Museum of Natural History, Chicago) for loan of specimens. This research was partially supported by Chungnam National University Research Grant to K.-J. Ahn.

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ESTABLISHMENT OF AN EXOTIC PLASTER BAGWORM IN CALIFORNIA (LEPIDOPTERA: TINEIDAE)

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Abstract.—This paper reports the first North American and California records of the plaster bagworm, *Phereoeca praecox* Gozmany and Vari. Distributional records for California are reported. A case history of *P. praecox* as a fabric pest in southern California is described. Food sources of *Phereoeca* are summarized. Dissection of live larval cases reveals that in southern California, *P. praecox* is essentially chitinophagous and keratinophagous.

Key Words.—Insecta, Lepidoptera, Tineidae, plaster bagworm, fabric pest, food sources, *Phereoeca praecox*.

The genus *Phereoeca* (Lepidoptera: Tineidae) was created in 1956 in order to separate a group of flat, case-bearing moths from case-making moths of the genus *Tineola* (Hinton & Bradley 1956). *Phereoeca* spp. are commonly referred to as wall bagworms, plaster bagworms, and household case-making moths. The larva live in, feed from and pupate inside a characteristic watermelon-shaped, flattened, broadly spindle-shaped case lined internally with silk. The outside of the case is usually covered with sand, soil particles, brick dust, and other miscellaneous debris found within the larva's habitat. The genus *Phereoeca* occurs throughout the wet tropics of the Old and New World. Robinson & Nielson (1993) stated that they are aware of six *Phereoeca* spp. worldwide of which four are named. The nomenclature and taxonomy of the genus *Phereoeca* has been, and remains confusing.

Prior to this paper, the only other *Phereoeca* species recorded from North America was *Phereoeca uterella* (Walsingham) which is reported from Florida, Louisiana, Mississippi, and North Carolina (Hetrick 1957). For many years, this species was reported as *Tineola walsinghamsi* (Busck) (Villanueva-Jimenez 1996, Katz 1997). *Tineola walsinghamsi* was put in synonymy in 1984 (Davis 1984). The species in Florida was then referred to as *Phereoeca dubitatrix* (Meyrick) (Villanueva-Jimenez 1996). *Phereoeca dubitatrix* was put in synonymy in 1993 (Robinson & Nielsen 1993). The *Phereoeca* from Florida is now designated as *P. uterella* (Walsingham). The name changes associated with this single species testifies to the confusion regarding the identity and nomenclature of the genus *Phereoeca*.

Phereoeca praecox Gozmany and Vari in California.—The first report of a plaster bagworm occurring in California was on 28 January 1986 when a number of larval cases were submitted by a pest control operator to Orange County Agriculture Commissioner for identification (Nick Nisson, personal communication). Adults reared from this sample were sent to the National Museum of Natural History for identification. A species determination could not be made at that time because the specimens submitted were in poor condition preventing proper identification. Adults of a *Phereoeca* sp. captured on 2 April 1997 from inside a residence on Granville Drive, Newport Beach, Orange County, California, and additional moths reared from larval cases retrieved from the above address were

sent to Dr. Davis of the NMNH for a species determination. Davis subsequently forwarded illustrations of his genitalia dissections of this species to Gaden Robinson of the British Museum (Natural History). Robinson identified the male as *P. praecox*, but he was uncertain if the female represented the same species. *Phereoeca* specimens reared from larval cases collected on 27 August 1998 from Gardena, Los Angeles County, California, were also submitted to Davis for identification. Males from this sample were found to be consistent with *P. praecox*.

P. praecox was originally described in 1973 (Gozmany & Vari 1973). The male holotype was reported to have been taken on 30 August 1928 in Njala, Sierra Leone. *P. praecox* has since been reported from Australia (Robinson & Nielson 1993).

This paper reports the first North American and California records of *P. praecox*. Other species of *Phereoeca* are not known to occur in California.

Since 1989, I have encountered plaster bagworms in southern California associated with structures during the course of my work as a structural pest management professional. Specimens collected by the author, and others submitted to him for identification, have always been empty larval cases. Empty cases are easily recognizable because the pupal exuviae are usually found partially protruding from one end of the case. I have collected cases from inside garages, in substructural areas, under exterior stairwells, on exterior walls, under eaves of structures, on walls and ceilings of entryways, under patio covers and at patio/building junction, and on bathroom and laundry room walls. On one occasion, a case with a live larva was found on the asphalt parking lot of a commercial office building about 10 m from the structure.

Distribution Records of P. praecox in Southern California.—U.S.A. CALIFORNIA. LOS ANGELES Co.: Los Angeles, 26 August 1987. California Dept. of Food & Agriculture, Plant Pest Diagnostic Branch record. Los Angeles, 20 July 1996. H. Gulmahamad. Gardena, 20 January 1998, R. Arias. Redondo Beach, 27 August 1998, S. Howard. Gardena, 27 August 1998, H. Gulmahamad. Gardena, 15 October 1998. D. Jimbo. Long Beach, 30 October 1998, S. Howard. Redondo Beach, 4 November 1998, S. Howard. San Pedro, 10 November 1998, S. Howard. ORANGE Co.: Westminster, 28 January 1986. Nick Nisson. Anaheim, 20 March 1989. H. Gulmahamad. Aliso Viejo, 15 June 1996. V. Herrera. Newport Beach, 2 April 1997. H. Gulmahamad. Irvine, 17 May 1997. D. Kern. Placentia, 22 May 1997. R. Lagana. Yorba Linda, 30 May 1997. P. Palamara. Anaheim Hills, 12 July 1997. D. Simkin. Mission Viejo, 4 August 1997. M. Tassinari. Anaheim, 31 October 1997. H. Gulmahamad. San Clemente, 16 February 1998. D. Eschevarria. Costa Mesa, 2 March 1998. B. Griffin. Costa Mesa, 11 March 1998. B. Smallwood. Newport Beach, 4 April 1998. H. Gulmahamad. Anaheim, 1 May 1998. H. Gulmahamad. Corona del Mar, 22 July 1998. V. Lucero. Newport Beach, 23 July 1998. V. Lucero. Irvine, 16 March 1999. H. Gulmahamad. RIVERSIDE Co.: Beaumont, 2 April 1993. Tracy. SAN BERNARDINO Co.: Chino, 17 September 1997. R. Lampman. SAN DIEGO Co.: San Diego, 12 December 1988. R. Skelly. San Diego, 19 March 1992. Glassford. Spring Valley, 27 March 1994. Taylor. SANTA BARBARA Co.: Santa Barbara, 25 February 1988. CDFa Plant Pest Diagnostic Branch record. YOLO Co.: Sacramento, 20 April 1993. L. Allen.

Food Sources of the Genus Phereoeca.—There is much disagreement regarding natural food sources of the larvae of the various species of *Phereoeca*. Cited food sources include insect parts, fur, flannel, wool, spider webs, bat and bird droppings, and other fabrics (Meyrick 1905; Walsingham 1914; Kea 1933; Busck 1933; Watson 1939, 1946; Mallis 1954; Hinton 1956; Hetrick 1957; NPCA 1977; Zimmerman 1978; Aiello 1979; Robinson & Nielson 1993; Koehler & Castner 1994). Dissection of 15 cases of *P. praecox* containing live larvae which were taken from three different locations in southern California, revealed that *P. prae-*



Figure 1. Top. Plaster bagworm cases hanging at wall/ceiling junction of garage. Ninety cases were counted in this area.

Figure 2. Bottom. Carpet below zebra skin rug showing plaster bagworm damage. Note more pronounced damage at periphery of rug.



Figure 3. Photograph shows damage caused by plaster bagworm to edge of carpet adjacent to a sliding glass door.

cox fed on dead insects, insect parts and fragments, human and animal hairs, and bird feathers. This is the first record of a *Phereoeca* species feeding on bird feathers.

A Case History of P. praecox as a Fabric Pest in California.—On 26 March 1997, the owner of a residence on Granville Drive, Newport Beach, Orange County, California called Terminix International and requested assistance with an unusual pest problem. On 2 April 1997, I interviewed the owner and conducted an inspection of the premises. In the detached garage, I found numerous cases of *P. praecox* on the walls and at the wall/ceiling junction. Many empty cases were hanging in spider webs at the wall/ceiling junction (Fig. 1).

The area of concern to the homeowner was a portion of the carpet in front of the fireplace which was covered with a natural zebra skin rug. The carpet was a two-year-old 100% looped wool Berber carpet portions of which under the zebra skin was eaten to the base (Fig. 2). No larval cases were present at this time. However, interviewing the maid, I discovered that, as part of her regular cleaning routine, the zebra skin rug is picked up at least once every two weeks and the area underneath it vacuumed. The maid claimed that it was during one of these bimonthly cleaning in March 1997 that she discovered the damage and about 30 larval cases of a plaster bagworm under the rug. She maintained that the damage occurred within a two week period. Damage to the carpet was also found at several other locations in the living room, primarily at the floor/wall junction (Fig. 3). At some of these areas, empty larval cases were found under the edges of the carpet. I conducted a meticulous inspection of the premises for other fabric pests. None were found. A number of live adult moths were found in one dimly

lit corner of the living room. Additional larval cases were taken from: in and on the fireplace, in the chimney, under a sofa, under a sofa cushion, under a chair, under and behind a china cabinet, behind baseboards, under the edges of the carpet, on walls and ceilings of closets, on the living room walls particularly in corners where two walls meet. Larval cases were also found on the stucco and brick walls on the exterior of the entryway to the home. The maid claimed that, at one time, plaster bagworm cases were so numerous on the exterior walls of the entryway that she had to wash them off with a water hose.

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PUPAL DIAPAUSE OF *COLORADIA PANDORA* BLAKE (LEPIDOPTERA: SATURNIIDAE)

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Abstract.—Pupae of the pandora moth, *Coloradia pandora* Blake, were collected in central Oregon and stored at 5° C for 8 to 24 weeks, then incubated at 25° C. The minimum cold storage time required to break diapause was 12 weeks, but emergence rates were highest (87.5%) for 14–18 weeks. In a separate experiment, 1000 pupae were maintained in field enclosures for 3 years while soil temperature was monitored. Seventy-two percent of these pupae emerged in Year 1. Soil temperature fell below 5° C for 21.7, 22.9, and 25.1 weeks over the three consecutive winters, and the minimum soil T was –2° C. In the lab study, ≥ 22 weeks at 5° C limited emergence to <40%, therefore mortality from duration of cold could be considerable in winters such as Year 3. Prolonged (extended) diapause was observed in only 0.6% of the sample population.

Key Words.—Insecta, *Coloradia pandora*, pandora moth, pupae, diapause, phenology, rearing, adult emergence.

The pandora moth, *Coloradia pandora* Blake, a native defoliator of *Pinus* spp. in the western U.S., has a biennial life cycle throughout most of its range (Tuskes et al. 1996). The pupal stage generally lasts 12 to 13 months (June through July the following summer in central Oregon) (Ross 1995, 1996), although pupal diapause as long as 6 year may occur (Carolin 1971). The proportion of the population remaining in diapause beyond 1 yr has been estimated at <5% (Massey 1940) up to “a substantial part of the generation” in some areas (Carolin & Knopf 1968). A recent outbreak of *C. pandora* in central Oregon was characterized by alternating summers of severe defoliation, and summers with dense moth populations. If a substantial proportion of an epidemic population remained in extended diapause, then conspicuous defoliation and moth flights during off-years would be expected, however, this was not observed.

The life histories of abundant, episodic forest insects can influence ecological processes such as predator-prey relationships and host tree physiology. In the case of *C. pandora*, a high incidence of extended diapause would diminish the biennial nature of its life cycle, possibly increasing defoliation stress on host pine trees and enhancing the availability of *C. pandora* pupae as prey for insectivores. Therefore, one objective of this study was to quantify the occurrence of extended diapause in central Oregon. To do this, we tracked emergence of a single cohort of pupae for three years under natural conditions.

The second objective of this study was to determine the length of cold storage required for successful pupation of *C. pandora*. We were interested in minimizing pupal diapause for the purpose of rearing adult moths in the laboratory. Massey (1940) attempted to break diapause by exposing pupae to low temperatures in December, then incubating the pupae at 21–27° C. He did not specify the cold storage temperature or duration of exposure, and his pupae required 4 months

exposure to high temperatures before any development was noted. Time to emergence generally decreases with the duration of exposure to cold, provided the temperatures are within an acceptable range for the species (Danks 1987). Our cold storage experiment, in conjunction with the extended diapause study, provided some insight about environmental conditions that could promote extended diapause in *C. pandora*, and conditions that could cause mortality in the pupal stage.

METHODS AND MATERIALS

Cold Storage.—Pupae were collected 1 November 1992 in an area of the Deschutes National Forest, Oregon, that had been heavily defoliated the previous spring based on USDA Forest Service Region 6 aerial surveys. The pupae were covered with sandy soil and refrigerated at 2 to 5° C for a minimum of eight weeks. After eight weeks, eight female and eight male pupae [sexed according to characteristics of the fourth and fifth abdominal segments (Tuskes et al. 1996)] were transferred to 4 liter paper buckets with screen tops, covered minimally with sand and incubated at 25° C in a rearing room with a 16:8 light:dark photoperiod. Another 8 female and 8 male pupae were removed from cold storage at 12, 14, 16, 18, 20, 22 and 24 weeks. Soil in the refrigerator and sand in the rearing room were misted with water several times weekly. Female and male emergence was monitored daily.

Extended Diapause.—Pupae were collected on 15 June 1995 from 2 locations in Pringle Falls Experimental Forest, about 45 km SW of Bend, Oregon. These sites had been moderately to heavily defoliated by the current generation, but not the previous generation of *C. pandora* based on USDA Forest Service Region 6 aerial surveys, so the pupae were unlikely to be more than 1 year old. Two hundred pupae were laid in the bottom of each of 5 screen enclosures (0.9 × 0.9 × 0.9 m) and covered with ≈6 cm top soil. Three of the enclosures were located within the Pringle Falls Research Natural Area in a mature stand of ponderosa pine, and the other 2 enclosures were placed 4 km distant at the Pringle Falls Research Forest Headquarters under a similar canopy. Adult emergence was tallied by gender for each enclosure on 3 or 4 dates in July and August from 1995 through 1997 (Year 1–Year 3). A soil and air temperature monitor (Omnidata Datapod® model DP-212, Logan, Utah) was installed in November 1994, to document exposure to cold temperatures in the first winter of pupal diapause prior to collecting the pupae, and for the remainder of the experiment. The soil temperature probe was buried at the same depth as the pupae (6 cm), and the air temperature probe was placed next to one of the enclosures at the Headquarters location. The Datapod® recorded maximum, minimum, and average daily temperatures.

RESULTS AND DISCUSSION

Cold Storage.—No adults emerged from the cohort receiving 8-weeks cold storage, even after 177 days at 25° C. Successful completion of diapause was first observed for pupae in the 12-week treatment group (Fig. 1). Optimal survival rates (87.5%) were achieved with 14 to 16 weeks at 5° C for males and 16 to 18 weeks for females. Female emergence lagged behind that of males, indicating protandry (Fig. 1). The length of time to emergence at 25° C declined with in-

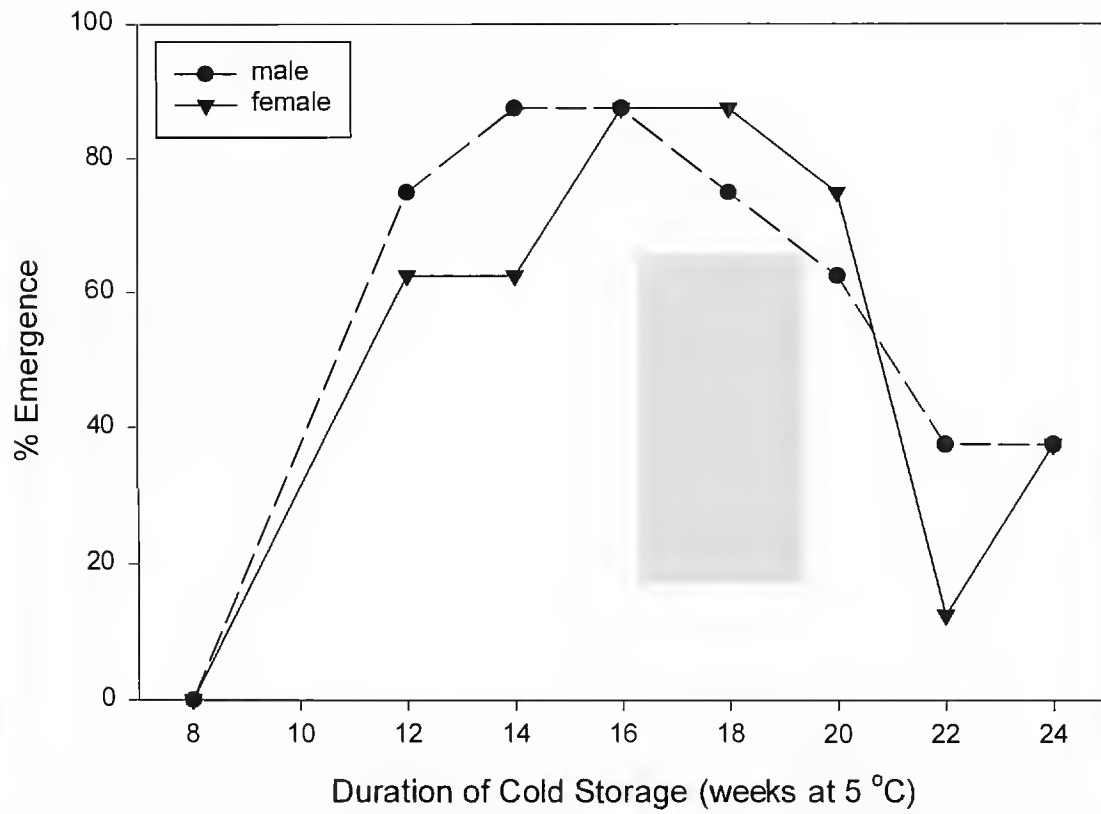


Figure 1. Percent *C. pandora* adult emergence relative to length of cold storage at 5° C. *n* = 8 female and 8 male pupae per time period.

creasing time in cold storage (Fig. 2). Pupae stored for 24 weeks at 5° C required 1 month less time at 25° C to complete diapause compared to pupae in cold storage for 12 weeks. Linear regression of time to emergence on the length of cold storage revealed that, for each additional week of cold storage, the incubation time declined by 3 days. Thus in a laboratory situation, additional cold storage beyond the minimum required to break diapause would not be time efficient, except that the rate of successful emergence was not constant (Fig. 1). The uni-

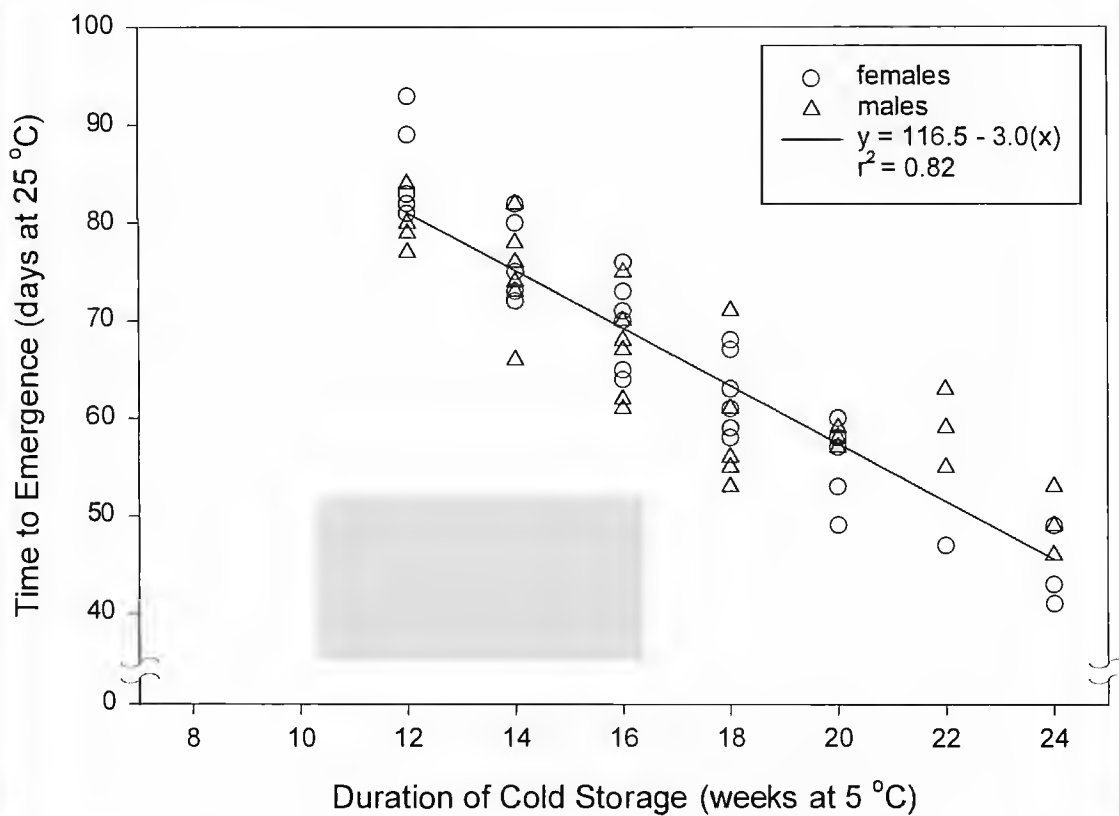


Figure 2. Incubation time at 25° C needed for *C. pandora* adult emergence relative to duration of 5° C cold storage period of pupae.

Table 1. Emergence rates of *Coloradia pandora* adults for 5 enclosures, each containing 200 pupae.

Enclosure	Year 1 %	Year 2 %	Year 3 %	Total %
A	74.0	0.5	0	74.5
B	70.5	0.5	0	71.0
C	73.5	0.5	0	74.0
D	75.0	0	0	75.0
E	66.5	1.5	0	68.0
Mean	71.9	0.6	0	72.5

form incubation temperature of 25° C was selected to favor rapid development, rather than to mimic field conditions. Soil temperatures measured in the field during the extended diapause experiment never exceeded 23° C.

There is a cold duration threshold between 8 and 12 week below which *C. pandora* pupae from this population are physiologically unable to complete diapause. Half of the pupae in the 8-week cold treatment group were dissected following the experiment and were found to be undifferentiated and apparently still viable. Because this experiment did not incorporate cold storage treatments between 8 and 12 week, we cannot determine the threshold more precisely. Twelve weeks should be considered minimal because the pupae in this experiment may have had some prior exposure to temperatures <5° C. They were collected from the field on 1 November 1992, and subsequent monitoring in 1995 and 1996 for the extended diapause experiment indicated that soil temperatures may drop below 5° C in the later half of October. Therefore, the actual length of cold treatment these pupae received could have been several weeks longer than treatments imposed in the lab.

Cold exposure in the pupal phase may not be prerequisite to adult emergence throughout the range of *C. pandora*. There are three geographically disjunct populations of the nominate subspecies (Tuskes et al. 1996). Central Oregon is the northern extent of the western distribution which extends south into California and Nevada. By several accounts (Aldrich 1921, Tuskes 1984), some adults in the isolated population of southern California have been observed emerging after just 2 months of pupation. Significant latitudinal variation in pupal diapause is common (Danks 1987, Tuskes et al. 1996). For example, the saturnid *Automeris io* (Fabr.) produces both diapausing and non-diapausing pupae in the lower latitudes of its range (Manley 1993).

Extended Diapause.—In Year 1, 67 to 75% of the pupae in the 5 enclosures successfully completed diapause (Table 1). An additional 0 to 2% emerged in Year 2, and none emerged the 3rd year following pupation, indicating extended diapause was rare in the sample population. Most of the pupae remaining in the enclosures after 3 years were desiccated, a few were moldy, and 4 appeared potentially viable upon dissection. Total emergence rates in the field enclosures (grand mean = 72.5%, Table 1) fell below the maximum successful pupation rates of the cold storage experiment (87.5%, Fig. 2), but this may be explained by soil temperatures. Soil temperatures averaged $\leq 5^\circ$ C for at least 152 days (21.7 weeks in Year 1 (Fig. 3A), so based on results from the cold storage experiment, we might expect successful pupation rates as low as 20–40% (Fig. 1). If the

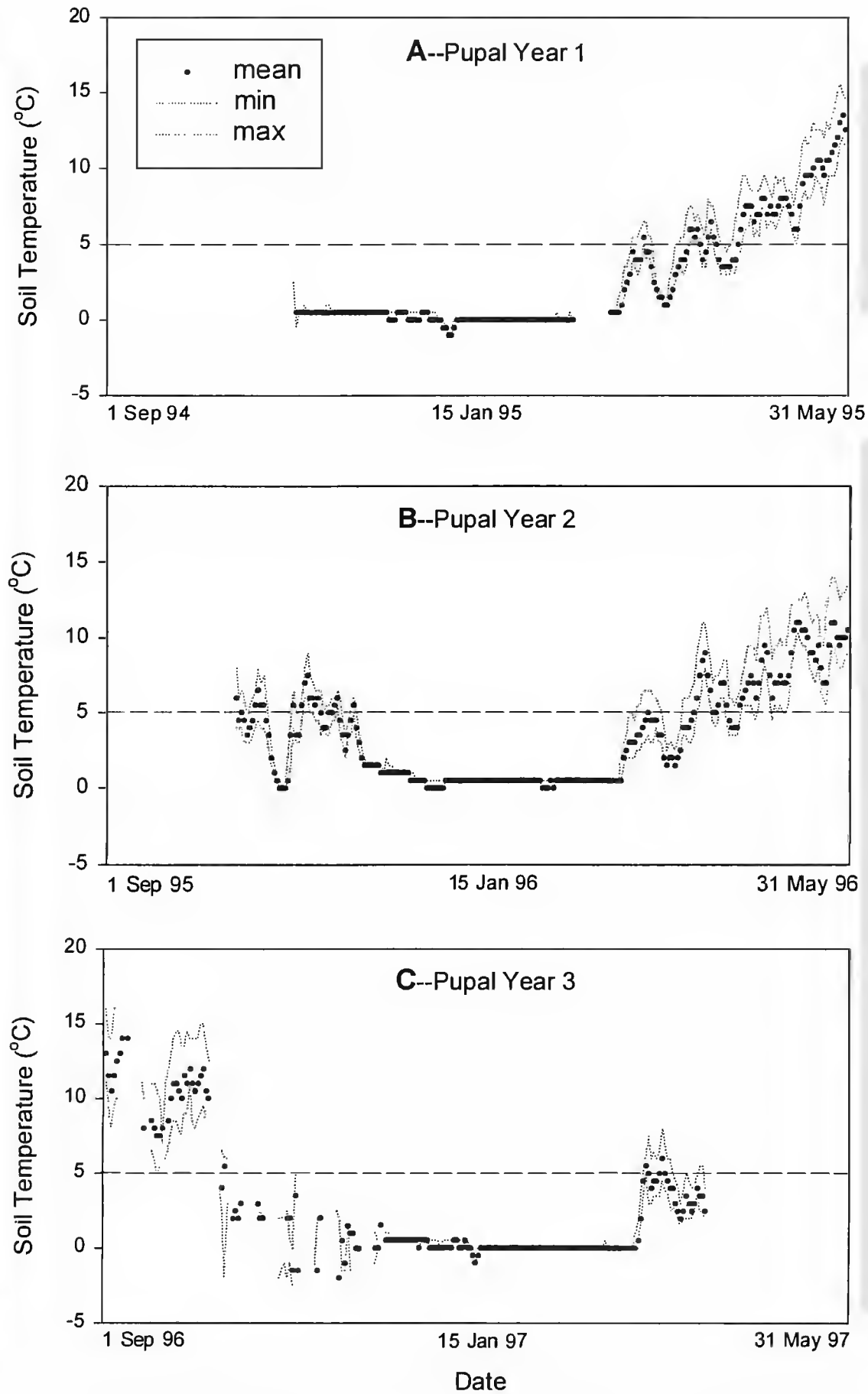


Figure 3. Daily soil temperatures at Pringle Falls Headquarters, Deschutes National Forest, Oregon. Temperature probe at 6 cm depth. (A) 1st year, (B) 2nd year, (C) 3rd year of pupal diapause.

pupae used for the cold storage experiment actually did have 1–2 weeks additional exposure in the field prior to collection, then the expected successful pupation rate for 22 weeks at 5° C would be 63–75%, which corresponds well with the emergence rate from the extended diapause experiment. During the winter of Year 2 there were 22.9 weeks with soil temperatures $\leq 5^{\circ}$ C, and in Year 3 there were 25.1 weeks $\leq 5^{\circ}$ C (Fig. 3B, 3C). These data, along with the cold storage results,

suggest that the duration of cold soil temperatures in central Oregon probably restricts the maximum successful pupation rates for *C. pandora*, perhaps as much as 60% over a long winter.

Winter mortality in other moth species is a function of degree, as well as duration, of cold (Turnock et al. 1983). Diapausing *A. io* pupae tolerate air temperatures in excess of -18°C , but freezing temperatures extend the duration of diapause (Manley 1993). The degree of sensitivity of *C. pandora* to freezing temperatures is unknown. In the first year of the extended diapause experiment, the minimum recorded soil temperature was -1°C and 72.5% of the pupae survived. Over 3 winters, soil temperatures hovered around 0°C for extended periods (Fig. 3) despite marked fluctuations in air temperatures, thus it seems likely that duration, rather than degree of cold, would cause winter mortality under typical field conditions. *Coloradia pandora* pupate about 6 cm below the soil surface in central Oregon which buffers exposure to cold. Snow cover can dramatically reduce winter mortality from freezing temperatures (Turnock et al. 1983), but persistence of the snow pack in spring could lengthen pupal exposure to cold by slowing soil warming. The insulating effects of leaf cover and snow have been shown to influence pupal development of *A. io* (Manley 1993). An open forest canopy that intercepts less snow in winter and allows for rapid snow melting in spring might be favorable to *C. pandora* pupation. Decreased canopy cover (Ross 1995), lower elevation and southerly aspect (Schmid 1984), all of which hasten melting of snow and possibly reduce the duration of cold soil, are known to promote earlier emergence of adult *C. pandora*. There is also some evidence that water from snowmelt may trigger developmental processes in diapausing insects (Danks 1987).

Synchronized emergence and protandry are characteristics of the temporal emergence patterns of lepidopteran populations that favor successful mating (Tuskes et al. 1996). *Coloradia pandora* appears to utilize both strategies to some extent. Moths emerge throughout a 30- to 40-day period, but the peak emergence period lasts about 7 days (Schmid 1984, Ross 1996). Overall emergence in our field enclosures was fairly coincident in Year 1 as 95% of the moths which emerged did so within a 2-week period (Fig. 4). More frequent observations may have narrowed this time frame. Adult *C. pandora* may live 7–10 days (Schmid 1984, personal observation) so this peak period is relatively broad compared to some shorter lived saturniids having synchronized emergence within several days (Tuskes et al. 1996). Protandry slightly offsets the synchrony of emergence toward males first, which may benefit the population by increasing the likelihood that females are able to mate and lay eggs soon after emergence (Tuskes et al. 1996). In Year 1 of the extended diapause study, 85% of male emergence and 70% of female emergence occurred by July 28 (Fig. 4). Protandry also was observed in the cold storage experiment (Fig. 1) and in other *C. pandora* studies (Massey 1940, Schmid 1984). A total of 299 females and 420 males emerged in Year 1, suggesting the sex ratio in the population may have been biased in favor of males. However, the one-thousand pupae in the enclosures initially were not sexed, so it remains possible that higher mortality rates in female pupae caused fewer adult females to emerge.

Coloradia pandora pupae are food for golden-mantled ground squirrels (*Spermophilus lateralis* Say), white-footed deer mice (*Peromyscus maniculatus* Wag-

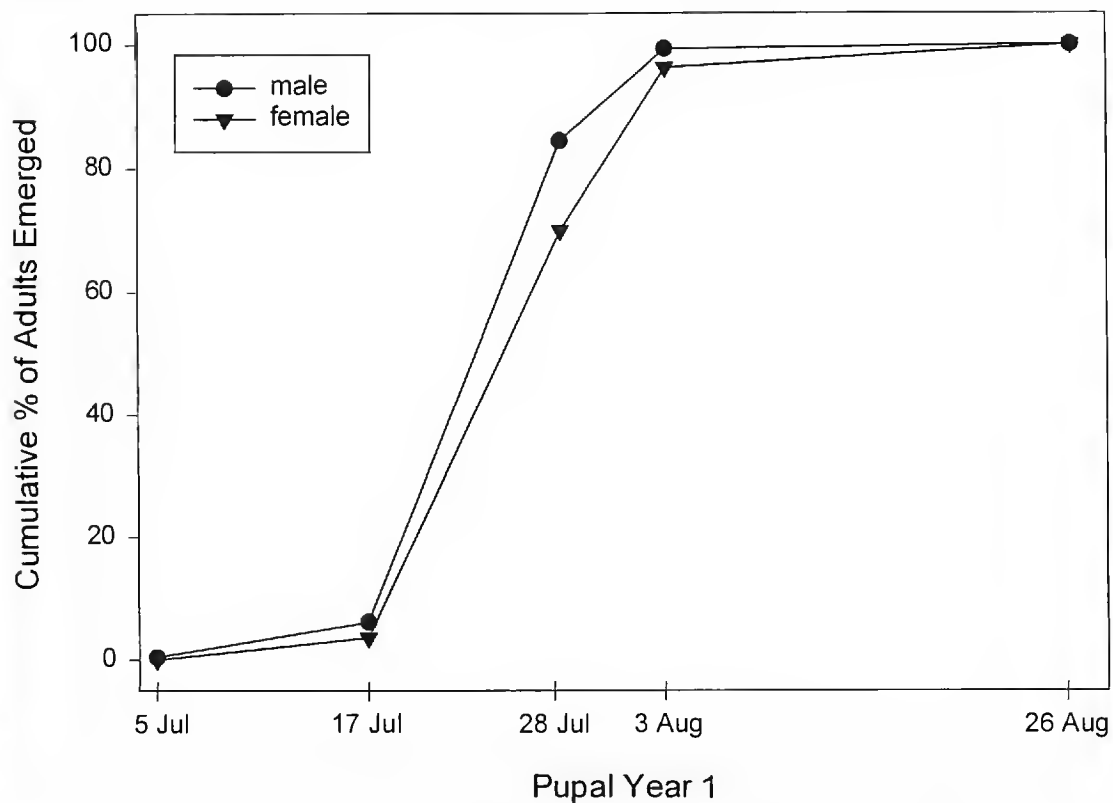


Figure 4. Cumulative emergence pattern for adult *C. pandora* moths. Percentages are based on the total number of males and females emerged in the 1st year of pupal diapause.

ner), and possibly other wildlife in central Oregon (unpublished data). Extended diapause in a biennial insect would provide a more reliable prey base for insectivores utilizing only the pupal stage. Fecundity and survivorship of wildlife with short lifespans (1–5 year), such as deer mice and ground squirrels, may be influenced by annually fluctuating food resources. In our study, less than 2% of pupae remained viable (i.e., edible) beyond 1 year of development, hence they would constitute a biennial food source in central Oregon. Carolin's (1971) paper on extended diapause has been interpreted as indicating that *C. pandora* provided an annual food base for aboriginal Paiute tribes in California, despite the biennial cycle of *C. pandora* (Weaver & Basgall 1986; but see Fowler & Walter 1985, Blake & Wagner 1987). In areas with milder winters (< 12 weeks below 5°C), *C. pandora* pupae could possibly hold over a second year in order to acquire the requisite cold period to complete diapause; but it is also possible that univoltinism created an annual supply of larvae in southern California (Tuskes et al. 1996).

Geographical differences in environmental regimes may explain Carolin's (1971) observations of extended diapause. He also collected pupae in central Oregon, but he held them over winters in Portland, Oregon which has a relatively mild, maritime climate. Carolin's data showed 18% of pupae emerged in their 2nd year, and another 37% emerged the 3rd year. However, even more important is the fact that his initial population of pupae were culled from unemerged pupae remaining after a large flight year. Therefore, the extended emergence rates Carolin reported are not applicable to whole populations.

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information and convenience of the reader and does not constitute official endorsement or approval by the U.S. Department of Agriculture.

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Scientific Note

NEW HOST RECORDS FOR THE BLACK POLYCAON

The black polycaon, *Polycaon stoutii* (LeConte) (Coleoptera: Bostrichidae) is a wood-boring beetle which occurs in British Columbia, Washington, Oregon, California, and Arizona (Ebeling, W. 1975. Urban entomology. Univ. of Calif. Press, Berkeley, California; Fisher, W. S. 1950. USDA Misc. Publ., 698). It has been reported to attack alder, curing eucalyptus logs, and three-ply panels which are used for making desks and other furniture (Doane, R. W. et al. 1936. Forest insects. McGraw-Hill Book Company, New York). Other host records include maple, oak, fruit trees, California laurel, madrone, manzanita, sycamore, and other native California trees (Essig, E. O. 1958. Insects and mites of western north America. The Macmillan Company, New York). The black polycaon has also been reported from white ash, *Fraxinus americana* L. an eastern hardwood species (Seybold, S. J. & D. L. Wood. 1993. Pan-Pacific Entomol., 69:33–35).

This paper reports two new host records for the black polycaon and describes a case history of an infestation in a hardwood warehouse in southern California.

On 30 October 1998, portions of infested hardwoods from a hardwood lumber warehouse in Santa Ana, Orange County, California, were brought to my office for identification purposes. Examination of the wood revealed the presence of adult beetle emergence holes in a few pieces of lumber. Further cutting of the wood revealed tunnels which were loosely packed with coarse frass (Fig. 1). Two live larvae, one full grown, were retrieved when portions of infested wood were dissected. The larvae and the type of damage present in these lumber are consistent with the activity of the black polycaon. An adult *P. stoutii* subsequently emerged from infested wood which was held at room temperature in an insect rearing cage confirming that this infestation was indeed that of the black polycaon.

On 2 November 1998, I visited the lumber yard in question and inspected several piles of hardwood lumber which were of concern to the owners. Piles of bostrichid frass were found in several areas of the stacks of lumber. The infested woods were American cherry (fruitwood), *Prunus serotina* Ehrhart and North American black walnut, *Juglans nigra* L. This is the first record of *P. stoutii* from these two eastern hardwood species. The principal source of both of these hardwoods is the eastern United States (Paxton, F. 1987. Beautiful hardwoods. Frank Paxton Company, Kansas City, Missouri).

According to the lumber company's records, the American cherry and North American black walnut in question originated from Bellplaine, Iowa. The infested lumber had been in storage in their warehouse in Santa Ana since September 1997. The records also show that this lumber was steamed and kiln-dried in Iowa prior to shipment to California. Upon completion of these processes, the moisture content of the woods was reported to be in the range of 6 to 8%. These procedures would have certainly killed any wood-boring insects which may have been present in the raw lumber. The fact that the black polycaon is not known to occur in Iowa and the lumber was kiln-dried prior to shipment ruled out the possibility that this infestation originated at the point of shipment. The owners of this lumber ware-



Figure 1. Black polycaon damage to hardwood taken from a lumber yard in Santa Ana, California.

house were keenly interested in the origins of this infestation because they were hoping that the shipper would be liable for the cost of eradicating the infestation. The owners of this lumber warehouse were concerned about the 22 species of hardwoods held in storage with an inventory value of millions of dollars. The source of this black polycaon infestation was from indigenous populations of this beetle. This bostrichid can complete a generation in one year (Ebeling 1975; Furniss, R. L. & V. M. Carolin, 1977. Western forest insects. USDA Misc. Publ., 1339). The infested wood in this incident had been in storage in Santa Ana for more than one year. This is certainly enough time to allow for adult emergence and other external manifestations of the infestation. It should be noted here that moisture content readings taken from both species of hardwoods on 2 November 1998 were 10.1%.

The black polycaon flies at night (Ebeling 1975), and it is attracted to bright lights particularly mercury vapor lamps. Over the years, I have encountered two cases where adult beetles were drawn to structures by external lights. In August 1990, on Fourth Street in Rancho Cucamonga, San Bernardino County, California, black polycaon were attracted by lights to a large defense contractor building, which was surrounded by wine grape vineyards, in such numbers that they created a nuisance. In August 1997, *P. stoutii* was found on and around a large glass-type structure located on Irvine Center Drive, Irvine, Orange County, California. This building is illuminated at night by four large banks of light which are located in concrete pits in the ground at the four corners of the structure. Bright beams of light are projected upwards on and towards the top of the structure. The property management company stated that the illuminated structure served as a good source of publicity because it attracts the attention of nighttime commuters traveling on the nearby freeway. These lights also attracted large number of other insects to the structure creating a nuisance.

It is recommended that hardwood lumber yards and lumber warehouses do not

use exterior mercury vapor lamps. These lamps will attract wood-boring beetles to the area creating a situation which is conducive to infestations of stored lumber.

Acknowledgment.—I thank Stoy Hedges and Ken Hobbs for reviewing the manuscript and offering suggestions for its improvement.

Hanif Gulmahamad, *Terminix International, 1501 Harris Court, Anaheim, California 92806.*

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PAN-PACIFIC ENTOMOLOGIST
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See volume 74: 248–255, October 1997, for detailed general format information and the issues thereafter for examples; see below for discussion of this journal's specific formats for taxonomic manuscripts and locality data for specimens. Manuscripts must be in English, but foreign language summaries are permitted. Manuscripts not meeting the format guidelines may be returned. Please maintain a copy of the article on a word-processor because revisions are usually necessary before acceptance, pending review and copy-editing.

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Blackman, R. L., P. A. Brown & V. F. Eastop. 1987. Problems in pest aphid taxonomy: can chromosomes plus morphometrics provide some answers? pp. 233–238. In Holman, J., J. Pelikan, A. G. F. Dixon & L. Weismann (eds.). Population structure, genetics and taxonomy of aphids and Thysanoptera. Proc. international symposium held at Smolenice Czechoslovakia, Sept. 9–14, 1985. SPB Academic Publishing, The Hague, The Netherlands.
Ferrari, J. A. & K. S. Rai. 1989. Phenotypic correlates of genome size variation in *Aedes albopictus*. *Evolution*, 42: 895–899.
Sorensen, J. T. (in press). Three new species of *Essigella* (Homoptera: Aphididae). *Pan-Pacif. Entomol.*

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Obituary: David W. Moss, Jr. (1947–1997)LARRY G. BEZARK¹ AND CLIFFORD Y. KITAYAMA²¹California Department of Food and Agriculture, Sacramento, CA 95814²Scientific Methods Inc., P.O. Box 599, Durham, CA 95938

Dave Moss: That name brings back a lot of memories for those of us who attended at San Jose State University with him. Although he was well known as the “party man,” a moniker not unwarranted, Dave represented the enthusiasm of a core of young students in the Biology Department hungry for knowledge. We shared medical entomology and larval taxonomy classes and along with the encouragement and enthusiasm of J. Gordon Edwards (‘Doc’), our interest in the field of entomology intensified. Entomology was no longer a simply a branch of biology to be studied in the laboratory but it became a way of life. It became fun to collect, study and learn about insects. It became a passion and there were people who shared that passion and enthusiasm. Dave Moss was one of those individuals who had that passion. He desired to learn as much as he could about insects and that meant spending time in the field as well as in the laboratory. Dave loved to be outdoors and collecting insects was a way to learn about them that transcended the textbook.

We fondly remember the many great collecting trips with Dave to local haunts or far away places. The trips up to Mt. Hamilton to collect *Rhagium inquistor* (Linnaeus) and trips to the local cherry tree orchard to pick up *Synaphaeta quexi* (LeConte), or walking to Williams Street Park, and pulling bark off dead trees in search of beetles. Weekend trips to blacklight bugs over the hill to Frank Raines Park, and adventures seeking the cicada-killer wasp, *Sphecius*. Whittaker’s Forest trips to collect everything and anything. Walking the creeks of Castle Rock Park and Uvas creek at Sveadal chasing *Amphizoa*. Week long trips to Arizona during spring break or during the summer, driving all night, sleeping in tents or our cars, running the blacklights all night long and dividing up the catch after we got home.

And while field trips offered a wide array of experiences outside of the classroom, we spent countless hours with Dave in the laboratory after trips were over, sorting, sharing and curating specimens, eating Togos sandwiches while poring over keys trying to figure out the identities of our catch, comparing material with identified specimens in the collection and wondering why our specimens didn’t fit the keys.

Dave, like many of Doc’s students gravitated towards the Coleoptera and eventually he settled on the elateroids as his group. Dave amassed a sizable collection of click beetles and developed considerable literature resources with the help of modern technology. Correspondence with specialists in other countries provided Dave with specimens and a broader understanding of the group. He was always willing to provide identifications and many of the click beetles in the San Jose State University entomology collection bear Dave’s identification labels.

Not being solely devoted to beetles, Dave also had a significant interest in agricultural entomology and parlayed that interest into a long tenure at Zoecon, a research firm in the bay area, where he worked in the insectary rearing large numbers of tobacco hornworms and other species of insects that were used for

research studies on economic pest problems. Some of the techniques he acquired in the insectary were shared with fellow students and at times the labs at school had several rearing projects in progress. One such project involved attempting to rear larvae of *Brachypsectra fulva* LeConte, the Texas beetle. The larvae were collected from under the bark of Eucalyptus trees in the Imperial Valley, and despite a steady supply of *Manduca* eggs which Dave provided, these fascinating immatures fed little and only a few pupated.

Dave Moss was a passionate man who possessed great enthusiasm for the field of entomology. His enthusiasm was contagious and many fellow students were affected. He organized numerous collecting trips which turned out to be great adventures for all those involved. He never let his battle with juvenile diabetes affect his enthusiasm or his desire to learn. Although Dave's accomplishments in entomology did not result in publications, it is appropriate that as a member of the Pacific Coast Entomological Society (from 1975 through 1982) and faithful attendee of its meetings at the California Academy of Sciences during his active entomological career, that he be recognized for his accomplishments. Dave earned his Bachelors degree in entomology in 1973 and he was an integral part of a time at San Jose State when entomology was special. Students present during this period of time shared a common bond, studied together, collected together and even those who graduated during different eras still share the common bond of an entomological education from San Jose State. You can find specimens from his many collecting efforts in San Jose State's J. Gordon Edwards insect collection.

What else can you say about him? He always had a grin on his face and always rolled with the punches. You could always walk into his house and not feel like you were intruding, in fact most of the time you were likely to be given a meal. If you were looking for a good time, he was always willing to help you look for it. If you needed help, Dave was there. He loved clickers.

Dave is survived by his wife Mercy Moss, and their three children; Priscilla, Tacy and David W. Moss, the third.

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LATE HOLOCENE SONORAN DESERT ARTHROPOD REMAINS FROM A PACKRAT MIDDEN, CATAVIÑA, BAJA CALIFORNIA NORTÉ, MÉXICO

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Abstract.—Arthropods are reported for the first time from a late Holocene-aged (1770 ± 60 radiocarbon years B.P.) packrat (*Neotoma*) midden located in a granite boulder field in the Cataviña region of the Central Desert, Baja California, México. More than 23 arthropod taxa have been identified from 315 fragments found in a subsample of the midden. Ten of these taxa have not previously been reported from *Neotoma* midden assemblages. Coleoptera (beetles) and Hymenoptera, Formicidae (ants) are the dominant forms recovered, possibly reflecting a taphonomic bias. We compared the taxa found in the midden assemblage with that found at the site today and found little difference, however a study of the midden plants has revealed that the modern vegetation and climate are drier than ~ 1770 years ago.

Key Words.—Insecta *Neotoma* (packrat) midden, Central Desert, Baja California, Mexico, Holocene, arthropods, beetles, ants.

Resumen.—Se reportan por primera vez artrópodos provenientes de un depósito de *Neotoma* del Holoceno tardío (1770 ± 60 años de antigüedad, fechado por C^{14}) localizado en un área de rocas graníticas en la región de Cataviña, en el Desierto Central de Baja California, México. Se identificaron más de 23 taxa de artrópodos de 315 fragmentos encontrados en una submuestra del depósito. Diez de estos taxa no habían sido reportados previamente para los depósitos de *Neotoma*. Las formas dominantes recuperadas fueron Coleoptera (escarabajos) e Hymenoptera (hormigas, Familia Formicidae), posiblemente reflejando un sesgo tafonómico. Comparamos los taxa encontrados en el depósito con los que se encuentran actualmente en el sitio y hallamos poca diferencia, sin embargo un estudio de las plantas del depósito reveló que la vegetación y el clima modernos son más secos que hace ~ 1770 años.

Fossil arthropods have received recent attention (Carpenter 1992a, b; Buckland & Coope 1991) especially from packrat (*Neotoma* spp.) middens (Ashworth 1973, 1976; Elias 1987, 1990, 1994; Elias & Van Devender 1990; Elias et al. 1992; Hall et al. 1988, 1989, 1990; Hebda et al. 1990; Morgan et al. 1983; Spilman 1976; Van Devender & Hall 1994). The objectives of this paper are to describe the arthropod assemblage from a midden and to compare it with that presently found in the area. *Neotoma* fecal pellets in this midden have been dated at 1770 ± 60 radiocarbon years B.P. Only two other packrat (*Neotoma*) middens have been reported in the literature from the peninsula of Baja California, México. The first is located near San Fernando and was discovered by Philip Wells (Axelrod 1979a, b; Van Devender et al. 1987; Wells 1969, 1976). These reports mention only two plants (*Juniperus* and *Prunus*) and three radiocarbon dates of the midden (10,000 years BP). The second midden was collected by a College of Idaho field

expedition during January 1984 to the Cataviña study site (Wells 1986). The midden contained *Juniperus*, and was radiocarbon dated at nearly 18,000 years BP. No detailed description of the middens are given and no mention of arthropods were reported in these publications. The present study expands this base of information and documents the first arthropods from a packrat midden in the peninsula of Baja California, México.

The packrat currently inhabiting the Cataviña area is *Neotoma lepida* Thomas (Huey 1964, Hall 1981). We have live-trapped numerous *N. lepida* at this study site.

There are a variety of reasons arthropods occur in packrat nests/dens: 1) seasonal inhabitants; 2) transported in on plants; 3) incidental visitors; and 4) those that are peculiar to the site (Davis 1934). Aalbu & Andrews (1992) have shown that at least one species of beetle feeds on *Neotoma* pellets. It may be difficult to determine exactly how some arthropods ended up in the midden but regardless the samples make a good datable record of past species and conditions (Van Devender & Hall 1994). We compared taxonomic groups found in the midden with those reported from stored food products (Olsen et al. 1996) because there may be similarities in the microhabitats of the two.

Many other *Neotoma* middens have been found at the Cataviña site, including several from the same boulder area. We report here the results of examination of the youngest midden found to date.

MATERIALS AND METHODS

Location and Habitat.—This midden is located 9 km northwest of Rancho Santa Inés, Baja California, México (Lat. 29°46' N, Long. 114°46' W, elevation 550 m). It is a mid-peninsular locality of the Central Desert in the Cataviña region (Bratz 1976) (Figs. 1 and 2). The area is characterized by the shrubs *Larrea tridentata* (Sessé and Mociño ex Decandolle) Coville, *Ambrosia dumosa* (A. Gray) Payne and *Ambrosia chenopodifolia* (Bentham) Payne, and by the cacti *Opuntia cholla* Weber, *Opuntia molesta* Brandegee, *Pachycereus pringlei* (S. Watson) Britton and Rose, *Lophocereus schottii* (Engelm.) Britton and Rose, *Ferocactus gracilis* Gates, and the boojum, *Fouquieria columnaris* Kellogg (Blom & Clark 1984). The cholla cactus *Opuntia ganderi* Rebman & Pinkava is common at the site (Rebman 1995). Mesquite, *Prosopis glandulosa* Torrey var. *torreyana* (L. Benson) M. C. Johnston is found in the Central Desert (Wiggins 1980) and at the site and is the dominant plant found in this midden (Sankey et al., unpublished data).

The mean annual precipitation for the Cataviña area is about 96 mm (3.8 in) with a mean annual temperature of 18.4° C ($n = 14$ years, 1956–1967) (Hastings 1964, Hastings & Humphrey 1969). Using 24 years of additional data, García (1981) reports the mean annual precipitation for the area as 101.7 mm (4 in) and temperature 19.0° C. Fifty percent of the precipitation occurs in the three winter months (Dec–Feb) and about another thirty percent of the precipitation occurs during the fall (Sep–Nov) (García 1981). Spring and summer receive little precipitation. Blom & Clark (1984) reported 46 mm of precipitation at the site from 9 Jul 1981 through 4 Jan 1982.

Precipitation measured at the site since that time appears to be less than that reported by García (1981) except for the 1990–1991 winter season (Clark, un-

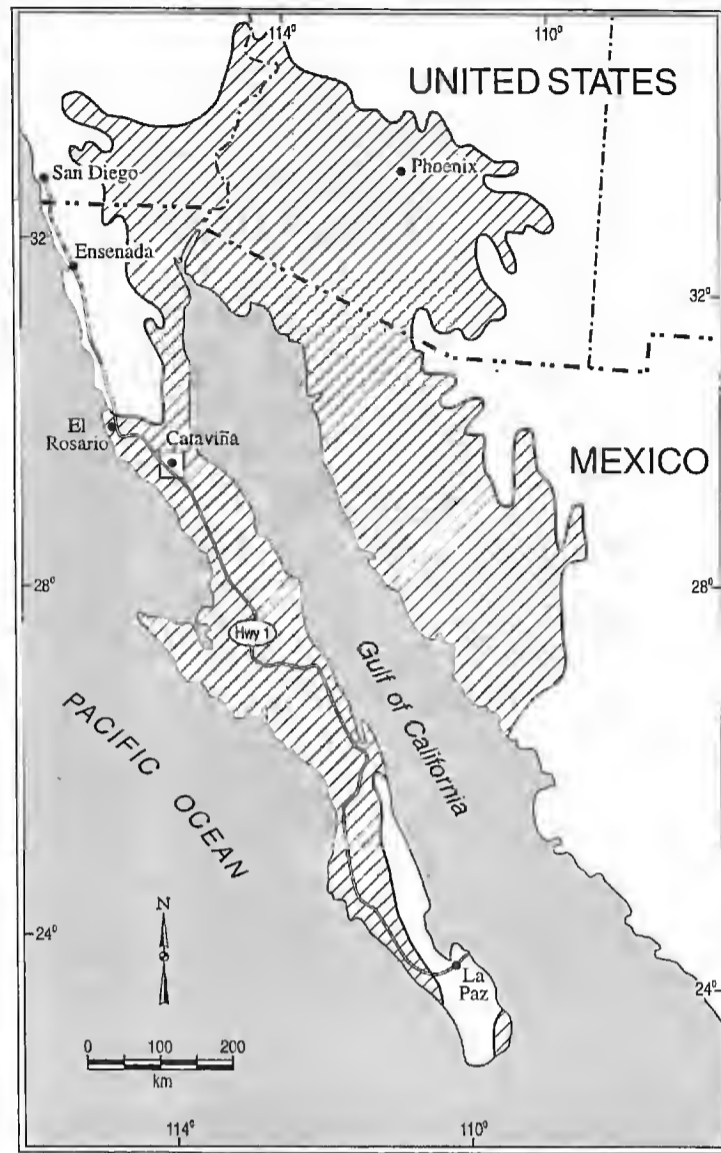


Figure 1. Map of the peninsula of Baja California, México, showing general location of the Cataviña region and an outline of the Sonoran Desert (cross hatched).

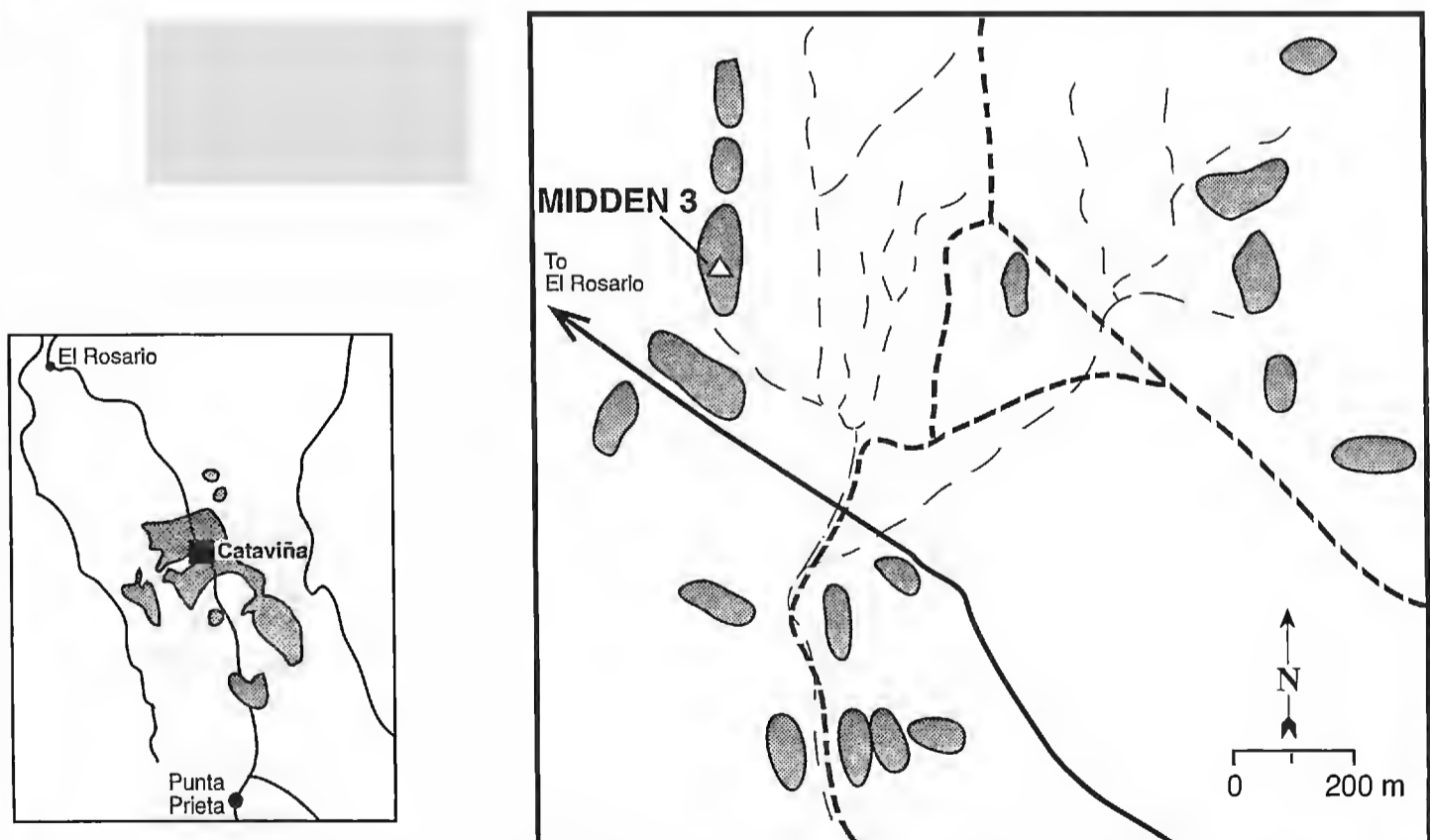


Figure 2. Map of the site showing the main areas of granite boulder outcrops (stippled) in the Central Desert, Baja California, México and the Cataviña site and the location of midden #3.

published data). Clark et al. (1993) reported 430 mm (16.9 in) of precipitation at this site from April 1985 through July 1991 for an average of about 61 mm per year. Mean summer temperatures are 25.8° C and mean winter temperatures are 13.2° C ($n = 24$ years) (García 1981). The above publications only list monthly averages of temperature. Through the use of maximum-minimum thermometers and individual observations during some winter months in some years Clark (unpublished data) has recorded freezing temperatures in this area. During the 1989–90 winter max-min thermometers in two different areas (one near granite boulders and one in the open) recorded lows of -3° C and -9° C, respectively.

The weathered Cretaceous granite rocks of the Jaraguay block (Gastil et al. 1975) form ideal areas for the preservation of water soluble middens. The midden (#3) reported here is located in a boulder pile approximately 10 m in elevation above the surrounding sandy wash (Fig. 3). The midden is wedged into a crack of large granitic rock, and is about 3 m below the top of the boulders (Fig. 4). The front of the midden is exposed to light from an opening in the boulders above but is protected from direct precipitation.

Midden.—The midden is 2 m in length and 1 m in width (Fig. 4). It is stratified, with the clearest stratification between the top 0.5 cm of unindurated, loose pale yellow plant material (subsample a) and the remaining 20–25 cm deep section of indurated, compacted, and stratified plant material. The radiocarbon date (Beta Analytic Inc. sample #30453) was obtained from a sample of *Neotoma* fecal pellets from the midden.

Material Examined.—A 652 g sample was soaked in distilled water for four days, until it was completely disaggregated. The arthropod and plant material was recovered after passing the liquid through a number 20 mesh (0.84 mm) soil sieve. After washing, 237 g of material remained (36.3%). The liquid was saved for pollen analysis (Sankey et al., unpublished data).

The dry material (237.0 g) remaining was separated into arthropods and vegetation under a dissecting microscope using low power. Individual arthropods and arthropod fragments were mounted on standard entomological card points with water soluble white glue (Borrer et al. 1989).

The arthropod material was then identified using entomological keys (Arnett 1985, Borrer et al. 1989) and by consulting specialists. Extant arthropods have been collected at this site since 1976 (Blom & Clark 1980, 1984, 1988; Hovore 1988; Papp 1989; Shook 1989; Leschen 1996; Triplehorn 1996) using pitfall traps (Clark & Blom 1992), mailaise traps, UV light traps, bait traps, pan traps, and a variety of hand collection techniques (Clark & Blom 1979, 1989, 1992) and these specimens were used to compare with the arthropod fragments found in the midden.

Voucher specimens of the arthropods, plants, and *Neotoma lepida* (vertebrate catalog numbers 46, 654, 655, and 656) are located in the Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell (ALBRCIDA).

RESULTS AND DISCUSSION

The following is a description of the identified arthropod remains from the subsample (315 arthropod fragments) of this *Neotoma* midden (Table 1). Taxa identified are briefly described with their known occurrence in *Neotoma* middens, known present occurrence in the Cataviña area (taken from the literature and our museum collection), and a brief account of their ecological status.

Archnida: Chelonethida (Chernetidae)

Material.—Two palpal chelae. These are from two individuals, one adult and one a tritonymph.



Figure 3. Photographs of the Cataviña site boulder area containing midden #3: a) boulder area from a distance showing shrubs, including mesquite on the left in the sandy wash; b) close-up of the boulder area showing no mesquite in the boulders.



Figure 4. Photograph of the Cataviña site, midden #3 in a granite rock crack. The midden is approximately one meter in width and two meters in length. The edge of the midden is indicated by the white arrow.

Occurrence in Packrat Middens.—Pseudoscorpions have previously been reported from middens (Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—Several pseudoscorpions of the family Chernetidae have been collected at this site in pitfall traps and were also found to be phoretic on Cerambycidae (Coleoptera).

Discussion.—These were the only arachnids found in the midden. The chelae are very chitinous and might be the only parts of the pseudoscorpions to survive. Pseudoscorpions often live around rock cracks and in litter and other organic deposits (Weygoldt 1969, Muchmore 1990) and stored-food products (Olsen et al. 1996) thus find good habitat in *Neotoma* nests.

Insecta

The majority of the arthropods collected in this midden are insects and most of these insects are beetles (Coleoptera) (Table 1). The fact that Coleoptera form the majority of the assemblage is not surprising considering they are “hard-bodied” (Elias 1990).

Coleoptera, Anobiidae

Material.—This family is only represented by one fragment.

Occurrence in packrat middens.—Only one midden literature record could be found (Hall et al. 1990).

Table 1. Arthropods from 1770 B.P. *Neotoma* midden sample, Cataviña area, Baja California, México. *"Body, bodies" refer to head, thorax, and abdomen, usually with legs and antennae missing.

Taxa	Material	Number
Arachnida		
Chelonethida		
Chernetidae	pedipalpal chela	2
Diplopoda		
unidentified	segment	
Insecta		
Coleoptera		
Anobiidae	body fragment	
Bruchidae		
<i>Algarobius prosopis</i> (LeConte)	bodies*	2
	body fragments	31
Carabidae		
<i>Harpalus</i> sp.	elytra	
Lathridiidae		
<i>Metophtalmus rudis</i> Fall	body	
	body fragments	10
Ptinidae		
<i>Niptus ventriculus</i> LeConte	bodies, abdomens	5
<i>Niptus</i> sp.	bodies, abdomens	10
<i>Ptinus verticalis</i> (?)	bodies, abdomens	17
Tenebrionidae		
<i>Blapstinus</i> sp.	head	
unidentified	body fragments	2
unidentified Coleoptera	body fragments	57
Diptera		
Syrphidae (?)	puparium fragment	
Hemiptera		
unidentified	heads	2
Hymenoptera		
Apoidea	head	
Chalcidoidea		
Pteromalidae (?)	head	
Formicidae		
Ecitoninae		
<i>Neivamyrmex nigrescens</i> (Cresson)	head	
Myrmicinae		
<i>Pheidole grallipes</i> Wheeler	heads	3
<i>Solenopsis xyloni</i> McCook	gasters, heads, thoraces	60
unidentified Formicidae	heads, gasters, thoraces	26
unidentified Hymenoptera	head	7
Lepidoptera		
unidentified caterpillar	heads	4
unidentified insects	body fragments	68
Totals: Total taxa 23 +	Total specimens	315

Occurrence in the Cataviña Area.—Anobiids are known to occur in this area and have been collected, but have not yet been determined to species.

Discussion.—Anobiids live in dry plant materials (Arnett 1985, Borrer et al. 1989) and could thus be expected to be found in a *Neotoma* den. They are also found in stored food products (Madenjian 1996).

Coleoptera, Bruchidae, *Algarobius prosopis* (LeConte)

Material.—Thirty three bodies and body fragments (Fig. 5a).

Occurrence in Packrat Middens.—Literature records for Bruchidae in *Neotoma* middens include Hall et al. (1989, 1990) and Elias & Van Devender (1990). *Algarobius prosopis* was one of the bruchids reported by Hall et al. (1989).

Occurrence in the Cataviña Area.—Modern Bruchidae recorded for this site include *A. prosopis* and *Mimosestes protractus* (Horn). *Algarobius prosopis* occurs in Texas, Arizona, and in México: Sonora, Sinaloa, Chihuahua and Baja California (Kingsolver 1986). Kingsolver (1986) notes that this beetle is the most common *Prosopis* bruchid in its range, but does not show it as known from the Central Desert area.

Discussion.—The dominant identifiable beetle in the midden is the mesquite beetle *A. prosopis* (Table 1, Fig. 5a). The Bruchidae or seed beetles are common in plant seeds especially those of leguminous species (Arnett 1985, Borrer et al. 1989). *Algarobius prosopis* is a common seed predator of *P. glandulosa* Torrey (Kingsolver et al. 1977, Kingsolver 1986). Because *Prosopis glandulosa* is the dominant plant found in the midden (Sankey et al. unpublished data) the beetles were probably transported into the den by *Neotoma* carrying in the mesquite. Bruchids are found in stored food products (Madenjian 1996).

Coleoptera, Carabidae cf. *Harpalus*

Material.—One elytron (Fig. 5b).

Occurrence in Packrat Middens.—Carabids have been reported from middens (Elias 1987; Elias & Van Devender 1990; Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—Many species of Carabidae have been collected and identified at this site, but *Harpalus* sp. has not been among them to date.

Discussion.—The ground beetles are the third largest family of beetles and are common in debris, under objects and on the ground surface (Arnett 1985, Borrer et al. 1989). Carabids are rarely found in stored food products (Madenjian 1996).

Coleoptera, Lathridiidae, *Metophtalmus rudis* Fall

Material.—One body (head, thorax, abdomen) (Fig. 5c).

Occurrence in Packrat Middens.—Lathridiidae have been reported from middens (Elias & Van Devender 1990, Van Devender & Hall 1994). *Metophtalmus rudis* has not previously been reported from midden habitats.

Occurrence in the Cataviña Area.—Modern species of Lathridiidae collected at this site include *Corticarina scissa* (LeConte), *Dienerella ruthae* Andrews, *M. rudis*, and *Metophtalmus trux* Fall.

Discussion.—The family consists of minute beetles which inhabit moldy ma-

terials and debris (Arnett 1985, Borror et al. 1989). *Metophtalmus* live in ground litter and feed on fungi (Andrews 1976). *M. rudis* has been reported from recent *Neotoma* nests in a variety of locations in the coastal area of Central California (Andrews 1976). Lathridiids are commonly found in stored food products (Madenjian 1996).

Coleoptera, Ptinidae, *Niptus ventriculus* LeConte and *Ptinus verticalis* LeConte

Material.—Five bodies and abdomens of *N. ventriculus* 17 bodies and abdomens of *P. verticalis* (Fig. 5d).

Occurrence in Packrat Middens.—Ptinidae are common in midden samples (Elias 1987; Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—Ptinidae are common at this site and are commonly caught in pitfall traps, but have not yet been identified to species. *Ptinus verticalis* is known only from southern California (Papp & Okumura 1959, Papp 1962). *Niptus ventriculus* is known from Texas to California south through Mexico (Papp & Okumura 1959, Papp 1962) and Baja California, including the Central Desert (Aalbu & Andrews 1992).

Discussion.—The family Ptinidae live in dried plant and animal material and in animal nests (Arnett 1985, Borror et al. 1989). *N. ventriculus* is known from *Neotoma* nests and *N. arcanus* feeds on *Neotoma* pellets (Aalbu & Andrews 1992). Ptinids are common in stored food products (Madenjian 1996).

Coleoptera, Tenebrionidae, *Blapstinus*

Material.—One head.

Occurrence in Packrat Middens.—Tenebrionidae are also common in midden samples (Elias 1987; Elias & Van Devender 1990; Hall et al. 1989, 1990), and *Blapstinus* has previously been reported from packrat midden samples from Sonora (Hall et al. 1988).

Occurrence in the Cataviña Area.—*Blapstinus histricus* Casey occurs at the site and Blaisdell (1943) lists an additional seven species of *Blapstinus* from Baja California.

Discussion.—Tenebrionidae generally feed on plant materials of some sort (Borror et al. 1989). The family Tenebrionidae are richly represented in stored food products (Madenjian 1996).

Diptera, Syrphidae

Material.—One puparium fragment.

Occurrence in Packrat Middens.—Syrphidae have not been reported from midden samples although Stratiomyidae are known from such samples (Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—Few of the Syrphidae collected at this site have been identified but we have found *Volucella isabellina* Williston.

Discussion.—The family contains many species and may be found in a wide variety of habitats including decaying vegetation (Arnett 1985, Borror et al. 1989). These flies are found in stored food products (Olsen 1996a).

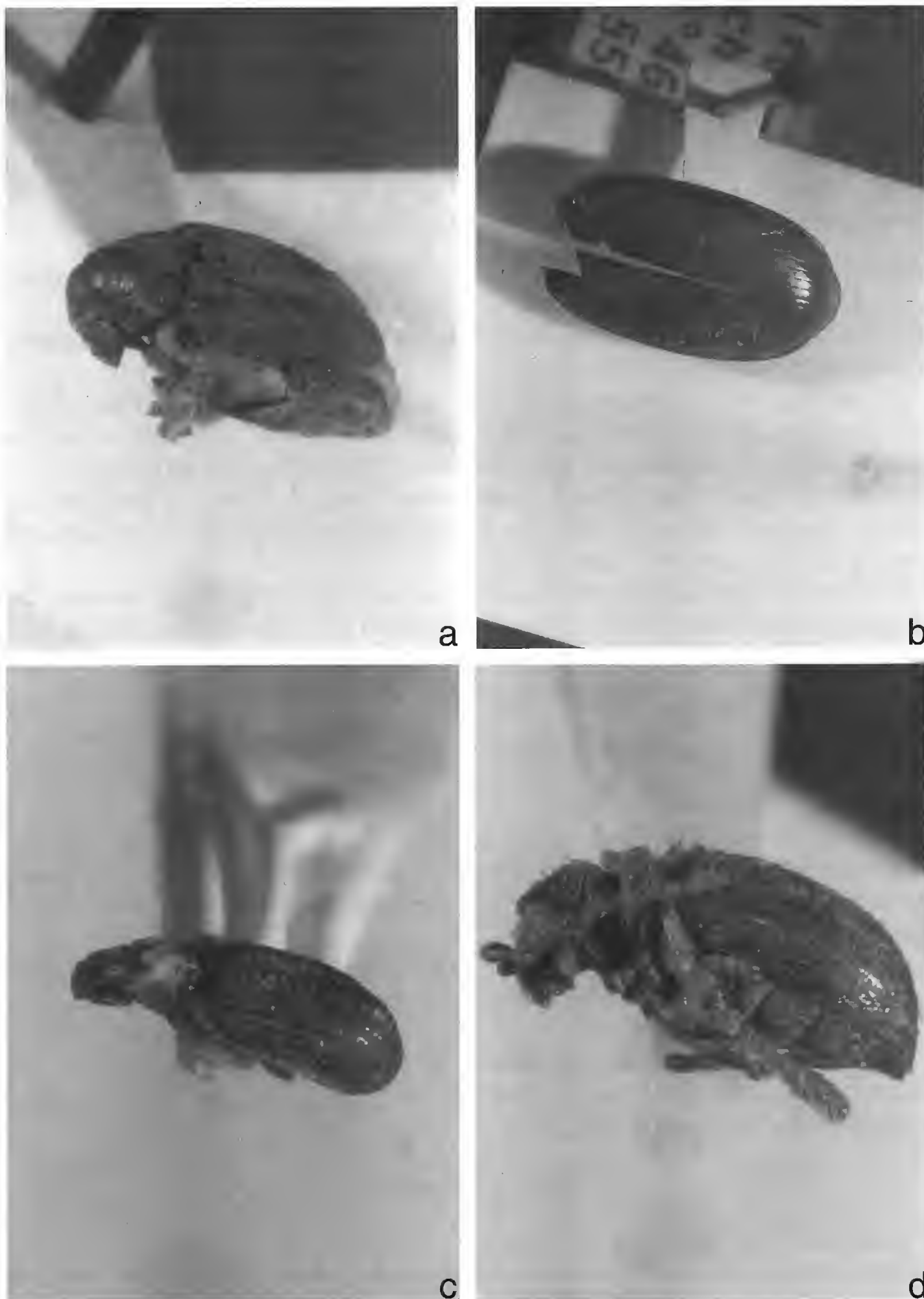


Figure 5. Photographs of selected arthropods from the Baja California, México, Central Desert, Cataviña site, midden #3. a) Coleoptera, Bruchidae, *Algarobius prosopis* (LeConte), entire beetle. Scale: length is 3.5 mm. b) Coleoptera, Carabidae, cf. *Harpalus*, elytra. Scale: length is 8 mm. c) Coleoptera, Lathridiidae, *Metophthalmus rudis* Fall, entire beetle. Scale: Length is 1.25 mm. d) Coleoptera, Ptinidae, *Ptinus verticalis* LeConte, entire beetle. Scale: Length is 3 mm.



Figure 5. (Continued.) e) Hymenoptera, Formicidae, *Neivamyrmex nigrescens* (Cresson), head and thorax. Scale: Length is 1.5 mm. f) Hymenoptera, Formicidae, *Solenopsis xyloni* McCook, petiole, postpetiole, and gaster. Scale: Length is 1 mm. g) Lepidoptera, unidentified caterpillar, head Scale: Length is 2 mm.

Hemiptera

Material.—Two unidentified heads.

Occurrence in Packrat Middens.—Hemiptera have been reported previously from middens (Elias 1987, Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—Many species of Hemiptera are found at this site today.

Discussion.—Hemiptera are plant feeders and are very common on vegetation (Arnett 1985, Borror et al. 1989).

Hymenoptera, Apoidea

Material.—One head.

Occurrence in Packrat Middens.—Apoidea have not previously been reported from packrat middens.

Occurrence in the Cataviña Area.—There are such a variety of species of bees known from the site that not much can be interpreted by its presence.

Discussion.—Bees are common on flowers where they feed on nectar and act as pollinators (Arnett 1985, Borror et al. 1989).

Hymenoptera, Pteromalidae

Material.—One head.

Occurrence in Packrat Middens.—The family has not previously been reported from packrat middens.

Occurrence in the Cataviña Area.—Pteromalidae have been collected in the area but remain unidentified.

Discussion.—Pteromalidae are a large family of parasitic wasps (Arnett 1985, Borror et al. 1989), which parasitize a large variety of insect groups and may have entered the midden within another insect. They are known to parasitize insects found in stored food products (Avaritt & Richter 1996).

Hymenoptera, unidentified Formicidae

Material.—Twenty six heads, gasters, and thoraces.

Occurrence in Packrat Middens.—Ants are a common component of midden faunas (Elias 1987; Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—Clark (1980) reported 25 species of ants from this area representing four subfamilies: Ecitoninae, Pseudomyrmecinae, Myrmicinae, and Formicinae.

Discussion.—Ants made up the second most abundant group found in the midden (Table 1). The vast majority of identifiable Hymenoptera from the midden are ants. Avaritt and Richter (1996) report ants from stored food products.

Hymenoptera, Formicidae, Ecitoninae, *Neivamyrmex nigrescens* (Cresson)

Material.—One head and thorax (Fig. 5e).

Occurrence in Packrat Middens.—The species has been reported from packrat midden samples twice (Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—This species occurs at the site (Clark & Blom 1988). Watkins (1982) records four species of *Neivamyrmex* for the state of Baja California Norte, including *N. nigrescens*.

Discussion.—The ant forages for insect prey (mostly ant brood) at night and may have strayed into the packrat den.

Hymenoptera, Formicidae, Myrmicinae, *Pheidole grallipes* Wheeler

Material.—Three heads.

Occurrence in Packrat Middens.—*Pheidole* has been reported previously from midden collections (Elias 1987; Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—*Pheidole grallipes* is known from this area.

Discussion.—*Pheidole grallipes* inhabits granitic crevices at this site (Clark et al. 1986) and is one of four species of this seed harvesting genus to be found here (Blom & Clark 1980, Clark, unpublished data). It also appears to feed on other arthropods (Clark et al. 1986). *Pheidole* is a very large genus of mostly tropical species (Naves 1985). There are no fossil *Pheidole* known previous to the Miocene (Brown 1973).

Hymenoptera, Formicidae, Myrmicinae, *Solenopsis xyloni* McCook

Material.—Sixty gasters (Fig. 5f), heads, and thoraces.

Occurrence in Packrat middens.—The *Solenopsis aurea* Wheeler has been reported from middens (Hall et al. 1989, 1990).

Occurrence in the Cataviña Area.—*Solenopsis xyloni* is the only species of the genus found at the site now (Blom & Clark 1980).

Discussion.—This is the native fire ant and it feeds primarily on other insects in this area (Clark 1980). Much literature is available on the genus (Rhoades 1977, Lofgren & Vander Meer 1986, for example).

Lepidoptera

Material.—Four heads (Fig. 5g).

Occurrence in Packrat Middens.—Lepidoptera have only been reported once in the midden literature (Hall et al. 1990). Caterpillars are very soft-bodied and would not preserve well as entire specimens in the midden environment (Elias 1990).

Occurrence in the Cataviña Area.—Lepidoptera are common in the area. Many species of butterflies and moths have been collected (Clark unpublished data, Brown et al. 1992).

Discussion.—Lepidoptera caterpillars feed on a large variety of plant material (Arnett 1985, Borror et al. 1989) and these specimens were probably brought into the midden on vegetation carried by a packrat. They are also found in stored food products (Olsen 1996b).

A significant portion (68 specimens) of the arthropod fragments found in the midden have not been identified because they are either too fragmentary or are not parts useful for identification (Table 1). In addition, there are many soft-bodied arthropods (including parasites of *Neotoma*) that probably inhabited the packrat den area that have not been preserved in this midden sample (Baird & Graham 1973). Elias (1990), Van Devender & Hall (1994) provide nice discussions of some of the problems with the taphonomy of arthropods in middens.

From this evidence we can not see a major difference between the late Holocene and recent arthropod assemblages of the Cataviña area. However a study of the midden plants has revealed that the modern vegetation and climate are drier than ~1770 years ago (Sankey et al., unpublished data).

CONCLUSIONS

1) This is the first record of Holocene arthropods from a *Neotoma* midden in Baja California. Study of this and other middens in the area will further paleoenvironmental reconstructions for the Central Desert area during the Holocene.

2) This Holocene (1770 radiocarbon years B.P.) *Neotoma* midden contains 23+ taxa from a subsample of 315 arthropod specimens. Ten of these taxa are reported from *Neotoma* midden assemblages for the first time. Most of these are common at the site today.

3) The most common arthropods are Coleoptera, especially the mesquite beetle, *A. prosopis*, and the mymicine ant, *S. xyloni*.

4) There is a close similarity between the arthropod and plant taxa from the midden and those living in the area today. From this evidence we can not see a major difference between the late Holocene and recent arthropod assemblages of the Cataviña area. However a study of the midden plants has revealed that the modern vegetation and climate are drier than ~1770 years ago.

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PHENOLOGY OF CANOPY ARTHROPODS OF A TROPICAL DECIDUOUS FOREST IN WESTERN MEXICO¹

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Abstract.—Arthropoda from canopy tropical deciduous forest was sampled. Twenty four major taxa were found. Collembola was the most abundant group (95% of total abundance), followed by Acarida (1.25%) and Hymenoptera (0.90%). Great seasonal variations were detected with modified density and composition of canopy arthropods.

Key Words.—Arthropoda, canopy, Chamela, seasonality.

Among other fundamental problems in the natural sciences we are urged to find ways to estimate just how many species share the planet with us. Moreover, embodied in this controversy (Wilson 1988, Erwin 1991) there is need to find mechanisms to preserve what is existing. Although it is clear that there is just no time to count everything, we still need to discover new ways to estimate local, regional and total biodiversity in order to make right decisions.

The pioneering studies of Erwin (1983, 1988), in tropical forests of Central and South America, allowed him to propose that nearly 30 million species of arthropods inhabited the world. Although the actual figure is unknown, it is suggested that the largest proportion of insect diversity lives among the tree tops of tropical forests (Stork 1988).

The arthropod fauna found within tree canopies includes that associated with the epiphytic plants (Palacios-Vargas 1981, Murillo et al. 1983), branches and foliage (Basset et al. 1992) and dead organic matter (Nadkarni & Longino 1990). Technical problems to study these habitats have limited our knowledge of vertical distribution of these organisms. Common methods for collecting in the canopy of the forest includes: cutting of the branches, selective tree cutting and fumigation by means of fogging (Erwin 1988) but none appears to offer a complete profile of the species richness of the insects and arthropods in any forest. However, the fogging approach for its simple design and practical utility appears to be the most widely used in recent years (Adis et al. 1984, Watanabe & Ruaysoongnern 1989, Stork 1991, Guilbert et al. 1995).

Early studies, using the method of fumigation by fogging, were made by Robert (1973) to collect grasshoppers (Orthoptera) in Costa Rica. Since then it has been used by other researchers in different regions of the world, modifying the technique depending on the necessities, both for the type of collection, and the kind of vegetation to be studied.

This study is part of an ongoing project to examine how human activities affect

¹ Project DGAPA UNAM IN-2078/91 and PAEP-2006.

arthropod richness in a tropical deciduous forest at Chamela Biological Station (Instituto de Biología, UNAM), Jalisco, México. Here we report the phenology of canopy arthropods as sampled by a contact insecticide applied by a thermal fogger apparatus.

MATERIALS AND METHODS

Study Site.—Field work was conducted at the Biological Station of Chamela (EBCh, Instituto de Biología, UNAM) on the coast of Jalisco, México (19°30'N, 105°03'W). Annual average rainfall is 707 ± 148 mm (range 585 to 961 mm); rainy season is from July to October and dry season from September to June (Bullock 1986, 1988). Annual mean temperature is 24.9° C (Bullock 1986). Floristic richness is more than 780 species; Leguminosae and Euphorbiaceae are the most diversified families (Lott 1985). Tropical deciduous forest is the dominant vegetation, however, semideciduous forest is present along seasonal water courses (Lott et al. 1987). The most prominent feature of the forest is that it remains leafless in the dry season. New leaf production starts in late June, early July, after 100 mm of rainfall has accumulated (Bullock & Solís-Magallanes 1990).

Our sampling plots were located within one watershed, named 4A by Cervantes et al. (1988). The total area for this watershed is 9 ha and the tree layer sampled was 25 m tall.

Seven fumigations were carried out to include both rainy (August and September 1992, July 1993) and dry seasons (May and November 1993, February and May 1994). For each fumigation, 100 m² were delimited in the late afternoon, and 50 funnels (0.5 m of diameter) were hung randomly in the shrub layer at about 50 cm above the ground. We used a fogging machine (Dyna fog) and a natural pyrethrum as the insecticide (Resmethrin 3% in kerosene solution) applied on the next day before sunrise (04:00 to 06:00 h), following the method of Erwin (1983). All specimens that fell on the funnels were collected by washing with alcohol (80%) some 5 h later. In 5 fumigations (August 1992, May and November 1993, February and May 1994), the fauna of ten funnels was quantified separately to estimate group distribution on the sampling surface, in fumigations made in September 1992 and July 1993, the total fauna collected were quantified together. The specimens were sorted to order level, and stored in 90% alcohol.

The distribution of the arthropod groups was analyzed by standard deviation among some funnels' samples in the same region and time. Simple regression analysis (Zar 1984) was performed between abiotic (temperature and precipitation) and abundance of arthropods.

RESULTS

A total of 1,098,248 organisms was collected in seven fumigations, with a mean density of 15,986 specimens/m². Twenty-five groups of Arthropoda were represented in the canopy samples (Table 1). In the first fumigation (Fog #1) August 1992, 17,616 organisms were collected (1794 specimens/m²); in September 1992 (Fog #2) highest number of organisms was collected 1,024,585 (104,363 specimens/m²), mostly Collembola (1,019,013); in May 1993 (Fog #3) 5653 were collected (576 specimens/m²); in July 1993 (Fog #4) collected 5499 (560 specimens/m²); November 1993 (Fog #5) recorded 28,704 (2924 specimens/m²); in

Table 1. Density (specimens/m²) and relative abundance of Arthropoda from canopy in Chamela collected by fogging (highest numbers in bold).

Taxa	Wet fogging 1 (August 1992)			Wet fogging 2 (September 1992)			Dry fogging 3 (May 1993)			Dry fogging 4 (July 1993)		
	Nber	%	Density	Nber	%	Density	Nber	%	Density	Nber	%	Density
Collembola	9738	55.28	991.90	1,019,013	99.5	103,795.81	206	3.6	20.98	252	4.58	25.67
Acarida	1858	10.55	189.25	1,870	0.18	190.48	1835	32.46	186.91	1116	0.20	113.68
Hymenoptera	1246	7.07	126.92	751	0.07	76.50	1467	25.95	149.43	988	17.97	100.64
Araneae	977	5.55	99.52	469	0.05	47.77	662	11.71	67.43	228	4.15	23.22
Diptera	1034	5.87	105.32	707	0.07	72.01	109	1.93	11.10	1231	22.38	125.39
Coleoptera	535	3.04	54.49	236	0.02	24.04	350	6.19	35.65	558	10.15	56.84
Homoptera	661	3.75	67.33	393	0.04	40.03	248	4.39	25.26	363	6.60	36.97
Psocoptera	378	2.14	38.50	404	0.04	41.15	82	1.45	8.35	130	2.36	13.24
Thysanoptera	353	2.0	35.96	358	0.03	36.46	141	2.49	14.36	162	2.94	16.50
Larvae	6	0.03	0.61	48	0.01	4.89	146	2.58	14.87	103	1.87	10.47
Orthoptera	283	1.61	28.83	79	0.01	8.05	90	1.59	9.17	103	1.87	10.49
Hemiptera	132	0.75	13.44	49	<0.01	4.99	38	0.67	3.87	116	3.11	11.81
Isopoda	136	0.77	13.85	51	0.01	5.19	25	0.44	2.55	39	0.71	3.97
Dictyoptera	77	0.44	7.84	47	<0.01	4.79	30	0.53	3.05	46	0.84	4.68
Lepidoptera	70	0.40	7.13	84	0.01	8.56	37	0.65	3.77	26	0.47	2.65
Pseudoscorpionida	53	0.3	5.40	4	<0.01	0.41	73	1.29	7.43	19	0.34	1.93
Isoptera	48	0.27	4.89	5	<0.01	0.51	107	1.89	10.90	2	0.04	0.20
Chilopoda	16	0.09	1.63	2	<0.01	0.20	2	0.03	0.20	—	—	—
Thysanura	10	0.06	1.02	12	<0.01	1.22	—	—	—	5	0.09	0.51
Neuroptera	2	0.01	0.20	3	<0.01	0.30	2	0.03	0.20	11	0.20	1.12
Embioptera	—	—	—	—	—	—	—	—	—	—	—	—
Scorpionida	3	0.02	0.30	—	—	—	3	0.05	0.30	—	—	—
Mecoptera	—	—	—	—	—	—	—	—	—	—	—	—
Solifuga	—	—	—	—	—	—	—	—	—	—	—	—
Odonata	—	—	—	—	—	—	—	—	—	1	0.02	0.10
Total	17,616	100	1794.35	1,024,585	100	104,363.37	5653	100	575.81	5499	100	560.12

Table 1. Continued.

Taxa	Dry fogging 5 (November 1993)			Dry fogging 6 (February 1994)			Dry fogging 7 (May 1994)			Total fogging		
	Nber	%	Density	Nber	%	Density	Nber	%	Density	Nber	%	Density
Collembola	13,641	47.52	1389.46	824	9.25	83.93	358	4.9	36.46	1,044,030	95.06	15,196.97
Acarida	2554	8.9	260.14	2076	23.36	211.46	2382	32.61	242.63	13,691	1.25	199.29
Hymenoptera	2249	7.83	229.08	1536	17.28	156.45	1613	22.08	164.30	9850	0.90	143.38
Araneae	2176	7.58	221.64	1822	20.5	185.59	999	13.67	101.76	7333	0.67	106.74
Diptera	1535	5.35	156.35	182	2.05	18.54	122	1.67	12.42	4872	0.45	71.62
Coleoptera	780	2.72	79.45	722	8.1	73.54	691	9.46	70.38	3872	0.35	56.36
Homoptera	1362	4.74	138.73	390	4.35	39.72	181	2.48	18.44	3592	0.33	52.37
Psocoptera	877	3.05	89.33	258	2.90	26.28	185	2.53	18.84	2314	0.21	33.68
Thysanoptera	773	2.69	78.73	380	4.27	38.71	143	1.96	14.56	2310	0.21	33.62
Larvae	1496	5.21	152.38	199	2.24	20.27	116	1.58	11.81	2114	0.19	30.77
Orthoptera	213	0.74	21.70	79	0.88	8.05	72	0.98	7.33	919	0.08	13.38
Hemiptera	294	1.02	29.94	133	1.49	13.55	76	1.04	7.74	838	0.08	12.20
Isopoda	311	1.08	31.68	62	0.70	6.31	64	0.87	6.52	688	0.06	10.01
Dictyoptera	174	0.61	17.72	71	0.64	7.23	32	0.44	3.26	463	0.04	6.94
Lepidoptera	131	0.46	13.34	39	0.44	3.97	21	0.29	2.14	408	0.04	5.94
Pseudoscorpionida	42	0.15	4.28	104	1.17	10.59	64	0.88	6.52	359	0.03	5.23
Isoptera	31	0.11	3.16	3	0.03	0.30	159	2.18	16.19	355	0.03	5.17
Chilopoda	35	0.10	3.56	—	—	—	14	0.19	1.43	64	<0.01	1.00
Thysanura	8	0.03	0.81	—	—	—	—	—	—	35	<0.01	0.51
Neuroptera	7	0.02	0.71	3	0.03	0.30	1	0.01	0.10	29	<0.01	0.42
Embioptera	14	0.05	1.43	3	0.03	0.30	9	0.12	0.92	26	0.38	0.38
Scorpionida	—	—	—	—	—	—	2	0.03	0.20	8	<0.01	0.12
Mecoptera	1	<0.01	0.10	—	—	—	—	—	—	1	<0.01	0.01
Solifuga	—	—	—	—	—	—	1	0.01	0.10	1	<0.01	0.01
Odonata	—	—	—	—	—	—	—	—	—	1	<0.01	0.01
Total	28,704	100	2923.76	8886	100	905.12	7305	100	744.08	1,098,248	100	15,986.14

Table 2. Simple statistics within samples of most abundant arthropods in five fumigations by sheets ($n = 10$).

Taxa	Mean	SD
Wet Fog #1 August 1992		
Collembola	301.60	98.46
Acarida	70.70	33.72
Diptera	32.70	8.31
Araneae	31.80	14.99
Homoptera	22.30	6.62
Hymenoptera	18.75	5.61
Coleoptera	14.30	4.71
Psocoptera	13.90	8.61
Thysanoptera	12.00	5.18
Orthoptera	9.30	6.63
Hemiptera	4.10	2.66
Isoptera	2.70	8.10
Isopoda	2.50	2.91
Dictyoptera	2.40	2.20
Lepidoptera	1.90	2.74
Pseudoscorpionida	0.80	0.60
Chilopoda	0.30	0.25
Larvae	0.10	0.3
Dry Fog #3 May 1993		
Acari	9.28	6.66
Araneae	7.19	5.30
Hymenoptera	4.43	5.42
Homoptera	2.19	3.95
Coleoptera	2.00	2.20
Collembola	1.28	1.31
Larvae	1.28	3.13
Orthoptera	0.62	0.78
Thysanoptera	0.52	0.96
Diptera	0.47	1.10
Neuroptera	0.47	0.21
Chilopoda	0.47	0.21
Pseudoscorpionida	0.38	0.65
Psocoptera	0.33	0.56
Dictyoptera	0.24	0.61
Hemiptera	0.14	0.35
Isoptera	0.09	0.42
Lepidoptera	0.09	0.29
Dry Fog #5 November 1993		
Collembola	201.50	20.14
Acari	41.50	8.19
Araneae	22.76	6.98
Diptera	18.63	11.12
Homoptera	17.56	3.34
Larvae	15.00	3.56
Thysanoptera	12.10	4.64
Hymenoptera	11.46	5.13
Psocoptera	10.56	0.83
Coleoptera	7.83	1.87
Hemiptera	4.26	1.22
Isopoda	3.00	2.06

Table 2. Continued.

Taxa	Mean	SD
Orthoptera	2.67	1.30
Dictyoptera	2.20	1.48
Lepidoptera	1.16	1.3
Pseudoscorpionida	0.23	0
Isoptera	0.56	0
Chilopoda	0.13	0
Neuroptera	0.03	0
Dry Fog #6 February 1994		
Acari	28.73	20.33
Araneae	19.03	10.35
Coleoptera	7.97	6.43
Hymenoptera	7.93	9.54
Collembola	7.70	6.03
Thysanoptera	5.87	7.25
Homoptera	4.23	2.94
Psocoptera	2.97	2.12
Larvae	2.40	2.36
Diptera	2.27	1.96
Hemiptera	1.57	1.65
Pseudoscorpionida	1.30	1.73
Orthoptera	0.93	0.99
Isopoda	0.77	1.41
Dictyoptera	0.63	0.79
Lepidoptera	0.40	0.88
Isoptera	0.067	0.25
Neuroptera	0.067	0.25
Dry Fog #7 May 1994		
Acari	34.93	22.45
Araneae	10.00	8.81
Coleoptera	8.90	16.60
Hymenoptera	7.96	9.13
Collembola	5.23	9.15
Isoptera	4.13	22.07
Homoptera	2.57	3.20
Dictyoptera	2.43	2.58
Larvae	1.73	2.01
Psocoptera	1.60	2.48
Diptera	1.40	1.92
Hemiptera	1.07	1.59
Pseudoscorpionida	0.93	1.39
Isopoda	0.80	2.88
Thysanoptera	0.77	1.20
Orthoptera	0.40	0.88
Chilopoda	0.37	0.83
Lepidoptera	0.30	0.58
Neuroptera	0.03	0.18

February 1994 (Fog #6), 8886 were captured (905 specimens/m²) and in May 1994 (Fog #7), 7305 were collected (744 specimens/m²).

The dominant group collected was Collembola (95.06%), followed by Acari (1.25%), Hymenoptera (0.90%, mostly Formicidae), Araneae (0.67%), Diptera (0.45%), Coleoptera (0.35%), Homoptera (0.33%), Psocoptera (0.21%) and Thysanoptera (0.21%). The percentage of other groups did not reach 0.1% (Table 1).

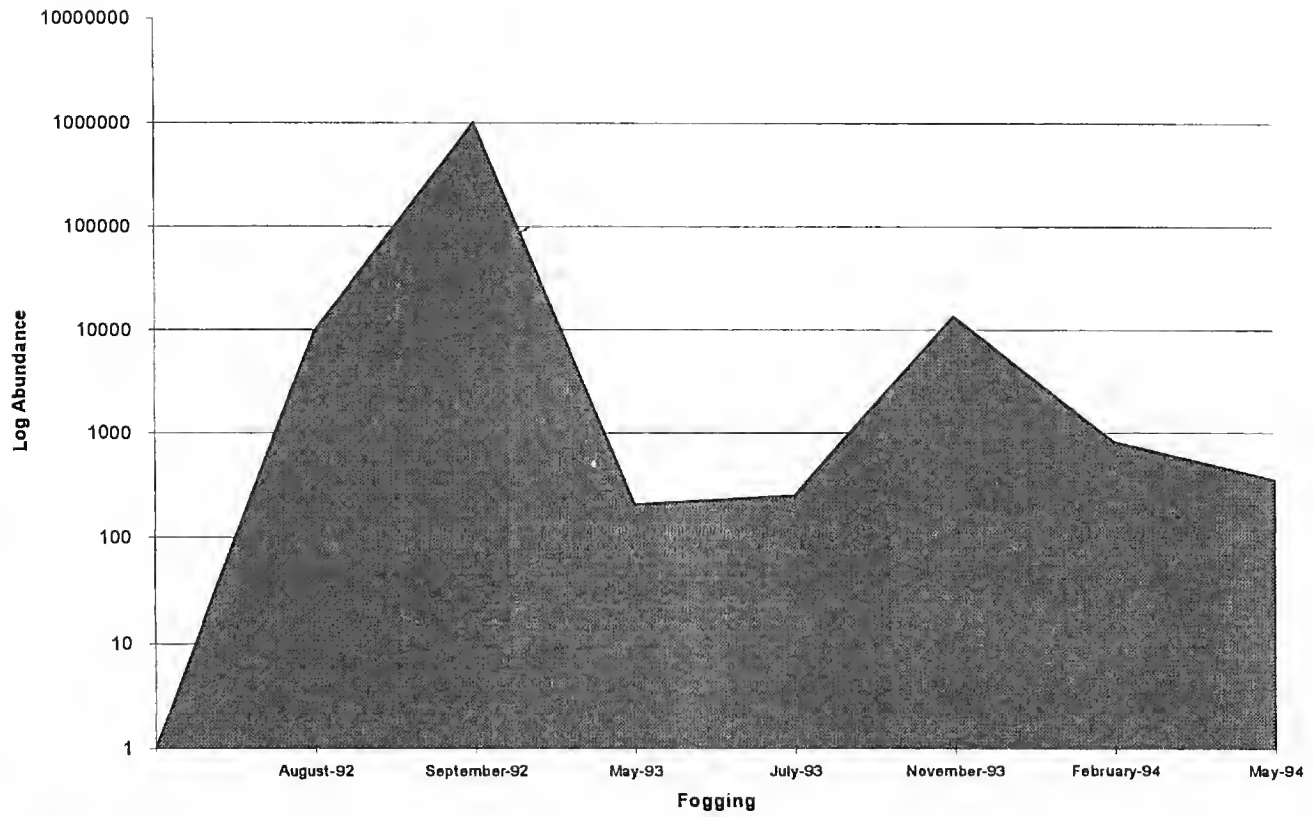
The Arthropod abundance showed heterogeneity among foggings (Table 2). Acari, Collembola, Hymenoptera, Araneae, Diptera and Coleoptera, are always very abundant, but their distribution is not the same across the study area, in spite of it being more homogenous in the rainy months than in the dry months.

Seasonal variation was evident in all groups, with phenological patterns varying from taxa to taxa. In 1993 we collected three contrasting seasonal stages of the forest: late dry season (forest completely leafless, Fog #3, 15 May), early rainy season (new leaf growth, Fog #4, 12–13 July) and late rainy season (although several tree species may start shedding their leaves, some years, due to cyclones, they keep them for an extended time; Fog #5, 11 November) according to Bullock & Solís-Magallanes (1990). Several taxa clearly followed leaf phenology that year: Coleoptera, Diptera, Dictyoptera, Hemiptera, Homoptera, Isopoda, Lepidoptera, Psocoptera and Thysanoptera. All had low numbers in May and early July and peaked in abundance in November. In Fig. 1 the variation of most abundant arthropod groups is shown. Coincidentally that year (1993) an unusual amount of rain fell in September–November. In contrast, several groups followed a different pattern. Hymenoptera had its maximum abundance in the dry season, but ants representing more than 50% of the total Hymenoptera, had their highest in November (end rainy season) and May (dry season). *Crematogaster*, an arboricolous genus, was the most abundant ant in the canopy, with two species being recovered: *C. brevispinosa* and *C. sumichrasti*.

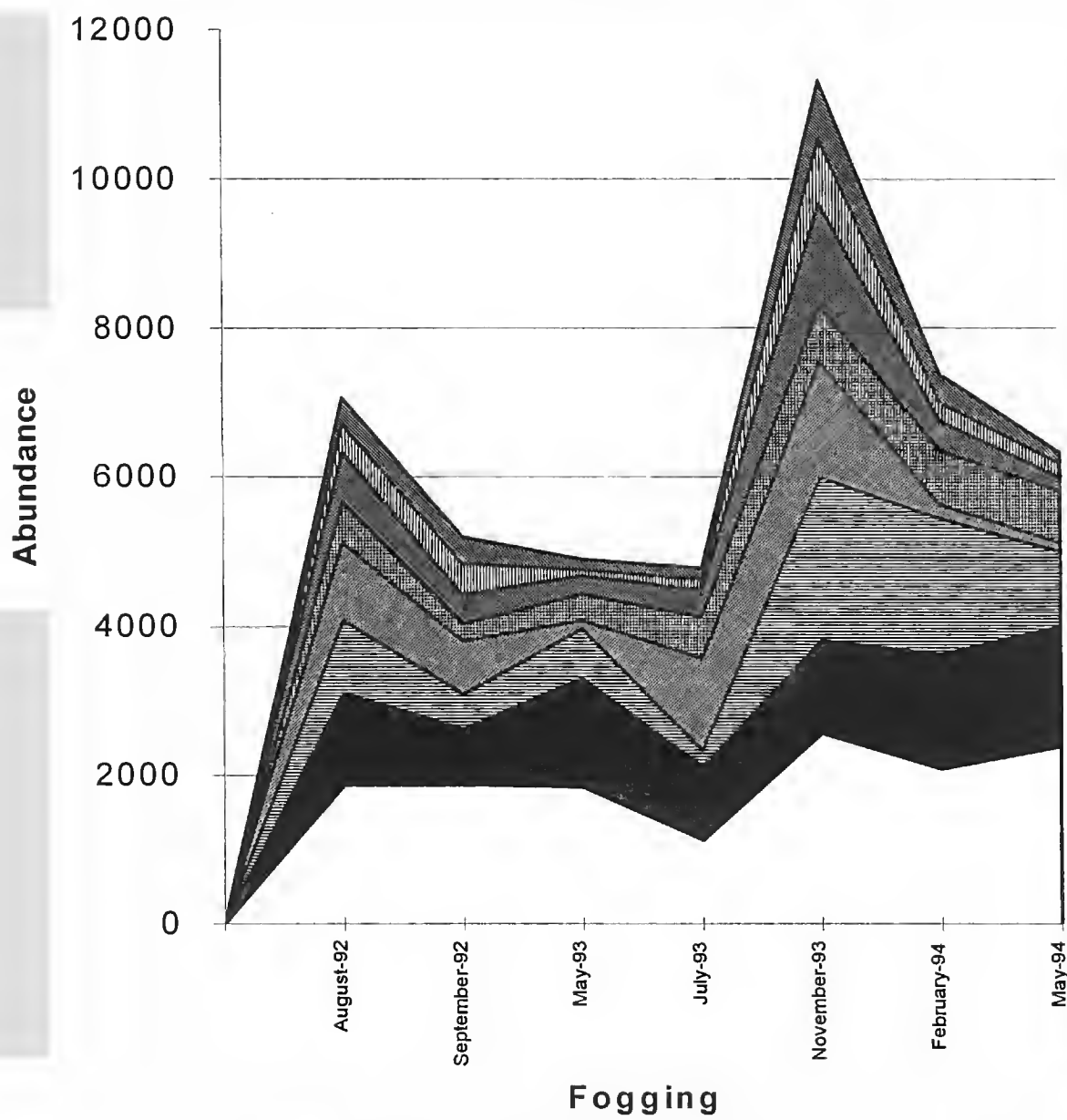
In 1993, Acari were equally abundant in May and November, their number depressed at the start of the rainy season, in July. Araneae, also had their peak of abundance in November, and their abundance was lower in the early rainy season.

Collembola represented 95.06% of Arthropoda collected, varying between 99.46% in September 1992, to 3.6% in May 1993. They were more common during the wet season than during the dry season. Similar results were observed in a Southeastern Perú by Pearson & Derr (1986). Even though abundant, diversity is low, compared with soil and litter in the same study area (Gómez-Anaya 1998). Nineteen species belonging to 13 genera were collected in the canopy, and the most abundant species was *Salina banksi* (Palacios-Vargas et al. 1998).

There were significant correlations between abundance of Arthropod and monthly average precipitation ($r = 0.52$, $df = 5$, $P = 0.04$) but not with temperature ($r = 0.39$, $df = 5$, $P = 0.39$). Considering isolated Orders, correlations between abundance of Coleoptera ($r = -0.16$, $df = 5$, $P = 0.02$), Hymenoptera ($r = -0.82$, $df = 5$, $P = 0.02$), Lepidoptera ($r = 0.79$, $df = 5$, $P = 0.03$), Pseudoscorpionida ($r = -0.80$, $df = 5$, $P = 0.03$), Thysanura ($r = 0.92$, $df = 5$, $P = 0.003$) and the precipitation were significant; temperature was significantly correlated with abundance of Coleoptera ($r = -0.91$, $df = 5$, $P = 0.04$), Pseudoscorpionida ($r = -0.97$, $df = 5$, $P = 0.02$) and Hymenoptera ($r = -0.72$, $df = 5$, $P = 0.03$). Figure 2 shows the precipitation and temperature recorded during the study time.



A



B



Figure 1. Abundance of most abundant arthropod groups. Figure 1A shows Collembola, and Figure 1B, other groups.

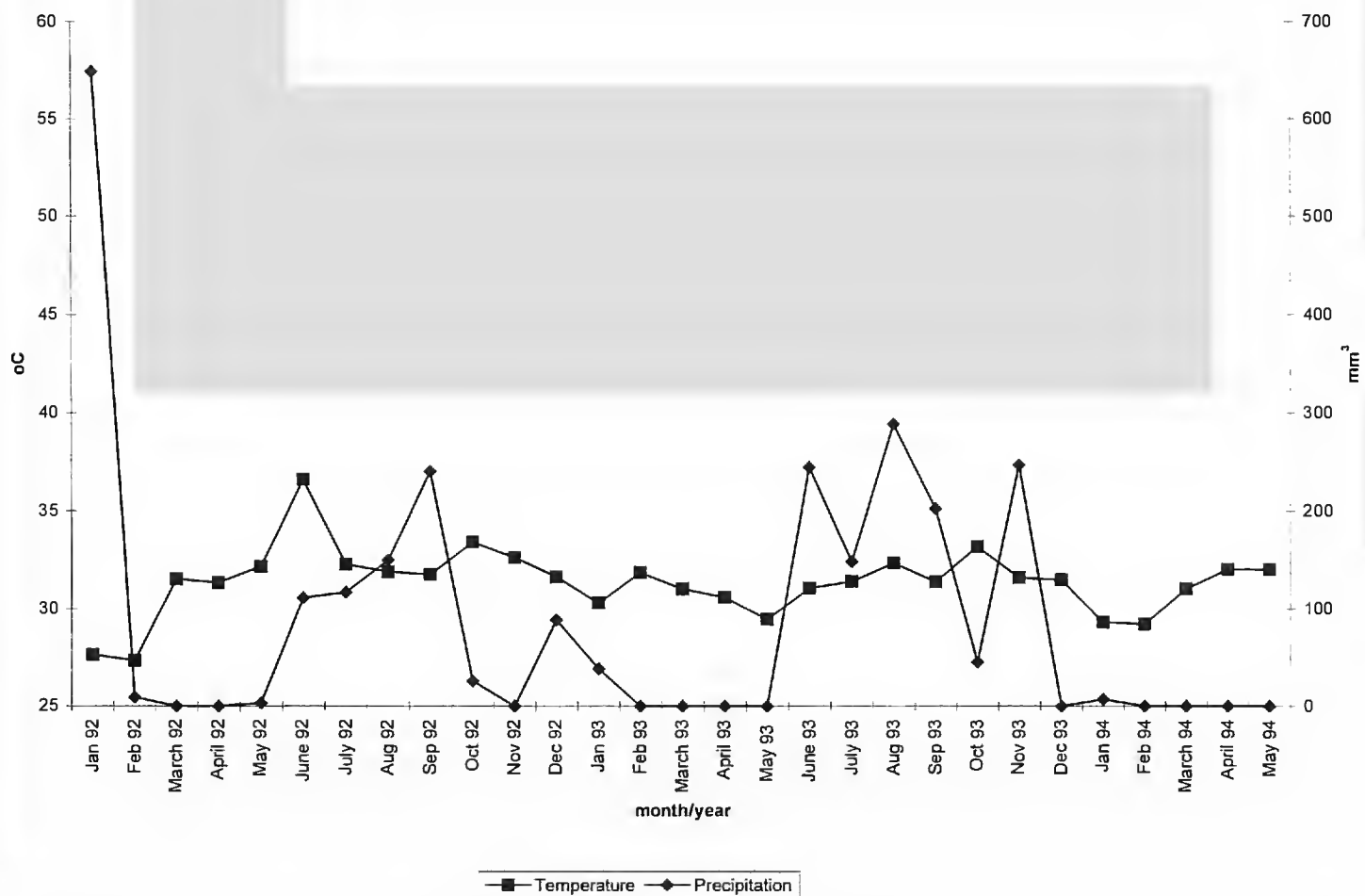


Figure 2. Precipitation and temperature recorded in the Biological Satiation of Chamela during 1991–1994.

The abundance of several arthropods groups was correlated with abundance of other groups as shown in Table 3.

CONCLUSIONS

A large number of different organisms was obtained in this study by means of fumigation; the majority being Collembola. In Cameroon (Basset et al. 1992) and South America (Erwin 1982) the dominate groups were ants (Hymenoptera: Formicidae) and beetles (Coleoptera), respectively. Despite their great abundance, Collembolan density in the trees was lower than that found in soil and litter (Gómez-Anaya 1998).

The third most abundant group was the Hymenoptera, mostly ants, mainly *Crematogaster*. Because it lives in trees, as it is always well represented in the canopy of the forest (Basset et al. 1992). The beetles occupied sixth place, being less abundant than the mites, flies and spiders. Mites (Acari) and springtails (Collembola) have also been recorded as the dominate groups in studies in Japan and in New Caledonia (Guilbert et al. 1995).

Arthropods density, surveyed using foggings, showed great variation depending on height and composition plant cover. Hijii (1986) in a *Cryptomeria japonica* (Linnaeus f.) D. Don forest in Japan, reported densities about 200 to 3500 specimens/m²; Guilbert et al. (1995) in a primary forest in New Caledonia, 74 to 140 specimens/m², Adis et al. (1984) for Amazonia reported 35 to 161 specimens/m², Watanabe & Ruaysoongnern (1989) for a dry evergreen forest in Northeastern Thailand, 195 specimens/m², and Stork (1991) in Borneo, 51 to 218 specimens/m²; in the present study, we have found from 560 to 104,363 specimens/m².

Table 3. Correlation coefficients between arthropod abundances. ns = not significant; * $P < 0.05$; ** $P < 0.005$; *** $P < 0.0005$.

Taxa	Ac	Ar	Ch	Di	Dy	Em	He	Ho	Hy	Is	Le	Pse
Acari												
Aranea	0.78*											
Chilopoda	ns	ns										
Diptera	ns	ns										
Dictyoptera	ns	0.79*	0.83*	ns								
Embioptera	0.80*	ns	0.82*	ns	ns							
Hemiptera	ns	0.77*	0.81*	ns	0.96***	ns						
Homoptera	ns	ns	ns	0.76*	0.98***	ns	0.93**					
Hymenoptera	ns	ns	ns	ns	ns	ns	ns	ns				
Isopoda	ns	ns	0.94**	ns	0.97***	0.76*	0.93**	0.98***	ns			
Lepidoptera	ns	ns	ns	ns	0.85*	ns	ns	0.89**	ns	0.85*		
Pseudoscorpionida	ns	ns	0.84*	ns	ns	ns	ns	ns	ns	ns	ns	
Psocoptera	ns	ns	ns	ns	0.93**	ns	0.84*	0.95**	0.90**	0.94**	0.95**	ns
Thysanoptera	ns	0.78*	ns	ns	0.96***	ns	0.87*	0.94**	ns	0.91**	0.92***	0.97***
Thysanura	ns	ns	ns	ns	ns	ns	ns	ns	0.82*	ns	ns	-0.76*

Using fogging it is possible to obtain a representative sample of the diversity and phenology of arthropods existing in the tropical deciduous forest.

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**BIOLOGY AND MORPHOLOGY OF THE MATURE
LARVA OF *OXYETHIRA ARIZONA* ROSS
(TRICHOPTERA: HYDROPTILIDAE)**

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Abstract.—The biology and morphology of the fifth instar of *Oxyethira arizona* Ross are given. Larvae were taken from a cattail stand (*Typha* sp.) growing in a constructed wetland located in southern California. Adults were collected in pan traps placed at the edge and center of the cattail stand. Laboratory observations showed that larvae fed on individual cells within filaments of the green alga *Oedogonium* which grew epiphytically on submerged portions of the plants. Larvae used asymmetric mandibles for simultaneously grasping and piercing the cell walls to remove the liquid contents. Most (88.1%) of the adults taken were males, and 82.1% of males and all females were obtained at the periphery of the cattail stand. This is the first report of a hydroptilid larva feeding on *Oedogonium*, and is the first time *O. arizona* has been reported from California.

Key Words.—Insecta, microcaddisflies, *Oxyethira*, larvae, algae, *Oedogonium*, constructed wetlands.

The Hydroptilidae (Trichoptera), or microcaddisflies, are represented by 16 genera (Wiggins 1996a) and more than 200 species (Morse 1993) in North America; the number of described species known from this region continues to increase (e.g., Houp et al. 1998). Little is known about their biology despite their notable species richness, and most of our information is based on observations of species from other biogeographic regions (Nielsen 1948, Ito & Kawamura 1980, Wells 1985). The immature stages are known for only a small fraction of the described species (Wiggins 1990, 1996a).

Oxyethira Eaton is represented in North America by roughly 40 described species (Wiggins 1996b). Larvae are associated with lentic or slow-flowing lotic environments (Wiggins 1996a) and consume the contents of individual cells within filaments of green algae (Chlorophyta) (Nielsen 1948, Keiper et al. 1998). Larvae in the final stadium are easily distinguished from other North American hydroptilid genera by their long legs, relatively long antennae, and unique flask-shaped case (Wiggins 1996a).

Herein, we describe the final instar of *Oxyethira arizona* Ross, a species newly recorded for California, and give biological details. Previously, this species was recorded from Arizona only (Blickle 1979) and the larva was unknown.

MATERIALS AND METHODS

Final instars, pupae, and adults were obtained from the Prado Wetlands, a constructed wetlands near Corona (Riverside County, California). This 121.5 ha marsh receives water from the Santa Ana River to act as a biofilter for potential drinking water and to aid in flood control. The marsh is composed of 46 individual ponds interconnected by water control structures. Cattails (*Typha* sp.) and California bulrush (*Schoenoplectus californicus* [Meyer] Soják) became established within 1 yr of pond construction, and other plants such as buttercups (*Ranunculus*

flammula var. *ovalis* [Bigel.] and *R. aquaticus* var. *capillaceus* [Thuill.]), pennywort (*Hydrocotyle ranunculoides* L.), smart weeds (*Polygonum* sp.), and pond weeds (*Potamogeton* sp.) colonized the marsh shortly thereafter.

Yellow pan traps (33 × 28 × 14 cm RubbermaidTM 11.5 quart dish basins) were placed biweekly in a *Typha* stand growing in approximately 1 m of water to collect adults. Each pan was filled with approximately 3 cm of water to which several drops of liquid detergent were added, and left for 24 h. Two traps were placed at the edge of the stand and were separated by 20 m. Two traps were placed within the stand 4–5 m from the periphery. The gender of each adult collected was determined, and specimens were preserved in 70% ethanol.

Larvae and pupae were taken from the submerged portions of cattail plants, woody debris, and dead cattail leaves floating near the water surface; these substrates had visible growths of the filamentous green alga *Oedogonium* sp. (Chlorophyta). All living specimens were placed in jars of marsh water, the jars put in a cooler with ice, and transported back to the laboratory for study.

A representative number of larvae and pupae were fixed in KAA solution, and preserved in 70% ethanol following the methods of Wiggins (1996a). The remainder were placed in small petri dishes with marsh water and sections of dead cattail with epiphytic *Oedogonium*. To observe larval feeding habits, living larvae were observed at 6–50 × with a Wild M5 dissecting microscope. Preserved specimens of mature larvae ($n = 4$) were described, and measurements obtained with an ocular micrometer on the Wild microscope.

RESULTS AND DISCUSSION

Morphology.—Living larvae and their cases appeared very similar to those illustrated by Wiggins (1996a), except sclerites pale. Non-sclerotized areas of body with many small green patches of pigmentation; this coloration was lost when placed in KAA solution or ethanol. Abdominal segments IX–X were curved ventrad in living and preserved larvae. Case constructed from silken secretions only, narrow and flask-shaped, tapering to constricted opening at anterior end, posterior edge of valves broad, flat, and compressed laterally, similar to case described by Wiggins (1996a) (Fig. 1); pupal cocoon not separate from the silken wall of the external case.

Total length, 2.307 ± 0.950 mm; head length, 0.231 ± 0.004 mm, width 0.196 ± 0.003 mm. Head pale, somewhat darker than abdomen. Two rows of 3–4 brown muscle scars slightly behind level of eye spots, 6 brown muscle scars staggered along posterior margin of head capsule. Setation as in Fig. 2. Antennae situated near antero-lateral margins of head, each with basal seta approximately half as long as antenna. Mandibles yellowish, asymmetrical, right pointed with subapical cusp, left serrated on inner margin and terminating with two teeth (incisor cusps), two setae on posteriolateral corner (Fig. 3).

Thorax concolorous with head, 0.423 ± 0.004 mm long. Three pairs of muscle scars near posterior margin of pronotum, variable number of muscle scars scattered laterally. Prosternal sclerites concolorous with head; lateral two sclerites narrow, central sclerite relatively large and rectangular; meso- and metanotal sclerites lacking muscle scars, posterolateral corners with black spot; meso- and metasternal sclerites positioned posteriorly, narrow, and black. Front leg (from base of coxa) 0.456 ± 0.009 mm long, tarsal claw long, fore tibiae each with medio-distal projection (Fig. 4), middle leg 1.006 ± 0.048 mm long, hind leg 1.053 ± 0.156 mm long; leg length ratio 1.00:2.21:2.31.

Abdomen 1.753 ± 0.040 mm long, milky white except for pigmented areas described above, greatly distended in mature larvae. Primary setae pale and short. Sclerites of segments 9 and 10 concolorous with head. Claw of anal proleg somewhat darker than other sclerites, approximately 0.020 mm long in lateral view.

Diagnosis.—Ross (1944) stated that there are no distinguishing characters to separate larvae of *Oxyethra* in Illinois. Conversely, Back (1983) provided a key

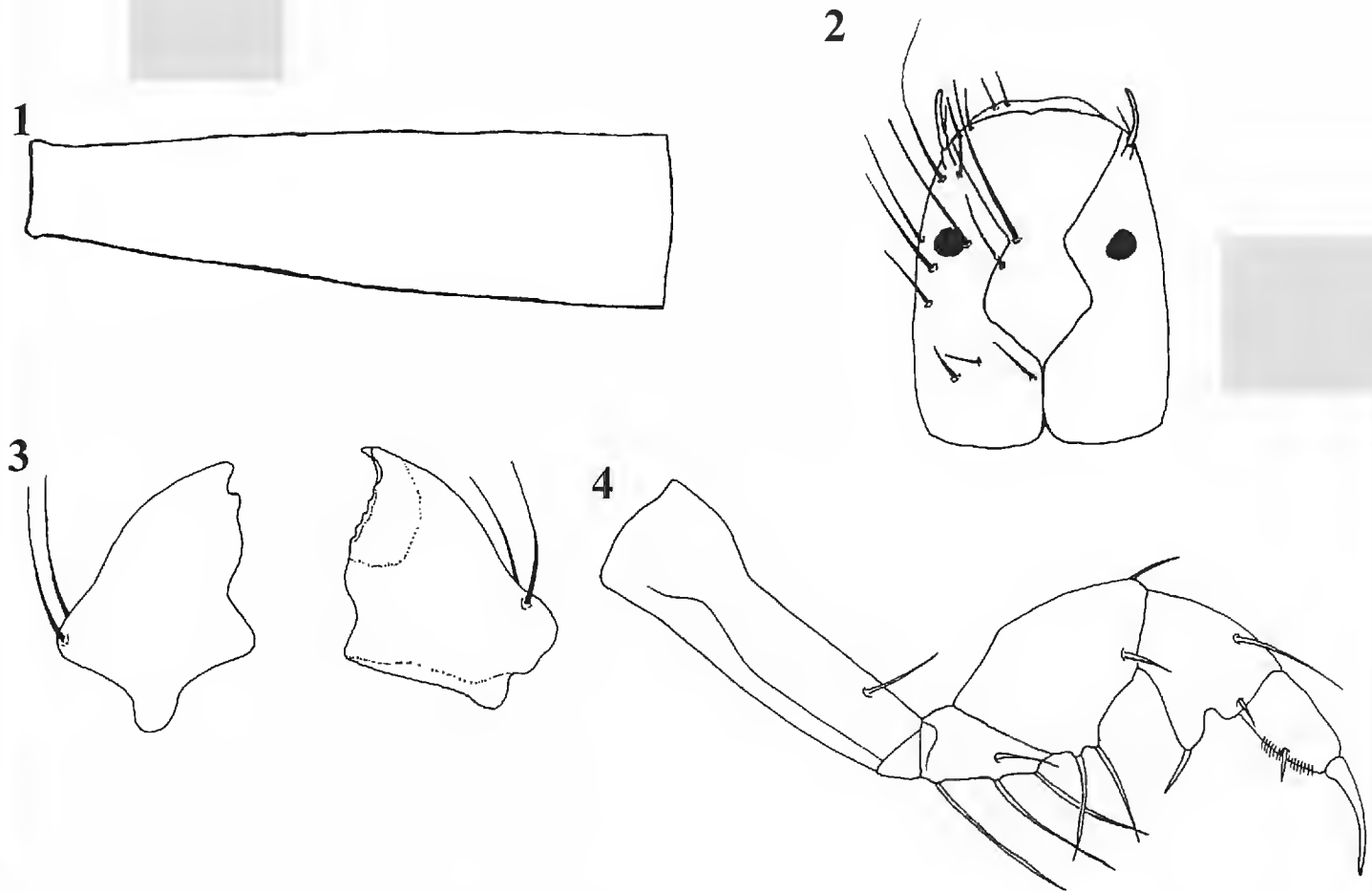


Figure 1. Profile of portable case, lateral view.
 Figure 2. Head capsule showing primary setae on left side, dorsal view.
 Figure 3. Mandibles, ventral view.
 Figure 4. Right foreleg, lateral view.

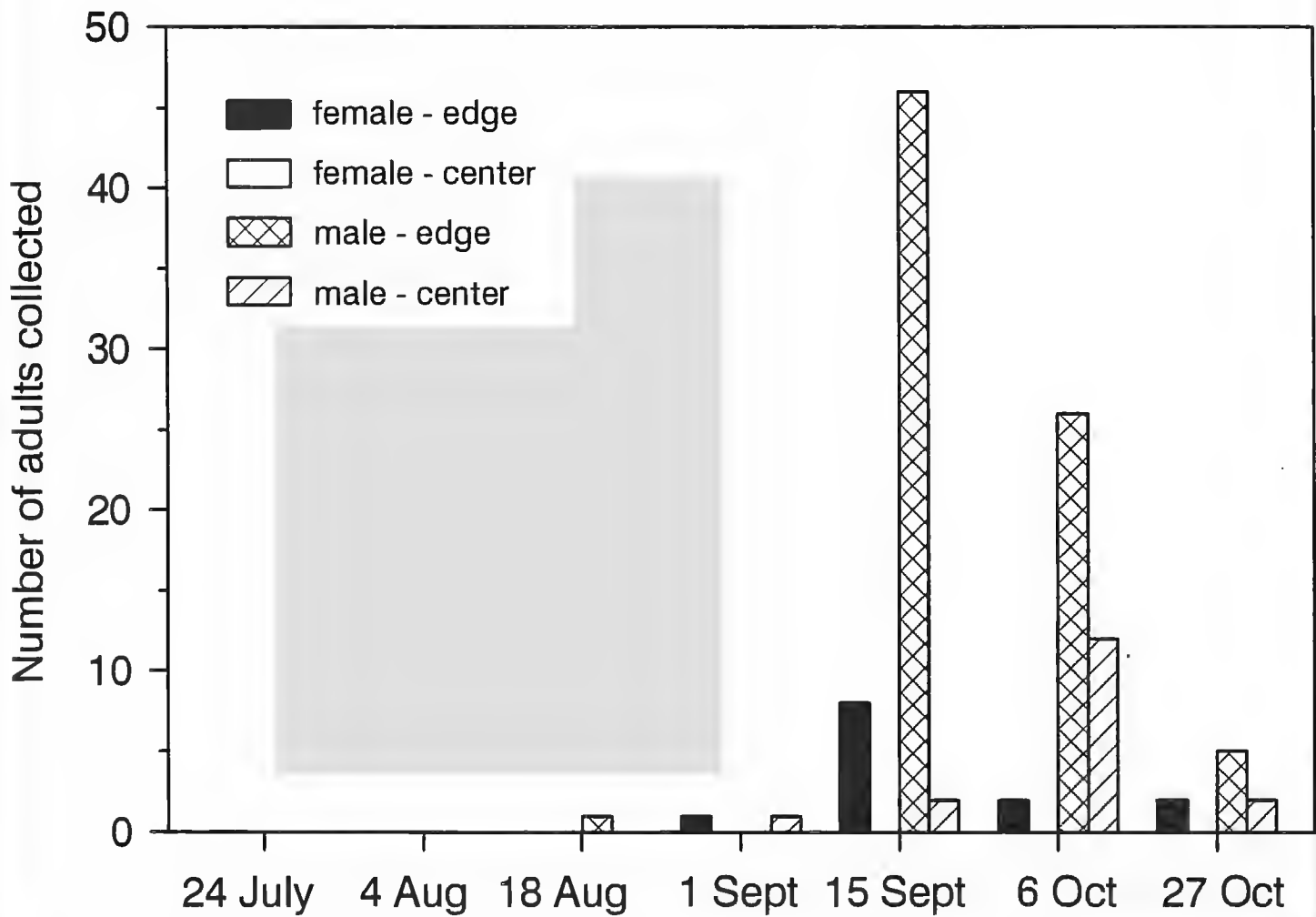


Figure 5. Total numbers of adult males and females taken in pan traps placed at the edge and center of a *Typha* stand during 1998.

to separate *O. leonensis* Kelly and *O. dualis* Morton, indicating that leg length ratio is important to identifying larvae to species. *Oxyethira arizona* has middle and hind legs twice as long as front legs, whereas *O. leonensis* and *O. dualis* have middle and hind legs four and three times as long as front legs, respectively. Our work suggests that mandible morphology is also important. The mandibles of Hydroptilidae are normally asymmetrical (e.g., Nielsen 1948, Huryn 1985, Wells 1985, Keiper & Foote 1998, Keiper & Walton, in press), but no asymmetry was described for those of *O. leonensis* (Back 1983). Furthermore, number of setae on the posterolateral corners of the mandibles are often distinct among species of the same genus (J. B. Keiper, unpublished data), as is the case with *O. arizona* and *O. leonensis*.

Biology—Larvae moved among masses of *Oedogonium*, pulling themselves along filaments with their forelegs. The middle and hind legs of larvae appeared to balance or steady larvae, but were not used to grasp filaments. One larva was observed on several occasions to move through a mass of algae, and halted when it reached the water surface. When it continued to move, its long middle and hind legs often became trapped in the surface tension of the water. It appeared to struggle when its legs were trapped, and was able to free its legs only by withdrawing completely into its case. Eventually, it reversed position within its case, forced its head and thoracic segments through the tightly appressed but flexible posterior end of the silken case, and moved down the algal mass toward the dish bottom. After clearing the water surface, the larva reversed position within its case again so that its head and thoracic segments protruded from the anterior opening.

Larvae fed on individual cells within filaments of *Oedogonium*. During feeding bouts, larvae grasped single filaments of *Oedogonium* with their forelegs, and passed them up past their mouthparts. The mandibles executed 2–3 adductions; the first one or two bites pierced the cell wall with the pointed right mandible while the left one maintained a stable hold on the filament with its serrated inner edge; the last bite pulled the filament tightly to their mouths. The larvae placed their mouths over the break in the cell wall, and removed the cellular protoplast with an apparent sucking action. Larvae then executed another feeding bout on the next cell in the filament. Larvae required approximately 2–3 sec to consume a cell, and up to 30 cells were attacked in rapid, machine-like succession. A bolus of protoplast formed by up to five cells accumulated in the foregut before the larva swallowed it, adding the bolus to the dark green mass within its gut. Several filaments of *Oedogonium* damaged by larval feeding were observed at 100 \times , and a single puncture created by the tip of the right mandible was present on each of the emptied cells. Although a biofilm of diatoms, unicellular green algae, and other organisms grew on the dead sections of cattails and algal filaments given to the larvae, they never attempted to scrape the biofilm from these substrates.

Larvae attached their cases to living and dead cattail stems using three silken guy lines; one was secured to the anterior end of the case, whereas the other two were positioned posterolaterally. The anterior opening was closed with a plug of silk, and the posterior flaps were sealed with silk as well. Pupating larvae were observed in the laboratory to weave their heads laterally and vertically while spinning a silken cocoon. Prepupae were positioned sideways in their cases, but all pupae observed were positioned so their ventral surfaces laid against the valve

Table 1. Preliminary list of aquatic macroinvertebrates collected from the Prado Constructed Wetlands.

Taxon	Functional feeding group
INSECTA	
Ephemeroptera	
Baetidae	
<i>Callibaetis</i>	collector/gatherer
Odonata	
Coenagrionidae	
<i>Enallagma</i>	predator
<i>Ischnura</i>	predator
Aeshnidae	
<i>Aeshna</i>	predator
<i>Anax</i>	predator
Libellulidae	
<i>Pachydiplax</i>	predator
<i>Sympetrum</i>	predator
<i>Tramea</i>	predator
Hemiptera	
Belostomatidae	
<i>Belostoma</i>	predator
Corixidae	
<i>Corisella</i>	detritivore/scavenger (generalist)
<i>Hesperocorixa</i>	detritivore/scavenger (generalist)
Notonectidae	
<i>Buena</i>	predator
<i>Notonecta</i>	predator
Coleoptera	
Dytiscidae	
<i>Cybister</i>	predator
<i>Laccophilus</i>	predator
<i>Thermonectus</i>	predator
Hydrophilidae	
<i>Berosus</i>	predator (larva); detritivore/herbivore (adult)
<i>Hydrophilus</i>	predator (larva); detritivore/herbivore (adult)
<i>Tropisternus</i>	predator (larva); detritivore/herbivore (adult)
Trichoptera	
Hydroptilidae	
<i>Hydroptila ajax</i>	piercer/herbivore (<i>Cladophora</i>)
<i>Oxyethira arizona</i>	piercer/herbivore (<i>Oedogonium</i>)
Diptera	
Chironomidae	collector/gatherer
Culicidae	
<i>Culex</i>	filter feeder
<i>Culiseta</i>	filter feeder
<i>Anopheles</i>	filter feeder
Ephydriidae	
<i>Brachydeutera</i>	collector/gatherer
<i>Hydrellia</i>	herbivore (<i>Lemna</i>)
Sciomyzidae	
<i>Dictya</i>	predator (Gastropoda)
<i>Pherbellia</i>	predator (Gastropoda)
<i>Sepedon</i>	predator (Gastropoda)
Syrphidae	collector/gatherer

Table 1. Continued.

Taxon	Functional feeding group
OTHER	
Platyhelminthes	
Annelida	
Hirudinea	
Gastropoda	
Acari	
Decapoda	

appressed to the substrate. Cases were located on living cattails approximately 0.3 meters above the sediment, and 0.2 meters below the water surface; there was no observable pattern to their distribution or orientation on the plants. On one plant examined, pupal cases were found between two closely-positioned cattail leaves. No algae grew here, but this location probably provided a superior pupation site for defense against predators and abiotic stress.

Wiggins & Wichard (1989) discussed the phylogeny of pupation in the Trichoptera and stated that microcaddisfly larvae usually spin cocoons discrete from the silken case prior to pupation. *Oxyethira arizona* is an exception to this generalization as larvae added a silken layer directly to the case interior. Examination of the pupal cases of other *Oxyethira* spp. and those of all hydroptilid genera should be performed to clarify microcaddisfly pupal cocoon morphology and its use in determining the higher phylogeny of Trichoptera.

Adults were taken first on 18 Aug 1998, total numbers peaked on 15 Sep 1998, and the numbers declined precipitously as the autumn months progressed (Fig. 5); the total catch comprised 88.1% males and 11.9% females. Most males (82.1%) and all females were collected in the traps placed at the edge of the stand. The high proportion of adults collected at the edge may represent a biological phenomenon such as oviposition preferences or mating behavior. The skewed sex ratio (over 7:1) may be a result of sampling technique (i.e., perhaps males alight on the water surface to rest more frequently than females), but laboratory rearings of 18 field-collected pupae produced 15 males and 3 females (5:1 ratio). This demonstrates that the population of *O. arizona* studied produces many more males than females.

Constructed wetlands are an increasingly common occurrence in the arid southwestern United States (Walton & Workman 1998), and invertebrate animals with the ability to colonize novel habitats are an important feature for their successful establishment as ecological communities. The *O. arizona* population of the Prado Constructed Wetlands appeared to be well established as many pupal cases were observed in several localities within the marsh. We provide a preliminary list of aquatic invertebrates taken from the Prado Constructed Wetlands because they represent important colonizers (Table 1). The only other microcaddisfly taken during this study was *Hydroptila ajax* Ross, a specialist consumer of *Cladophora* (J. B. Keiper, unpublished data); only a few larvae and adults were collected suggesting that this species is either a recent colonizer or not well suited for the marsh environment. The two hydroptilid species are unique components of the invertebrate community because of their apparently specialized feeding habits.

Table 2. Known food sources consumed by larval Hydroptilidae.

	Chlorophta					Rhodophyta		liverwort	diatoms	detritus	References
	<i>Cladophora</i>	<i>Oedogonium</i>	Oedogoniales	<i>Spirogyra</i>	<i>Zygnema</i>	<i>Batrachospermum</i>	<i>Lemanea</i>				
Ptilocolepinae											
<i>Palaeagapetus</i>								x			Flint 1962; Ito, 1997, 1998
<i>Ptilocolepus</i>								x			Ito 1993
Hydroptilini											
<i>Agraylea</i>	x								x		Nielsen 1948
<i>Dibusa</i>							x				Resh and Houpp 1986
<i>Hydroptila</i>	x		x		x				x		Nielsen 1948, Ito & Kawamura 1980, Huryrn 1985, Wells 1985, Keiper et al. 1998, Keiper and Foote 1999
<i>Maydenoptila</i>							x				Wells 1985
<i>Ochrotrichia</i>	x								x		Keiper & Foote 1998, Keiper & Walton, in press
<i>Oxyethira</i>		x		x	x						Nielsen 1948, Back 1983, Keiper et al. 1998
Stactobiini											
<i>Stactobiella</i>										x	Wiggins 1996b
Leucotrichiini											
<i>Leucotrichia</i>									x		McAuliffe 1982
<i>Zumatrichia</i>									x		Wiggins 1996a, b
Orthotrichiini											
<i>Ithytrichia</i>									x		Wiggins 1996a, b
<i>Orthotrichia</i>	x								x		Nielsen 1948, Wells 1985, J. B. Keiper, unpublished data
Neotrichiini											
<i>Neotrichia</i>									x		Wiggins 1996b
<i>Mayatrachia</i>									x		Wiggins 1996a, b

Although a variety of functional feeding groups (Merritt & Cummins 1996) are represented, the other taxa encountered appear to be predators or otherwise generalized trophically, with the exception of an undetermined species of *Hydrellia* (Diptera: Ephydriidae) which appears to be a specialist consumer of duckweed (Lemnaceae: *Lemna minor* L.) (J. B. Keiper, unpublished data).

Remarks.—This is the first report of hydroptilid larvae from North America consuming *Oedogonium*. Ito & Kawamura (1980) noted that *H. itoi* Kobayashi from Japan fed on Oedogoniales and diatoms, but no further descriptions of the food sources were given. Our report confirms that *Oedogonium* is consumed by Hydroptilidae (Table 2). Further investigations into the general biology of this relatively neglected group will probably describe additional food items, such as other genera of filamentous green algae, consumed by this speciose group. These data will facilitate a better understanding of the adaptive radiations that have taken place among the species of *Oxyethira* and the Hydroptilidae in general.

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**THE HAWAIIAN ‘DANCING MOTH’,
DRYADAULA TERPSICHORELLA, HAS COLONIZED
COASTAL SOUTHERN CALIFORNIA
(LEPIDOPTERA: TINEIDAE)**

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Abstract.—*Dryadula terpsichorella* (Busck, 1910) has been discovered at two sites in San Diego, California, near the harbor and 24 km distant, in July 1998 and February 1999. The species is widespread in the western Pacific and has been known in Hawaii for a century, where the larvae occur among dead leaves of various plants. The adults perform peculiar, circular ‘dances’ upon alighting.

Key Words.—Insecta, detritivore, fungivore, introduced insect.

Dryadula terpsichorella (Busck, 1910) was described from Hawaii, where it was presumed to have been introduced about 1900, because 19th Century collectors did not find it, and no specimens were available for *Fauna Hawaiiensis* (Walsingham 1907). It was first collected in 1901 and had become abundant in Honolulu by 1909, according to Swezey (1909). Busck (1910) speculated that *terpsichorella* had been introduced from Central America because several congeners occur there. Later this species also was recorded from Polynesia, Samoa, and Fiji (Zimmerman 1978). *Dryadula* is most strongly represented in Australia and New Zealand (Robinson 1988, Robinson & Nielsen 1993), suggesting the western Pacific as a possible source. Originally *terpsichorella* was described in the genus *Cyane* Chambers, 1873, a homonym that was replaced by *Chloropleca* Durrant, 1914. Robinson & Nielsen (1993) treated *Chloropleca* as a subjective synonym of *Dryadula* Meyrick, 1893, which was based originally on an Australian species.

Dryadula terpsichorella in California.—While I was visiting my father’s home in San Diego, California, in July 1998, he pointed out a tiny moth that runs in circles after alighting, and he said he had seen others recently. I thought I recognized it as a species I had seen in Hawaii and later determined as *D. terpsichorella*. Although no more living examples were observed during three days, I found several dead specimens on a window frame that faces the afternoon sun. These were in various stages of bleached colors and damage, suggesting that a colony had existed there for some time, perhaps several weeks.

Coincidentally, just four days earlier Norris Bloomfield captured one *D. terpsichorella* at the Miramar Marine Corps Air Station, about 24 km NE of my San Diego collection site. The synchrony of collection dates is remarkable because Bloomfield conducted inventory under contract on the extensive MCAS at 12 sites for three years (more than 250 dates in all months, involving more than 1000 blacklight trap samples—seasonally and taxonomically one of the most extensive surveys of moths any place in the western U.S.) and did not find other *D. terpsichorella*.

In February 1999 at the same San Diego locality, I found two living and several dead specimens of *D. terpsichorella*, again at windows facing the afternoon sun.

This site is located near the San Diego River channel, 2.75 km from its mouth at the Pacific Ocean and ca. 4 km NNW of the U.S. Naval Training Center at San Diego Bay, a major military and commercial shipping port. I examined unidentified tineids and miscellaneous microlepidoptera at the Los Angeles County Museum of Natural History and San Diego Natural History Museum in February 1999 but failed to find any specimens of *Dryadaula*.

Diagnosis.—Adults of *D. terpsichorella* are small (FW length 3.4–3.9 mm) but morphologically distinctive from any other Californian moth. The labial palpi are drooping but recurved with diverging, porrect, spatulate apices. The forewing is rounded distally, slightly bowed, longitudinally streaked with pale rust and dark gray-brown, with a row of delicate metallic spots at the end of the cell. The pattern is lost in old specimens, fading to mostly whitish. Abdominal terga I & II of the male are fused and strongly modified, with large lateral scale tufts that extend mesally over a patch of modified scales, in repose resembling a patch of tan velvet. The male genitalia are bizarre, grotesquely asymmetrical and incorporating parts of abdominal segment VIII. The structures are almost impossible to interpret if mounted intact on a slide. Morphological homologies of *Dryadaula* genitalia have been discussed by Robinson & Nielsen (1993).

Photographs of the adult and genitalia of both sexes and line drawings reproduced from Swezey are shown by Zimmerman (1978).

Larval Habits and Life History.—The biology of *Dryadaula* was reviewed by Robinson (1988), based mainly on *D. pactolia* Meyrick in Britain (Morrison 1968), where it is an introduced species, and on *D. terpsichorella* in Hawaii (Swezey 1909, Zimmerman 1978). Swezey described the larva, pupa, and biology of *terpsichorella* ahead of Busck's description and called it "The Dancing Moth," derived from characteristic circular gyrations, with a crab-like sideways gait, which the adult performs each time it alights. Robinson (1988) in Asia, and I, in Costa Rica, have observed quite similar behavior by several unrelated gelechioid species in Asian and Costa Rican tropics. The larvae of *terpsichorella* are found among dead leaves of various plants, including banana, pineapple, and sugar cane (Zimmerman 1978), whence introduction might occur. The larvae are thought to be detritivorous, but Zimmerman (1978) stated the actual food was unknown, and they may be fungivores. Larvae of *pactolia* inhabit damp wine cellars and warehouses and feed in silk-lined tunnels in mats of fungus.

At San Diego adults were active in late afternoon, and none was attracted to indoor lights nor a porchlight. On Maui, Hawaii, I observed *D. terpsichorella* in two coastal situations: near Mokolea Point, where the moths were flushed diurnally from non-native shrubs, including *Lantana* and *Rubus*, on a grazed, xeric, sandstone bluff; and at Napili Bay, where adults were attracted to lights at buildings in totally artificial, landscaped surroundings.

Material Examined.—CALIFORNIA: *San Diego Co.*: San Diego [Midway-S. D. River], 1f VII-14-1998 [JAP slide 7792] + 4m, 2f, 2 no abdomen, DOA VII-1998 [JAP slides 7793m, 7797m, 7853m] (J. A. & P. C. Powell), same data 2f + 4f DOA, II-23/24-1999; Miramar, Marine Corps Air Station [site 6], 1f VII-10-1998, blacklight trap (N. Bloomfield). HAWAII: *Maui*: Napili Bay, 2m XII-24/27-1982, at lights; near Mokolea Pt., 1m, 3f XII-25-1982 (J. Powell) [JAP slide 7803 m]. All vouchers in Essig Museum of Entomology, U. California Berkeley.

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species; J. W. Brown, SEL, USDA, U.S. National Museum, who initiated and coordinated the Miramar inventory, arranged for its third year specimens to be deposited in the Essig Museum, and searched the previous collections at San Diego Natural History Museum and U.S. National Museum for *Dryadula*; and Norris Bloomfield, who conducted the Miramar inventory.

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Scientific Note

NEW RECORDS OF SIXTEEN CADDISFLY SPECIES (TRICHOPTERA) FROM THE KURIL ARCHIPELAGO, THE ASIAN FAR EAST

The Kuril Archipelago forms the eastern boundary of the Okhotsk Sea and a bridge between Hokkaido (43°23' N, 145°49' E), the northern most island of Japan, and the Russian peninsula of Kamchatka (50°52' N, 156°32' E). The island chain consists of 34 islands, ranging in size from 0.15 to 3200 km². All of the Kuril islands are volcanic in origin, ranging in age from Upper Cretaceous to late Pleistocene. The islands are often fog-bound in summer, and snow-covered much of the rest of the year. Each island's fauna is shaped by its own geological history, adjacent channel depths and currents, as well as the proximity to mainland biota.

Ueno (Ueno, M. 1933. Bull. Biogeogr. Soc. Jap., 4: 171–212) and Miyadi (Miyadi, D. 1933. Jap. J. Zool., 5: 171–207) first reported on Kuril Island caddisfly fauna. After 1950 Russian scientists added considerably to knowledge of the Kuril Island caddis fauna, and by 1997, 101 species were known (Levanidova, I. M. 1979. Syst. & Ecol. Fish. Far East Cont. Reservoirs.; Levanidova, I. M. 1982. Amph. Insec. Mountain Regions Far East USSR; Vshivkova, T. S., Nozaki, T., Kuranishi, R., & T. I. Arefina. 1994. Bull. Biogeogr. Soc. Jap., 49: 129–142; Arefina, T. I., Ivanov, V. D., & I. M. Levanidova. 1996. Far East. Entomol., 34: 1–12; Arefina T. 1997. Key to the Insec. of Rus. Far East. 5: 41–46 & 82–89). Recently (1994–1997) on annual international biological survey expeditions by American, Russian and Japanese scientists, 16 additional species, including one family (Psychomyiidae) and four (*Orthotrichia*, *Wormaldia*, *Lype*, *Nothopsyche*) new generic records, were collected. These records bring the present total number to 117 species.

Specimens of the newly recorded species were collected by V. A. Teslenko (VT), N. Minakawa (NM), P. B. H. Oberg (PO), M. Ohara (MO), R. I. Gara (RG), A. Lelej (AL) and R. L. Crawford (RC) and examined by T. I. Arefina (TA), T. Nozaki (TN), I. M. Levanidova (IL), T. Ito (TI), V. D. Ivanov (VI) and M. Uenishi (MU). The specimens are deposited at the Institute of Biology and Soil Sciences, Russian Academy of Sciences, Far Eastern Branch, Vladivostok, Russia and at the School of Fisheries, University of Washington, Seattle, Washington, U.S.A.

Records.—(1) *Orthotrichia* sp. (Hydroptilidae): ZELIONYI: 2 females, Kamenskoye Lake, 43°30' N, 146°06' E, 6 Aug 1994, col. VT, det. VI. (2) *Wormaldia* sp. (Philopotamidae): KUNASHIR: 1 female, unnamed stream adjacent to the hot spring, 44°00' N, 145°41' E, 3 Aug 1995, col. VT, det. VI. (3) *Kisaura tsudai* Botosaneanu, 1970 (Philopotamidae): KUNASHIR: 10 males, 18 females, unnamed stream adjacent to the hot spring, 44°00' N, 145°41' E, 27 Jul 1997, col. NM, det. TA. (4) *Hydropsyche albicephala* Tanida, 1986 (Hydropsychidae): KUNASHIR: 2 males, 2 females, unnamed stream adjacent to the hot spring, 44°00' N, 145°41' E, 27 Jul 1997, col. NM, det. TA. (5) *Cheumatopsyche infascia* Martynov, 1934 (Hydropsychidae): KUNASHIR: 1 male, unnamed stream adjacent to the hot spring, 44°00' N, 145°41' E, 3 Aug 1995, col. VT, det. VI; 88

males, 126 females, same locality, 27 Jul 1997, col. NM, det. TA. (6) *Lype excisa* Mey, 1991 (Psychomyiidae): ITURUP: 1 female, Zapravochnyi Waterfall, 45°20' N, 147°60' E, 19 Aug 1996, col. VT, det. TA; KUNASHIR: 1 male, unnamed stream adjacent to the hot spring, 44°00' N, 145°41' E, 3 Aug 1995, col. NM and PO, det. TN; 1 male, 2 females, same locality, 27 Jul 1997, col. NM, det. TA. (7) *Oligotricha lapponica* Hagen, 1864 (Phryganeidae): PARAMUSHIR: 1 female, unnamed pond in Utyosnaya River Valley, 50°38' N, 156.07' E, 1 Aug 1996, col. RC, det. TN; 1 female, unnamed pond near Savushkina River, 50°44' N, 156°08' E, 4 Aug 1997, col. VT, det. TA. (8) *Brachycentrus americanus* Banks, 1899 (Brachycentridae): KUNASHIR: 4 larvae, Ilyushina River, 44°09' N, 145°56' E, 1 Aug, 1994, col. NM and RG, det. TI. (9) *Hydatophylax soldatovi* (Martynov, 1914) (Limnephilidae): KETOI: 1 female, Stochnaya River, 47°18' N, 152°30' E, 19 Aug 1995, col. NM, det. TN; 1 male, 1 pharate female, 1 larva, same locality and date, col. VT, det. TA; 1 pharate male, unnamed waterfall near Storozheva Cape, 47°22' N, 152°28' E, 17 Aug 1995, col. VT, det. TA; SIMUSHIR: 4 males, unnamed stream that drains Srednaya Bay, 46°59' N, 152°01' E, 21 Aug 1995, col. VT, det. IL; 3 larvae, same locality, 22 Aug 1995, col. VT, det. TA; 1 female, same locality and date, col. NM and PO, det. TN; 2 pharate males, 2 pharate females, 4 larvae, unnamed stream that drains Malaya Bay, 47°05' N, 152°08' E, 18 Aug 1995, col. VT, det. TA; URUP: 1 male, Lopukhovaya River, 45°48' N, 149°54' E, 29 Aug 1995, col. VT, det. TA; 1 male, Vesyolaya River, 46°05' N, 150°08' E, 6 Aug 1995, col. NM and PO, det. TN; 1 male, unnamed tributary of Ukromnaya River, 45°36' N, 149°31' E, 20 Aug 1996, col. NM, det. TN; 1 pharate female, 2 larvae, same locality and date, col. VT, det. IL; ITURUP: 1 larva, Nezhnyi Creek, 45°17' N, 147°52' E, 3 Aug 1995, col. VT, det. TA; 4 males, 1 female, unnamed stream that drains Konservnaya Bay, 45°20' N, 147°60' E, 18 Aug 1996, col. NM, det. TN; KUNASHIR: 1 male, unnamed stream that drains Lake Lagunnoye, 44°03' N; 145°44' E, 1 Sep 1995, col. NM, det. TN. (10) *Limnephilus femoratus* Zetterstedt, 1840 (Limnephilidae): PARAMUSHIR: 1 male, Utyosnaya River, 50°38' N, 156°08' E, 1 Aug 1996, col. MO, det. TN; ITURUP: 2 males, Natasha Lake, 44°46' N, 147°11' E, 22 Aug 1996, col. VT, det. TA; ITURUP: 3 males, unnamed stream that drains Konservnaya Bay, 45°20' N, 147°60' E, 31 Jul 1997, col. NM, det. TA. (11) *L. incisus* Curtis, 1834 (Limnephilidae): PARAMUSHIR: 1 female, unnamed pond near Vasilyeva Cape, 50°01' N, 155°24' E, 3 Aug 1996, col. MO, det. TN; 1 female, same locality, 16 Aug 1997, col. AL, det. TA; 4 males, 9 females, unnamed lake near Kapustnyi Cape, 15 Aug 1997, col. VT, det. TA. (12) *Nothopsyche* sp. (Limnephilidae): KUNASHIR: 1 larva, Lake Aliger, 44°02' N, 145°44' E, 31 Jul 1994, col. NM and RG, det. TN. (13) *Molannodes tinctus* (Zetterstedt, 1840) (Molannidae): SHUMSHU: 5 males, 5 females, unnamed lake near Yuzhanka River, 10 Aug 1997, col. VT, det. TA; PARAMUSHIR: 6 males, 1 females, unnamed pond near Vasilyeva Cape, 50°02' N, 155°23' E, 3 Aug 1996, col. NM, det. TI. (14) *Ceraclea alboguttata* (Hagen, 1860) (Leptoceridae): KUNASHIR: 1 female, unnamed stream that drains Lake Lagunnoye, 44°03' N; 145°44' E, 1 Sep 1995, col. NM, det. MU. (15) *Triaenodes pellectus* Ulmer, 1908 (Leptoceridae): KUNASHIR: 1 male, unnamed stream adjacent to the hot spring, 44°00' N, 145°41' E, 25 Aug 1996, col. NM and PO, det. MU; 2 females, same locality, 27 Jul 1997, col. NM, det. TA. (16) *Oecetis morii* Tsuda, 1942 (Leptoceridae): KUNASHIR:

1 male, Lake Aliger, 44°03' N, 145°44' E, 26 Aug 1996, col. NM and PO, det. MU.

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Scientific Note

EXTIRPATION OF ONE EXOTIC ANT SPECIES BY ANOTHER IN SOUTHERN CALIFORNIA

On 7 March 1989, the junior author discovered an infestation of an exotic ant, *Pheidole teneriffana* Forel in and around Admiral Kidd Park, 2125 Santa Fe Avenue, Long Beach, Los Angeles County, California (Martinez, M. J. 1992. Pan-Pacific Entomol., 68: 153-154). This ant was originally described in 1893 from Teneriffe in the Canary Islands (Forel, A. 1893. Ann. soc. Entomol. Belgique, 37: 454-466). It is now reported to occur across North Africa extending as far east as Egypt (Snelling, R. R. 1992. Bull. Southern Cal. Acad. Sci., 91: 121-125). *P. teneriffana* has also been recorded from Cuba (Aguayo, C. G. 1932. Bull. Brooklyn Entomol. Soc., 27: 215-227).

Between 1989 and 1991, populations of *P. teneriffana* at Admiral Kidd Park and surrounding areas increased and the ant expanded the area it infested advancing into habitats occupied by the Argentine ant, *Linepithema humile* (Mayr). It eventually colonized about 2 ha of the 3 ha park (Martinez 1992). During this time interspecific aggression was observed between *P. teneriffana* and another entrenched exotic ant, the Argentine ant. Originally, *P. teneriffana* was the aggressor attacking and destroying Argentine ant colonies and taking over many of its nest sites (Martinez 1992). Agonistic interactions were also observed between colonies of the endemic southern fire ant, *Solenopsis xyloni* McCook and *P. teneriffana*. *Solenopsis xyloni* was observed attacking and usurping some nests of *P. teneriffana*. Interspecific hostility was also observed between the California harvester ant, *Pogonomyrmex californicus* (Buckley) and *P. teneriffana* at this location.

The early interactions between *P. teneriffana* and *L. humile* in 1990 and 1991 were not significant because the two ants essentially occupied different areas in the park with *P. teneriffana* dominant in arid areas at the south and east sides of the park, in the parking lot, and along 21st Street to Willard Street. Willard Street, 21st Street, and Santa Fe Avenue delineate an area encompassing a contiguous industrial/commercial structure which encircled an asphalt parking area in the center. No external moisture source could be located on the interior and exterior perimeters of the structure. *Linepithema humile* was well established on the north side of the park where sprinklers provided it with water.

Several events occurred at Admiral Kidd Park which adversely impacted ant populations which occurred there. In March/April 1990, employees of the Los Angeles County Agriculture Commissioner attempted to eradicate the *P. teneriffana* infestation. The Agriculture Commissioner's representatives applied chlorpyrifos, using compressed air sprayers, to *P. teneriffana* nests (R. Garrison, personal communication). This was an unsuccessful attempt at eradication because many nests were not found, and hence, they were not treated. *Pheidole teneriffana* continued to thrive in the park and its surrounding areas along 21st and Willard Streets after this eradication effort.

Between April and June 1993, a section on the north side of Admiral Kidd

Park was renovated and a 0.8 ha soccer field was established. The turf in this area was reseeded and additional sprinklers were installed making the area favorable for Argentine ants because of the continuous source of moisture. At about the same time, the children's play area on the south side, and the parking lot on the east side of the park were also renovated. Some areas of the parking lot were repaved with bricks. These habitat modifications negatively impacted populations of *P. teneriffana* which existed at the east and south sides of the park. However, both the Argentine ant and *P. teneriffana* continued to exist in the park and surrounding areas after the renovations were completed.

In November 1994, at the southwest corner of the park, Argentine ants were observed encroaching on and invading territories occupied by *P. teneriffana*. Battles between the two species continued in this area from November 1994 to about October 1995, at which time, *L. humile* succeeded in eliminating all *P. teneriffana* colonies from this area of the park. By April 1996, *P. teneriffana* was driven out of Admiral Kidd Park and its parking lot by the Argentine ant. However, nests of *P. teneriffana* continued to exist along the south side of 21st. Street and extending all the way to Willard Street. Inspections conducted by the junior author on 16 January 1997 revealed only four *P. teneriffana* nests remaining in the pavement areas between 1731 and 1807 Willard Street. On 10 February 1997, only two nests of *P. teneriffana* remained in this area. Argentine ants were observed attacking these nests and pillaging their contents. On 3 June 1997, only one *P. teneriffana* nest remained adjacent to 1741 Willard Street. An inspection made at this site on 21 August 1997 revealed that *P. teneriffana* no longer existed at this location.

On 12 September 1998, a thorough and careful survey and reconnaissance of the park, and all surrounding areas originally occupied by *P. teneriffana*, was conducted in an attempt to locate nests of this ant. We were not successful in finding any nest of *P. teneriffana*. Additionally, 66 bait points consisting of about two grams each of 30% fat ground beef were placed in many areas of the park, its parking lot, and adjacent streets where *P. teneriffana* nests and foragers had been observed in the past. One hour after placement, these bait locations were inspected and the ant species present were recorded. Sixty three of these bait placements were found to be heavily monopolized by the Argentine ant. We believe that the other three bait placements were not discovered by *L. humile* because they were placed in cracks in the concrete pavement which were exposed to direct sunlight and thus were too hot for foragers of Argentine ant to traverse.

Further surveys and inspections conducted at Admiral Kidd Park and surrounding areas on 10 and 11 October 1998 failed to locate any nest or foragers of *P. teneriffana*. We are convinced that *P. teneriffana* has been extirpated at this location.

When *P. teneriffana* was originally discovered at Admiral Kidd Park, it occupied arid areas on the south and east sides of the park. These dry areas were marginal habitats for the Argentine ant which occurred on the north side of the park which was subjected to periodic irrigation. Renovations on the north side of the park, which took place in 1993, probably contributed to a build-up of Argentine ant populations at this location.

Other environmental changes, including several wetter and warmer than normal winters, fostered an enormous build-up of Argentine ant populations at Admiral

Kidd Park and the surrounding areas which permitted *L. humile* to venture into and colonize previously marginal habitats.

Renovations at the south and east sides of the park and pesticide applications to some *P. teneriffana* nests contributed to altering the competitive advantage in favor of the Argentine ant. Based on our observations we believe that the final extirpation of the exotic ant, *P. teneriffana*, at Admiral Kidd Park and its immediate surroundings was done by the Argentine ant. This should come at no surprise to anyone as *L. humile* has been reported to displace species of *Pheidole* in Madeira (Goetsch, W. 1957. *The ants*. The University of Michigan Press, Ann Arbor). *Linepithema humile* has also extirpated other ant species in several areas (Haskins, C. P. & E. F. Haskins. 1965. *Ecology*, 46: 736–740; Crowell, K. L. 1968. *Ecology*, 49: 551–555; Fluker, S. S. & J. W. Beardsley. 1970. *Ann. Entomol. Soc. Am.*, 63: 1290–1296; Erickson, J. M. 1972. *Psyche*, 78: 257–266; Lieberberg, L. P. et al. 1975. *Ecology*, 56: 473–478; Ward, P. S. 1987. *Hilgardia*, 55: 1–16).

We also observed that other ant species: *Solenopsis xyloni* McCook, *P. californicus* (Buckley), *Dorymyrmex insanus* (Buckley), *Dorymyrmex bicolor* Wheeler, *Tapinoma sessile* (Say), *Formica francoeuri* Bolton, *Monomorium ergatogyna* Wheeler, and *Cardiocondyla ectopia* Snelling, existed at Admiral Kidd Park at the time *P. teneriffana* was discovered (Martinez 1992). Surveys conducted on 12 September 1998 and on 10 and 11 October 1998 found only two of the above species in the park and its immediate surroundings. A single *P. californicus* nest was found on a section of 21st. Street that turns at right angles and connects to Willard Street. Several *C. ectopia* nests currently exist in the park, along its borders, and in the parking lot at the east side. This ant possesses a repellent chemical which it frequently uses when threatened by the Argentine ant (Gulmahamad, H. 1997. *Pan-Pacific Entomol.*, 73: 21–27).

We believe that the Argentine ant is responsible for the reduction of formicid biodiversity in Admiral Kidd Park and its immediate surroundings. We think that changing environmental conditions in the future will periodically cause the Argentine ant to abandon/recolonize marginal habitats in and around the Admiral Kidd Park and this will result in cycles of recolonization and displacement of endemic ant species in the park and its surrounding areas.

Acknowledgment.—We thank Stoy Hedges for critically reviewing the manuscript.

Hanif Gulmahamad, *Terminix International, 1501 Harris Court, Anaheim, California 92806* and Michael J. Martinez, *Department of Parks and Recreation, City of Long Beach, Long Beach, California 90815*.

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PROCEEDINGS OF THE PACIFIC COAST ENTOMOLOGICAL SOCIETY, 1998

FIVE HUNDRED FORTIETH MEETING

The 540th meeting of the Pacific Coast Entomological Society was held at 8:00 PM on the 16th of January 1998 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco with President Warren E. Savary presiding.

A motion made to table all committee reports until the February meeting was seconded and passed. President Savary passed the gavel to incoming President of the Society, Dr. William D. Shepard of Sacramento State University. The Society is most grateful to Mr. Savary for his leadership, enthusiasm, and many contributions over the past year.

Mr. Curtis Y. Takahashi of the California Department of Food and Agriculture announced that the examination for the State of California Entomologist will be held next month in Sacramento.

Mr. Vincent F. Lee of the California Academy of Sciences proposed three candidates for membership.

Dr. Russell C. Biggum of Moscow Idaho and Dr. C. Eugene Jones of CSU Fullerton were elected as regular members, and Mr. Eugene R. Hannon of San Francisco State University is elected as a student member.

Mr. Ron Robertson of the California Academy of Sciences presented a slide note of some lepidopterans he encountered in Arizona; an unusual geometrid that mimics an arctiid and a wonderful example of crypsis in a sphingid.

The featured speaker, Dr. Tanya Wolf of the University of California, Berkeley presented a slide lecture entitled "The Fly's Eye View of Polarity." Dr. Wolf detailed the identification and mapping of the gene responsible for polarity of the ommatidia in *Drosophila*. Tissue polarity is a highly conserved evolutionary trait. Dr. Wolf explained how the epithelial sheets that rotate in the development of the normal compound eye arise from the equator of the third instar larvae. When the so called "strabismus" gene is activated, the epithelial sheets rotate in such a fashion so as to scatter the ommatidia in a non-linear arrangement. In addition to the scattered notal bristles of the ommatidia, tarsal segments increased from 5 to 6 in "strabismus" *Drosophila*.

The meeting was adjourned at 9:00 PM and was followed by a social hour in the Department of Entomology Conference Room. The following 29 persons were present; (23 members) M. M. Arnaud, P. H. Arnaud Jr., C. B. Barr, L. G. Bezark, H. K. Court, M. Delmas, B. Deutsch, R. L. Langston, A. L. LeMon, V. F. Lee, J. D. McCarty, S. T. O'Keefe, D. R. Parks, N. D. Penny, A. E. Rackett, R. E. Robertson, W. E. Savary, J. S. Schweikert, W. D. Shepard, R. E. Stecker, C. Y. Takahashi, D. Ubick, and S. E. Vaughn; (6 guests) J. E. Court, M. Delmas, S. E. Haskin, S. Mead, C. Spencer, and T. Wolff.

FIVE HUNDRED FORTY-FIRST MEETING

The 541st meeting of the Pacific Coast Entomological Society was held at 8:00 PM on the 20th of February 1998 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco with President William D. Shepard presiding.

Mr. Vincent F. Lee of the California Academy of Sciences proposed three candidates for membership. Mr. Bohdan Bilyi of Otobicoke, Ontario, Canada; Ms. Patricia W. MacCulloch of the Royal Ontario Museum, Toronto, Canada, and Mr. Eugene R. Miliczky of Zillah, Washington. All were elected as regular members.

Dr. Norman D. Penny of the California Academy of Sciences introduced Ms. Linda Seabrooks, a scientific illustrator whose drawings would be on display during the social hour following the meeting; and Dr. William Shepard presented Ms. Karen Converse of Sacramento State University as guests of the Society.

Mr. Larry G. Bezark nominated Mrs. Laura A. Irons of San Jose State University as President-Elect of the Society. The motion was seconded, and passed unanimously. Mr. Warren E. Savary of the Food and Drug Administration nominated Ms. Julieta F. Parinas as Treasurer, Mr. Vincent F. Lee as Managing Secretary, and Mr. Stanley E. Vaughn as Recording Secretary. Again, all nominees were voted in to continue their current responsibilities.

Dr. J Gordon Edwards of San Jose State University presented a slide note of a woman that had

several human bot flies surgically removed from her back and lower trunk in the Rio Napo region of Ecuador; and followed that with series of slides that chronologically detailed the oviposition, development, pupation and ultimately the emergence and curation of the cuterebrid *Dermatobia hominis* in his former student Mr. Darryl Ubick, now of the California Academy of Sciences.

The featured speaker, Dr. Felix Sperling of the University of California, Berkeley presented a slide lecture entitled "Species Boundaries in Lepidoptera". Dr. Sperling elegantly described how mitochondrial DNA can be used as a powerful tool in systematic studies and presented several case studies utilizing economically important lepidopterans. Mitochondrial DNA provides a mechanism by which information regarding species limits can be related to Haldane's Rule and can illustrate both ecological and mating traits.

The meeting was adjourned at 9:00 PM and was followed by a social hour in the Department of Entomology Conference Room. The following 29 persons were present; (23 members) M. M. Arnaud, P. H. Arnaud Jr., C. B. Barr, L. G. Bezark, H. K. Court, M. Delmas, B. Deutsch, R. L. Langston, A. L. LeMon, V. F. Lee, J. D. McCarty, S. T. O'Keefe, D. R. Parks, N. D. Penny, A. E. Rackett, R. E. Robertson, W. E. Savary, J. S. Schweikert, W. D. Shepard, R. E. Stecker, C. Y. Takahashi, D. Ubick, and S. E. Vaughn; (6 guests) J. E. Court, M. Delmas, S. E. Haskin, S. Mead, C. Spencer, and T. Wolff.

FIVE HUNDRED FORTY-SECOND MEETING

The 542nd meeting of the Pacific Coast Entomological Society was held at 8:00 PM on the 20th of March 1998 in the Morrison Auditorium of the California Academy of Sciences, Golden Gate Park, San Francisco with President William D. Shepard presiding.

President Shepard announced that an Executive Board Meeting will be held in May and among the agenda items to be discussed at the meeting are improvements to the Pan-Pacific Entomologist. President Shepard asked all members present for any suggestions to increase the numbers of manuscripts submitted for publication in the journal.

Mr. Vincent F. Lee of the California Academy of Sciences announced the publication of *Introduction to Insect Biology and Diversity*, 2nd Edition by Daly, Doyen, and Purcell.

Ms. Leslie Saul-Gershenz, of the San Francisco Insect Zoo, announced that a bowl-a-thon fundraiser will be held to benefit the American Center for Ecosystem Survival. Details of the benefit can be obtained by calling the San Francisco Zoo.

Ms. Josephine Jose of San Jose State University announced that the annual San Jose State Entomology Club Overnighter to Arroyo Seco will be held on the weekend of April 24–26. Details of the collection trip can be obtained by calling the J. Gordon Edwards Entomology Museum at 408.924.4878.

The featured speaker, Dr. Gregory F. Grether of the University of California at Santa Barbara presented a slide lecture entitled "Mechanisms of Selection on Wing Coloration in a Territorial Damselfly". Dr. Grether explained that although the secondary sexual characteristics of organisms have been the subject of study since the time of Darwin, there are still many neglected areas. The evolutionary constraints of those characteristics and the influence of ornaments on flight are examples of such neglected areas. Dr. Grether addressed these problems in his study of the territorial damselfly, *Hetaerina americana*. Males of the species exhibit a ruby red spot on their wings. These spots enlarge as the damselfly reaches sexual maturity, and after fifteen days are fully developed. Dr. Grether indicated that an enlarged wing spot related to increased territory holding and a corresponding increase in mating frequency. Selection pressure that favors such a phenotypical appearance and behavior also resulted in decreased survival. Dr. Grether associated the enlarged wing spots with increased predation as *H. americana* is far more susceptible than its clear winged counterparts.

The meeting was adjourned at 9:00 PM and was followed by a social hour in the Department of Entomology Conference room.

The following 31 persons were present: (25 members) A. M. Alterman, M. M. Arnaud, P. H. Arnaud Jr, R. M. Brown, P. G. daSilva, W. A. Doolin, J. G. Edwards, J. Gulbransen, W. Hammersky, E. R. Hannon, J. Jose, R. L. Langdon, A. L. Le Mon, V. F. Lee, N. D. Penny, A. E. Rackett, J. L. Rasgon, L. S. Saul-Gershenz, C. Saux, W. E. Savary, K. N. Schick, J. S. Schweikert, W. D. Shepard, F. A. H. Sperling, and D. Ubick; (6 guests) L. Dunipau, A. Gondor, G. F. Grether, T. Manolis, F. S. Ren, and G. S. Spicer.

FIVE HUNDRED FORTY-THIRD MEETING

The 543rd meeting of the Pacific Coast Entomological Society was held at 8:00 PM on 17 April 1998 in the Goethe Room of the California Academy of Sciences, Golden Gate Park, San Francisco with President William D. Shepard presiding.

Mr. Stanley E. Vaughn of San Jose State University proposed Dr. Javier Alba-Tercedor from the Departamento de Biología Animal y Ecología, Universidad de Granada, Spain and Dr. Gregory S. Spicer of San Francisco State University as regular members and Ms. Corrie Saux of San Francisco State University as a student member. The candidates were voted on and approved as members of the Society.

Mr. Curtis Y. Takahashi of the California Department of Food and Agriculture announced that the CDFFA seeks individuals for hire on the current Japanese Beetle project.

Ms. Cheryl B. Barr of the University of California announced that the University will be hosting Cal Day, an open house to be held on the 18th of April 1998.

The featured speaker, Dr. Christina Sandoval of the University of California at Santa Barbara presented a slide lecture entitled, "Micro and Macro-evolution of Host Plant Specialization and Color Polymorphism in *Timema* walking-sticks."

Dr. Sandoval described the mechanisms of color polymorphisms within populations of *Timema* walking-sticks, as well as describing how selection for a high degree of crypsis in a heterogeneous host-plant environment may lead to speciation. New species of *Timema* may result more from adaptation and not necessarily from reproductive isolation. The meeting was adjourned at 9:03 PM and was followed by a social hour held in the Department of Entomology Conference Room.

The following 23 persons were present: (20 members) M. M. Arnaud, P. H. Arnaud Jr., C. B. Barr, K. W. Brown, R. M. Brown, H. K. Court, J. G. Edwards, J. Gulbransen, L. A. Irons, J. Jose, R. L. Langston, A. L. LeMon, D. R. Parks, W. E. Savary, K. N. Schick, W. D. Shepard, M. Sharp, C. Y. Takahashi, S. E. Vaughn, and R. L. Zuparko; (3 guests) J. E. Court, C. Sandoval, and G. Zolnerowich.

FIVE HUNDRED FORTY-FOURTH MEETING

The 544th meeting of the Pacific Coast Entomological Society was held at 8:00 PM on 15 May 1998 in the Goethe Room of the California Academy of Sciences, Golden Gate Park, San Francisco with President William D. Shepard presiding.

Managing Secretary Mr. Vincent F. Lee of the California Academy of Sciences nominated three candidates for membership in the Society. The nominations of: Dr. Shih-Chang Kang of Taiwan City, Taiwan; Mr. Ralph J. Michels of Ridgecrest, California; and Dr. Christina Sandoval of the University of California at Santa Barbara were elected as regular members. Mr. Lee also announced that the University of California at Riverside has employment openings for research assistants.

Dr. Norman D. Penny of the California Academy of Sciences announced that there are current employment opportunities at the San Mateo County Department of Agriculture, and that the Entomological Society of America is asking for volunteers for the upcoming national meeting in Las Vegas, Nevada.

President William D. Shepard announced that in lieu of the September meeting, the Society will sponsor a field trip to the University of California's Sagehen Creek Field Station on September 18-19, 1998 and Mr. Warren E. Savary announced that two new species of *Timema* walking-sticks from Arroyo Seco were described by Dr. Christina Sandoval. Dr. Sandoval spoke on the evolution of *Timema* at the April meeting of Pacific Coast Entomological Society.

Recording Secretary Mr. Stanley E. Vaughn announced the retirement of Dr. Ron Stecker, after 34 years of teaching at San Jose State University. Dr. Stecker became a member of the Pacific Coast Entomological Society in 1967, served on numerous committees and as president in 1977. Over the years, Ron's support and enthusiasm has been evidenced by the many students he has introduced to entomology and to the Society. We wish him well in his retirement.

The featured speaker, Dr. Robert S. Lane of the University of California at Berkeley presented a slide lecture entitled "Lyme Disease in California: An Overview". Dr. Lane chronicled Lyme disease from the identification of its spirochete pathogen to current prosthetic practices and described the ecology and epidemiology the infection. Lyme disease has been described by public health officials as the most important vector-borne disease of the temperate regions of the world, and the most commonly reported arthropod-borne infection of humans in California. Dr. Lane detailed many of the mechanisms of *Borrelia* maintenance and distribution in nature and described some of the control

methodologies for reducing the risk of transmission and infection. The meeting was adjourned at 9:00 PM and was followed by a social hour held in the Department of Entomology Conference Room.

The following 37 persons were present; (27 members) A. M. Alterman, M. M. Arnaud, P. H. Arnaud Jr., K. W. Brown, H. K. Court, P. R. Craig, J. G. Edwards, A. S. Hunter, M. A. Isaak, J. Jose, R. L. Langston, V. F. Lee, L. A. Norton, D. R. Parks, N. D. Penny, W. W. Pitcher, J. L. Rasgon, R. G. Robertson, W. E. Savary, K. N. Schick, M. Sharp, W. D. Shepard, R. E. Stecker, J. E. Tobler I, D. Ubick, S. E. Vaughn, and R. L. Zuparko; (10 guests) I. Brown, J. E. Court, D. K. Dabney, J. Gulbransen, A. Hom, R. S. Lane, K. Macropal, P. Pitcher, J. Robertson, and P. Schlemmer.

FIVE HUNDRED FORTY-FIFTH MEETING

The 545th meeting of the Pacific Coast Entomological Society was held at 8:00 PM on 16 October 1998 in the Goethe Room of the California Academy of Sciences, Golden Gate Park, San Francisco with President William D. Shepard presiding.

Dr. J. Gordon Edwards of San Jose State University announced that Dr. Pierre Jollivet of the Paris, France Museum of Natural History, is looking for graduate students interested in the systematics of the *Timarcha* complex (Family Chrysomelidae).

Mr. Vincent F. Lee of the California Academy of Sciences announced that volume number 4 of the Pan-Pacific Entomologist will be mailed out in about a month and Dr. Norman D. Penny of the California Academy of Sciences announced that the Academy has Cornell unit trays and Schmidt boxes available for sale.

The featured speakers, Dr. Norman D. Penny and Mr. Jere Schweikert of the Department of Entomology, California Academy of Sciences presented a multimedia lecture entitled "Recent Entomological Encounters in Madagascar".

Dr. Penny and Mr. Schweikert shared some of the experiences of the Department of Entomology's five week sojourn into Madagascar as part of the ongoing biotic survey of Ranomafana National Park. The expedition, sponsored by the Oracle Company, yielded over 15,000 insect and arachnid specimens many of which were displayed for viewing following the presentation. The meeting was adjourned at 9:00 PM and was followed by a social hour held in the Department of Entomology Conference Room.

The following 55 persons were present: (35 members) R. A. Aalbu, A. M. Alterman, C. B. Barr, J. R. Beley, T. S. Briggs, K. W. Brown, P. Buickerood, R. Buickerood, J. R. Clopton, A. I. Cognato, H. K. Court, P. G. da Silva, M. Delmas, J. G. Edwards, S. S. Ferguson, W. E. Ferguson, E. M. Fisher, E. R. Hannon, L. A. Irons, M. A. Isaak, R. L. Langston, V. F. Lee, T. C. Meikle, J. F. Parinas, A. M. L. Penny, N. D. Penny, J. L. Rasgon, C. Saux, W. E. Savary, J. S. Schweikert, W. D. Shepard, S. E. Vaughn, and D. T. Wyatt; (20 guests) R. Boynton, J. E. Court, B. Delmas, L. Delmas, P. Delmas, M. DeVault, S. Donagher, J. Donald, B. Erkson, K. Galakates, S. Hinz, L. Hosford, A. Lohman, Q. S. McFrederick, J. Marnault, M. Moffett, W. Rauscher, S. Renz, M. Ruh, V. Saxe, P. Schlemmer, E. H. Simmons Jr., C. Suematsu, I. Wilson, and 1 illegible signature.

FIVE HUNDRED FORTY-SIXTH MEETING

The 546th meeting of the Pacific Coast Entomological Society was held at 8:00 PM on 20 November 1998 in the Goethe Room of the California Academy of Sciences, Golden Gate Park, San Francisco with President William D. Shepard presiding.

Mr. Vincent F. Lee of the California Academy of Sciences proposed seven candidates for membership in the Society. Elected as regular members were: Dr. Joe B. Keiper of the University of California at Riverside, Dr. Ronald F. Lang of Montana State University, Dr. Thomas R. Prentice of the University of California at Riverside and Ms. Patricia B. Thompson of Davis, California; as student members, the Society welcomes Ms. Margaret E. Hart of the College of Marin, Ms. Catherine M. Suematsu of San Francisco State University, and Ms. Robin K. Wall of the California State University Sacramento.

Dr. Edward S. Ross, Curator Emeritus of the California Academy of Sciences sadly announced the passing of H. Vannoy Davis, Auditor of the Pacific Coast Entomological Society. Dr. Ross presented a slide note that detailed a collection trip that he and Mr. Davis embarked on in Africa and detailed some of Mr. Davis' many years of service and numerous contributions to the Society.

Ms. Barbra Deutsch reported on the conservation of the Monarch Butterfly migration routes and Dr. Kirby Brown a cultural entomology exhibit that included a mask and a walking stick from China.

The featured speaker, Dr. Philip S. Ward of the Department of Entomology at the University of

California at Davis presented a slide lecture entitled "Ant-Plant Interactions in Amazonia: Biogeography and Patterns of Host-Plant Interactions. Dr. Ward discussed some recently completed studies of the genus *Pseudomyrmex*, a generalist group that nest in the domatia of dead plant stems, and detailed their phylogeny. Dr. Ward indicated that in these ants, aggressive behavior evolved before obligate associations with specialized ant-plants, and may have precurred the evolution of such associations. Species richness of the *Pseudomyrmex viduus* group suggests a possible model for host-plant evolution where shifts between plant genera involve an intermediate period of host-plant use.

The meeting was adjourned at 9:15 PM and was followed by a social hour in the Department of Entomology Conference Room. The following 55 persons were present: (35 members) R. A. Aalbu, A. M. Alterman, F. G. Andrews, M. M. Arnaud, P. H. Arnaud Jr., C. B. Barr, K. W. Brown, J. R. Clopton, H. K. Court, P. R. Craig, M. Delmas, S. V. Fend, E. M. Fisher, J. E. Hafernik Jr., E. R. Hannon, A. S. Hunter, L. A. Irons, M. A. Isaak, R. L. Langston, A. L. LeMon, N. D. Penny, A. E. Rackett, J. L. Rasgon, S. Renkes, E. S. Ross, W. E. Savary, K. N. Schick, J. S. Schweikert, W. D. Shepard, J. T. Sorenson, F. A. H. Sperling, C. M. Suematsu, D. Ubick, S. E. Vaughn, and T. J. Zavortink; (20 guests) K. Alcala, S. Brady, I. Brown, A. Classen, J. E. Court, M. Delmas, B. Echeverra, D. D. Giuliani, D. Hulsey, R. Hunt, S. Junger, S. Lew, T. J. McCormick, V. Moseley, M. Rink, F. S. Pinero, N. Saniles, P. Schlerrer, R. Waugaman, and A. Whelchel.

FIVE HUNDRED FORTY-SEVENTH MEETING

The 547th meeting of the Pacific Coast Entomological Society was held at 8:00 PM on 19 December 1998 in room 1111, Academic Surge Building at the University of California at Davis with President William D. Shepard presiding.

Mr. Vincent F. Lee of the California Academy of Sciences proposed seven candidates for membership in the Society. Elected as regular members were: Dr. Joe B. Keiper of the University of California at Riverside, Dr. Ronald F. Lang of Montana State University, Dr. Thomas R. Prentice of the University of California at Riverside and Ms. Patricia B. Thompson of Davis, California; as student members, the Society welcomes Ms. Margaret E. Hart of the College of Marin, Ms. Catherine M. Suematsu of San Francisco State University, and Ms. Robin K. Wall of the California State University Sacramento.

Mr. Warren E. Savary, Chair of the Nominations Committee announced the nominations of officers of the Pacific Coast Entomological Society for 1999. President Laura A. Irons, President-elect David Wyatt, Managing Secretary Vincent F. Lee, Recording Secretary Stanley E. Vaughn, and Treasurer Julieta F. Parinas. All nominees were voted on and elected as officers of the Society.

The featured speaker, Dr. William D. Shepard of the Department of Biology, California State University, Sacramento presented a slide lecture entitled, "What are Montane Stream Beetles doing in the Desert?" Dr. Shepard discussed the geo-evolution and distribution of riffle beetle populations in the deserts of the United States. These beetle populations are remnants from the wetter Pleistocene and Tertiary periods and indicate that there has been constant outflow of water for these populations to endure. The evolution of these beetles for survival in these xeric habitats include adapting to warmer water, much lower dissolved oxygen content, and virtually no opportunity for dispersal. Dr. Shepard also detailed the threats that face these populations due to increased water use by humans, fish habitat conservation efforts, and competitions with introduced species. The meeting was adjourned at 9:20.

The following 24 persons were present (15 members) F. G. Andrews, M. M. Arnaud, P. H. Arnaud Jr., C. B. Barr, L. G. Bezark, R. M. Brown, J. A. Benedictis, E. M. Fisher, R. E. Hill, A. S. Hunter, L. A. Irons, D. H. Kistner, C. Y. Kityama, V. F. Lee, N. D. Penny, J. A. Powell, J. L. Rasgon, D. C. Rogers, W. E. Savary, K. N. Schick, W. D. Shepard, S. P. Taormino, R. W. Thorp, S. E. Vaughn, and D. T. Wyatt; (11 guests) R. L. Aalbu, G. Brsiagno, D. Drom, S. L. Heydon, A. C. Kistner, A. Lohman, A. Lohman, R. A. O'Flaherty, E. Rogers, S. Udayagiri, and L. Zinn.

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Ferrari, J. A. & K. S. Rai. 1989. Phenotypic correlates of genome size variation in *Aedes albopictus*. *Evolution*, 42: 895–899.
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