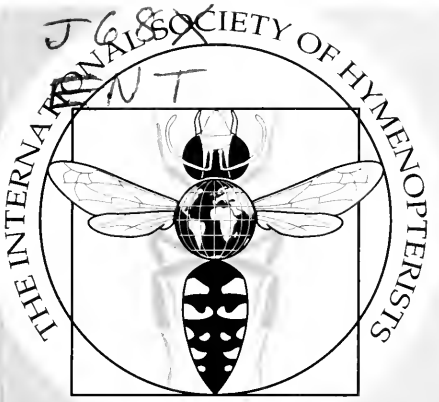

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The Cleptoparasitic Bee Tribe Rhathymini (Hymenoptera: Apidae): Description of a New Genus and a Tribal Review

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Abstract.—The new genus ***Rhathymodes*** is proposed for *Rhathymus acutiventris* Friese [with its **new synonym,** *R. friesei* Ducke], and *R. bertonii* Schrottky; resulting in the **new combinations**: *Rhathymodes acutiventris* (Friese) and *R. bertonii* (Schrottky). A lectotype is newly designated for *R. friesei*. To accommodate the new genus, changes are suggested for a key to subfamilies and tribes of Apidae. The tribe Rhathymini and its two genera are characterized, as are the two species of *Rhathymodes*.

The neotropical cleptoparasitic apine tribe Rhathymini consists of moderate sized to large (13–28 mm body length) species superficially resembling vespid wasps, especially *Polistes*, or suggesting in form giant species of the bee genus *Nomada*. The impetus for the present paper was the discovery by Martin Cooper of Lyme Regis, U.K., and almost simultaneously by one of us (MSE), that some of the smaller species hitherto placed in *Rhathymus* do not run to the Rhathymini in the key to the subfamilies and tribes of Apinae by Michener (2000: 571–574). These smaller species represent a second genus of the, until now monogeneric, Rhathymini. It is a genus with some probable plesiomorphies relative to *Rhathymus* and therefore likely to provide some insight into relations between Rhathymini and other tribes of Apinae. We hope that recognition of the new genus, named below *Rhathymodes*, will encourage the discovery of its unknown hosts, and of its larval characteristics.

The morphological terminology used below follows that of Michener (2000) with some modifications as proposed by Engel (2001); equivalents are indicated in brackets in keys and descriptions. The abbreviations T and S are for metasomal terga and sterna; T3, for example, is the third metasomal tergum. Antennal flagellar segment is abbreviated F. Photomicrography was done using a Microptics ML-1000 Digital Imaging System.

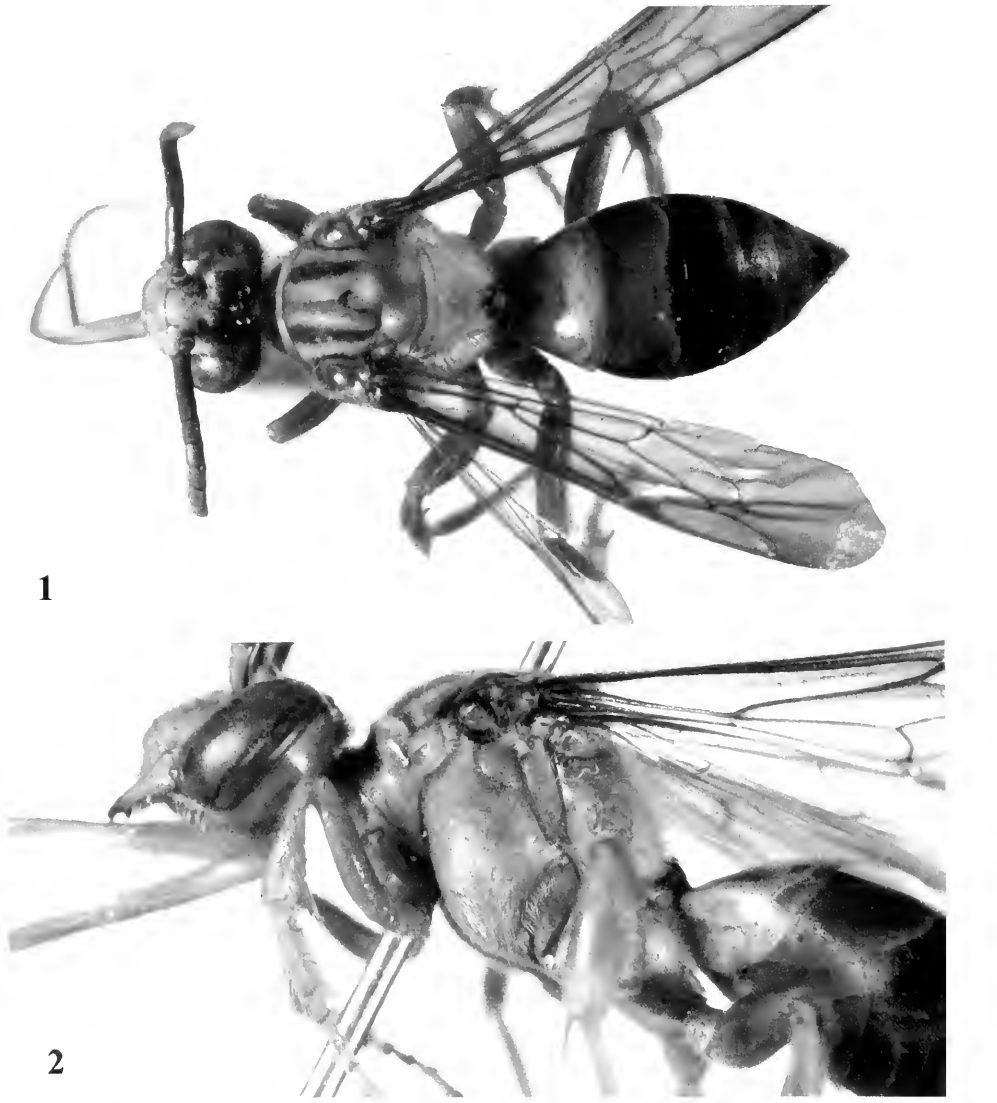
Collections in which specimens are preserved are indicated by names of cities or towns in brackets, with names of relevant curators in parentheses, as below:

[Berlin] = Museum für Naturkunde, Berlin, Germany (Frank Koch).

[Budapest] = Hungarian Natural History Museum, Budapest, Hungary (Lajos Zambon).

[Chamela] = Instituto de Biología, Universidad Nacional Autonoma de México, research station at Chamela, Jalisco, Mexico (Ricardo Ayala).

[Heredia] = Instituto Nacional de Biodiversidad (InBio), Heredia, Costa Rica (Carolina Godoy).



Figs. 1–2. *Rhathymodes bertonii* (Schrottky). 1, Dorsal habitus. 2, Lateral view of head, mesosoma, and anterior metasoma (note absence of pleural tubercle).

[Lawrence] = Division of Entomology, University of Kansas Natural History Museum and Biodiversity Research Center, Lawrence, Kansas, USA.

[Lyme Regis]= Martin Cooper collection; Lyme Regis, UK (Martin Cooper).

[New York] = American Museum of Natural History, New York, New York, USA (Jerome G. Rozen, Jr.).

[San Lorenzo]= Museo Nacional de Historia Natural del Paraguay, San Lorenzo, Paraguay (Bolivar [illegible]rete-Barrett).

SYSTEMATICS

Tribe RHATHYMINI Lepeletier

Rhathymites Lepeletier 1841: 539. Type genus: *Rhathymus* Lepeletier and Serville 1828. Combining stem: Rhathym–.

Description.—Body usually without areas of dense pale appressed pubescence; form elongate, pubescence short, so that habitus suggests *Polistes* wasps or giant *Nomada* (e.g., Fig. 1); coloration black to largely yellow, sometimes with metasoma red, or all red. Compound eyes slightly diverging below. Clypeus protuberant to less than width of compound eye in lateral view because lower part of compound eye quite broad. Mandible slender, simple. Labrum as long as or longer than median length of clypeus. Proboscis long, in repose reaching between or to apices of procoxae; labial palpus with first two segments subequal in length, last two segments minute, directed laterally; maxillary palpus absent. Antennal scape short, less than three times as long as wide; F1 about half as long as F2. Epistomal sulcus absent below anterior tentorial pits so that clypeus and lower paraocular areas are fused. Lateral ocellus separated from median ocellus by one-third ocellar diameter or less; preoccipital area rounded. Scutellum grading from somewhat elevated to form transverse shining ridge to distinctly bituberculate, posterior declivitous part longer, sometimes much longer, than anterior subhorizontal part; axilla small, rounded, not produced to form tooth. Propodeal triangle hairy. Procoxa tapering, mesal apical margin produced as flattened hairy process that looks like slender hairy spine in ventral view (Fig. 5). Protibia and mesotibia each with distinct outer apical spine; tibial spurs unmodified. Claws each with flattened basal tooth; arolia present. Scopa absent. Forewing with three submarginal cells; marginal cell large, longer than distance from apex to wing tip, apex rounded and separated from costal wing margin; pterostigma one-fourth to one-fifth as long as marginal cell, border of pterostigma in that cell straight or gently concave; wing hairy, alar papillae absent (Fig. 4). Hind wing with cu-a [cu-v] oblique, longer to slightly shorter than second abscissa of M+Cu; jugal lobe minute, rounded, about one-tenth as long as vannal lobe. Metasoma widest at T2 and T3; T1 markedly narrower than T2, lateral profile slanting, dorsal surface only weakly differentiated and less than half as long as slanting, more anterior, surface. T7 of male tapering to bidentate apex, without pygidial plate; S4, S5, and sometimes S3 of male strongly fringed; S7, S8, and male genitalia as illustrated (Figs. 6–13), genitalia with both upper and lower gonostylar processes well developed, upper rather slender with branched hairs, lower broad and translucent; penis valve heavily sclerotized, spatha largely membranous but with heavily sclerotized longitudinal bar at each side. Female without pseudopygidial area; pygidial plate present, tapering to apical narrowly rounded point, lateral margins weakly concave to weakly convex. Sting well developed; gonoplac [= gonostylus] long, slender, parallel-sided.

Comments.—Some of the characteristics used to identify the Rhathymini by Michener (2000) turn out to be generic characters of *Rhathymus* rather than tribal features. The key to subfamilies and tribes of Apidae (Michener 2000: 572) should be changed so that **couplet 17 omits the phrases about the mesepisternal tubercle.** Furthermore, because of probable confusion at couplet 16, Rhathymini should run out not only at couplet 17 but also through couplet 20. Change the outcome of the second alternative of couplet 20 to 20a and add a new couplet as follows:

20a (20). Maxillary palpus absent and axilla small, not at all produced; epistomal sulcus absent below anterior tentorial pit so that clypeus and lower paraocular areas are fused ..... **Apinae, Rhathymini**

– Maxillary palpus present, or if absent, then axilla produced to point (*Odyneropsis* in Epeolini); epistomal sulcus usually complete **21**

KEY TO GENERA OF RHATHYMINI

1. Mesepisternum with large submedian tubercle; vein cu-a [cu-v] of hind wing strongly oblique and distinctly longer than second abscissa of M+Cu; supraclypeal area strongly elevated, crested medially, not continuing convexity of clypeus; ocellocular area depressed below level of adjacent areas ..... ***Rhathymus* Lepeletier and Serville**

– Mesepisternum without tubercle; vein cu-a [cu-v] of hind wing less strongly oblique and slightly shorter than or subequal to second abscissa of M+Cu; supraclypeal area with surface generally a continuation of convexity of clypeus although with small frontal tubercle at lower end of frontal line; ocellocular area not depressed ..... ***Rhathymodes* Engel, Michener, and Rightmyer**

Genus *Rhathymus* Lepeletier and Serville

Figs. 6, 7, 10, 11

Colax Lepeletier and Serville 1825: 4, 213. *Nomen nudum.*

Rhathymus Lepeletier and Serville 1828: 448. Type species: *Rhathymus bicolor* Lepeletier and Serville 1828, monobasic. Lepeletier 1841: 539. Dalla Torre 1896: 323. Michener 2000: 739. Silveira *et al.* 2002: 129.

Colax Lepeletier and Serville 1828: 448. *Nomen praeoccupatum* [*nec* Hübner 1819 (Lepidoptera); Wiedemann 1824 (Diptera); *et* Stephens 1829 (Hymenoptera)]. Type species: *Rhathymus bicolor* Lepeletier and Serville 1828, monobasic. Established as a synonym of *Rhathymus* Lepeletier and Serville 1828 and therefore not available (ICZN 1999: Art. 11.6); see also Michener (1997).

Liogastra Perty 1833: 146. Type species: *Rhathymus bicolor* Lepeletier and Serville 1828, monobasic.

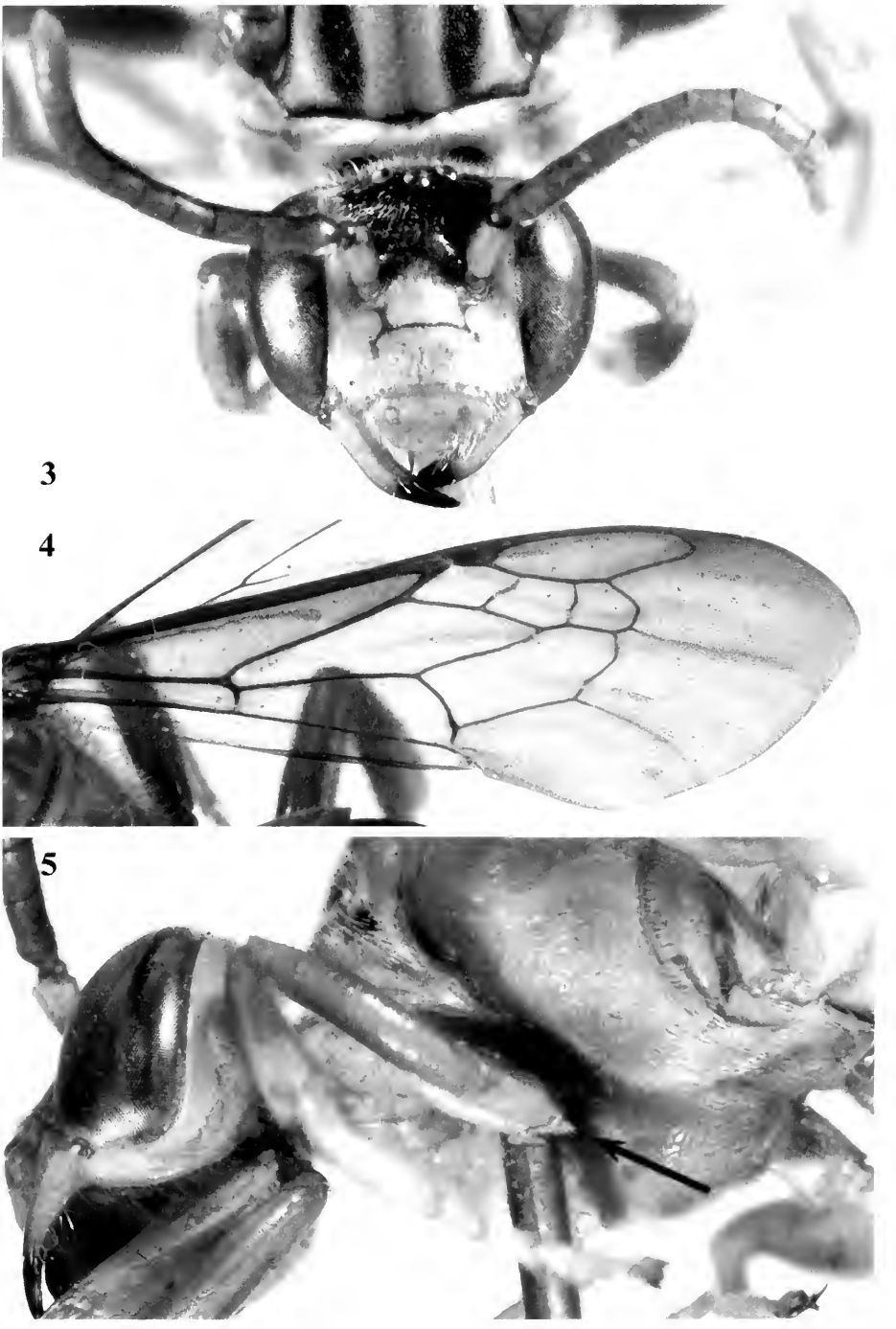
Rathymus Smith 1854: 278. *Lapsus calami et praeoccupatum* [*nec* Dejean 1831 (Coleoptera), *et* Gistel 1848 (Echinodermata)].

Bureauella Dominique 1898: 61. Type species: *Bureauella insignis* Dominique 1898, monobasic.

Diagnosis.—The principal characters of this genus are included as contrasting parenthetical notations in the description of *Rhathymodes*, below.

Comments.—The name *Bureauella* was synonymized by Michener (2000: 739). Its type species, briefly described by Dominique (1898), was very large, yellowish with dark metasomal bands. It is a possible senior synonym of *Rhathymus versicolor* Friese 1906. Friese (1912) gave a key to the species, including species now placed in *Rhathymodes* and in the genus *Odyneropsis* of the Epeolini. About 16 species-group names have been proposed for *Rhathymus* but the actual number of species is probably smaller; the genus is in need of revision and comprehensive cladistic study.

Biology.—So far as known, *Rhathymus* species are cleptoparasites of *Epicharis* (Apidae: Centridini), apparently depositing their eggs through a small opening in the host's brood-cell closure (Camargo *et al.* 1975; Hiller and Wittmann 1994; Rozen 1969, 1991, 2003). The hospicidal, first instar dispatches the host larva before feeding on the provisions (Rozen 1969, 1991).



Figs. 3–5. *Rhathymodes bertonii* (Schrottky). 3, Frontal view of head. 4, Forewing. 5, Ventral-oblique view of head and mesosoma; arrow indicates short, setose extension of procoxa (note absence of pleural tubercle).

Larval stages were described by Rozen (1969, 1991), McGinley (1981), and Camargo *et al.* (1975) who also described the pupa. Rozen (2000, 2001) gave additional characters for distinguishing the mature larva and pupa of *Rhathymus* and Rozen (2003) described the eggs (as mature oöcytes) of two species. Raw (1991, 1992) gave an account of the post-emergence flight behavior of male *Rhathymus* as well as some host data.

Rhathymodes Engel, Michener, and Rightmyer, new genus

Figs. 1–5, 8, 9, 12, 13

Type species.—*Rhathymus acutiventris* Friese 1906.

Diagnosis.—The generic characters are listed below, each followed by the state of the same character in *Rhathymus*, in parentheses. Body length 13–18 mm (16–28 mm in *Rhathymus*). **1.** Supraclypeal-frontal area convex, in profile continuing convexity of clypeus, frontal tubercle and carina above it rather weak, see figures 2–3 (this area strongly produced as crest, in profile elevated above imaginary continuation of clypeal convexity, sloping steeply at sides into depressions around antennal bases). **2.** Ocellocular area not depressed (strongly depressed below level of adjacent areas). **3.** Scutellum bituberculate, the two convexities (sometimes weak) forming line between dorsal and posterior declivitous surfaces (with shining ridge, sometimes depressed medially to form weak bituberculation, on line between dorsal and declivitous surfaces). **4.** Mesepisternum without anteromedian tubercle (with large, mostly impunctate and hairless, anteromedian tubercle). **5.** Mesobasitarsus shorter than mesotibia (as long as mesotibia). **6.** Forewing with second submarginal cell receiving 1m-cu [= first recurrent vein] near middle or distal third, see figure 4 (near apex of cell). **7.** Hind wing with cu-a [c-v] subequal to or shorter than second abscissa of M+Cu (longer than). **8.** Pygidial plate of female with lateral margins weakly concave, meeting apically to form translucent apex of T6 (margins straight or weakly convex, apex of T6 opaque and largely formed by extension of elevated discal part of pygidial plate). **9.** Apical process of second valvifer of female forming slender hook above base of gonoplac [= gonostylus] (more robust and not hooked). **10.** Male S4 and S5 simple, transverse, exposed surfaces as long as those of adjacent sterna (male S4 and S5 broadly emarginate, much shortened medially so that only narrow margins are exposed, thus exposed part of S6 large). **11.** Lateral extremities of male S5 not produced (strongly produced posterolaterally and hairy, supporting hair tuft noticeable from above, see Michener 2000: fig. 102–2). **12.** Male S3–S5 with apical fringes of erect, curved or sigmoid hairs (fringes appressed, not conspicuous, well developed only on S4 and S5). **13.** Genitalia and hidden sterna as in figures 8–9, 12–13 (cf. Figs. 6–7, 10–11 for *Rhathymus*); lateral sclerotization of spatha arcuate and produced (not arcuate, not produced).

Included species.—Three names have been provided for species of *Rhathymodes*, as follows: *Rhathymodes acutiventris* (Friese), *R. friesei* (Ducke), and *R. bertonii* (Schrottky). All are new combinations and, as indicated below, the first two are subjective synonyms.

Etymology.—The new genus-group name is a combination of *Rhathymus* (Gr. *rhathymos*, meaning "carefree" or "lazy") and the suffix *–odes* (Gr., an adjectival derivative of *eidos*, meaning "resembling"). The gender is masculine.

Distribution.—Jalisco, Mexico, to Paraguay, essentially the same as for *Rhathymus*.

Phylogenetic commentary.—Comparison with other tribes of Apinae suggests that characters 1, 2, 4, 10, and 11 are plesiomorphic relative to *Rhathymus*. Perhaps characters 3 and more certainly 9 and the spatha in 13 are derived (admittedly, the sting and male genitalia are unknown in *R. bertonii*).

KEY TO SPECIES OF *RHATHYMODES*
(based on females only)

1 Mandible longer than minimum distance between compound eyes; third submarginal cell as long as to longer than second submarginal cell; mesoscutal surface with four yellow stripes; propodeum yellow with black, median, longitudinal stripe on posterior surface (narrower and slightly fainter in specimens from Nicaragua); metasoma yellow or dusky yellow ..... ***R. acutiventris* (Friese)**

– Mandible shorter than minimum distance between compound eyes (Fig. 3); third submarginal cell markedly shorter than other submarginal cells (Fig. 4); mesoscutal surface appearing yellow with two black stripes (Figs. 1, 3); propodeum yellow without black, median, longitudinal stripe (Fig. 1); metasoma mostly black (Figs. 1–2) ..... ***R. bertonii* (Schrottky)**

Rhathymodes acutiventris (Friese), new combination

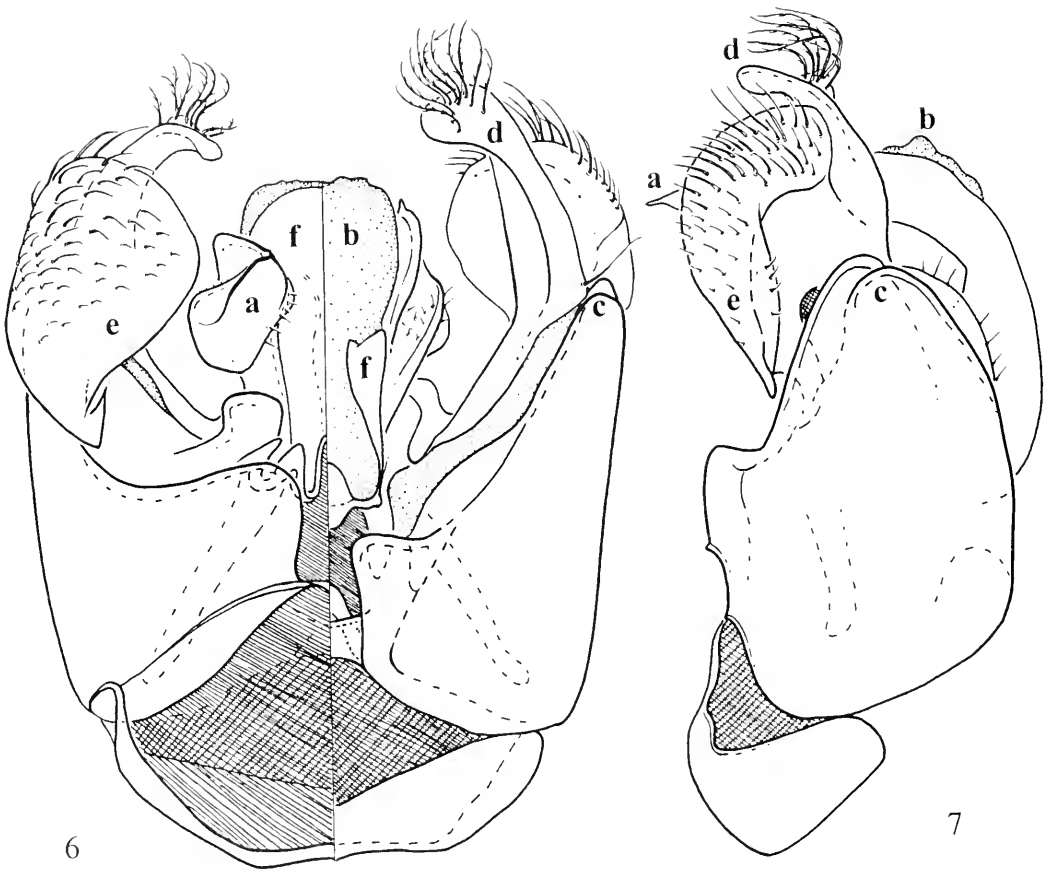
Figs. 8–9, 12–13

Rhathymus acutiventris Friese 1906: 120. Friese 1912: 226. Holotype [Budapest], examined.

Rhathymus friesei Ducke 1907: 458. Friese 1912: 225. Silveira *et al.* 2002: 129. Lectotype [Berlin], examined. **New synonym.**

Description.—Body length 13–18 mm. Mandible of female longer than minimum distance between eyes. Third submarginal cell measured on posterior margin nearly as long as to longer than second. Body and legs yellow (sometimes brownish yellow), the following areas black or blackish: apical half of mandible; labrum except for two brownish spots near base; subantennal sulci and epistomal sulcus between anterior tentorial pits; upper surface of antenna (sometimes brownish) except sometimes yellow or yellow-brown on base and apex of flagellum; ocellar area extending down on either side of supraclypeal elevation to antennal bases and usually extending laterally on occiput behind summit of compound eye; transverse spots on anterior surface of pronotum; spot at anterior base of pronotal lobe; mesoscutum except for lateral marginal yellow band, broadened anteriorly, and submedian longitudinal yellow band, thus four yellow bands on mesoscutum, none of them attaining anterior and posterior mesoscutal margins or lateral bands attaining posterior mesoscutal margin, submedian bands sometimes partly fused; pretarsal claws; longitudinal median stripe on posterior surface of propodeum; apex of pygidial plate (sometimes brown rather than black). Ventral surface of flagellum yellow-brown except yellow F1. Tibial spurs dark brown. Metasomal terga sometimes dusky yellow with lighter yellow apical bands, although usually uniformly yellow. Wings transparent brownish, veins and pterostigma dark brown to blackish. Pubescence golden, short except on distal part of labrum (where it forms two tufts), genal area, sides of mesosoma and propodeum; pubescence of mesoscutum of rather uniform length, shorter than ocellar diameter, erect; pubescence of metasomal terga appressed, appearing dark against yellow background. Punctation fine and dense so that most surfaces are dull but labrum, clypeus (especially impunctate lower margin), pronotal lobe and hypoepimeral area shining because punctures less dense; metasomal terga especially uniformly dull because of fine punctuation and dense short hair. Male hidden sterna and genitalia as in Figs. 8–9, 12–13.

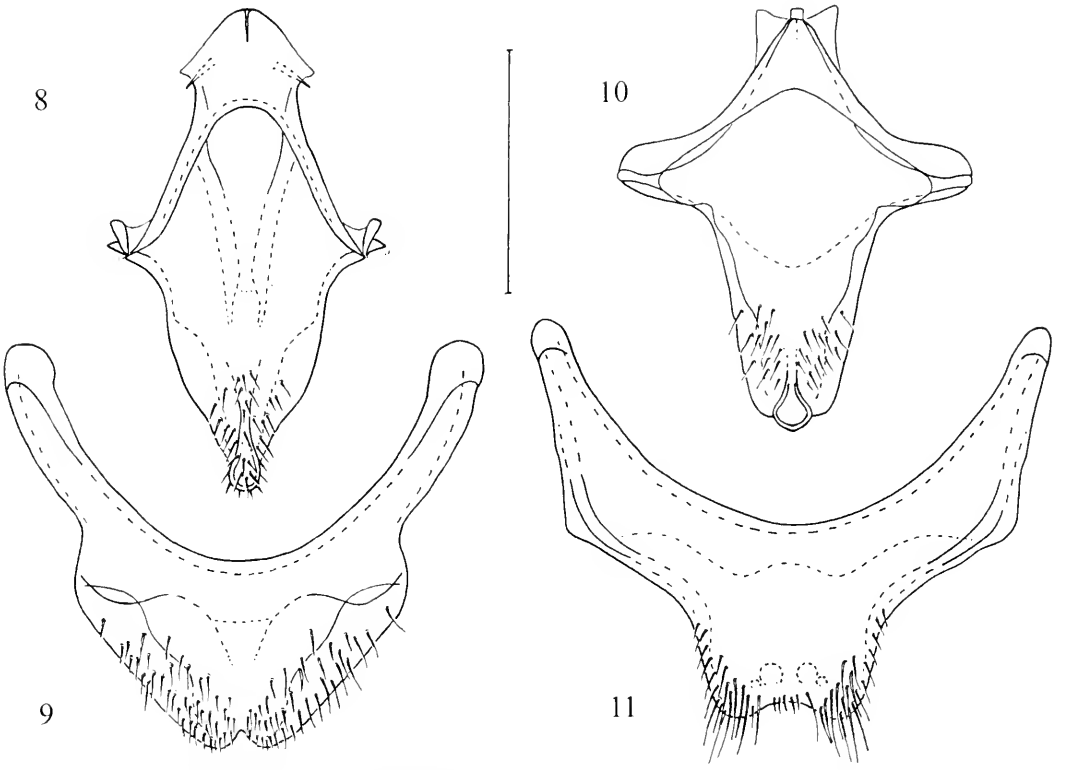
Variation.—Because of variation in scutellar form we at first believed that the specimens here placed in *R. acutiventris* represented two or more species. Frequently the convexities are prominent so that the declivitous surface below their



Figs. 6–7. *Rhathymus bicolor* Lepeletier and Serville, male genitalia. 6, Ventral (left) and dorsal (right) views. 7, Lateral view. Letters serve to indicate identical structures seen in different views (a = penis valve; b = aedeagus; c = upper gonocoxite; d = upper gonostylar process; e = lower gonostylar process; f = spatha).

summits is about one and one half times as long as the dorsal surface (seen in lateral view). Less commonly the convexities are smaller. Thus, in a specimen from Suriname the declivitous surface is more than twice as long as the dorsal surface and this condition is approached in a specimen from Cerro Campana, Panamá, although another collected on the same day had larger convexities. From the few specimens available we see no geographical significance in the scutellar variation. It would have been desirable to examine male terminalia from all parts of the range but males are available only from southern Mexico, Honduras, and Panamá; we have made dissections of specimens from Mexico and Honduras and find no differences between them.

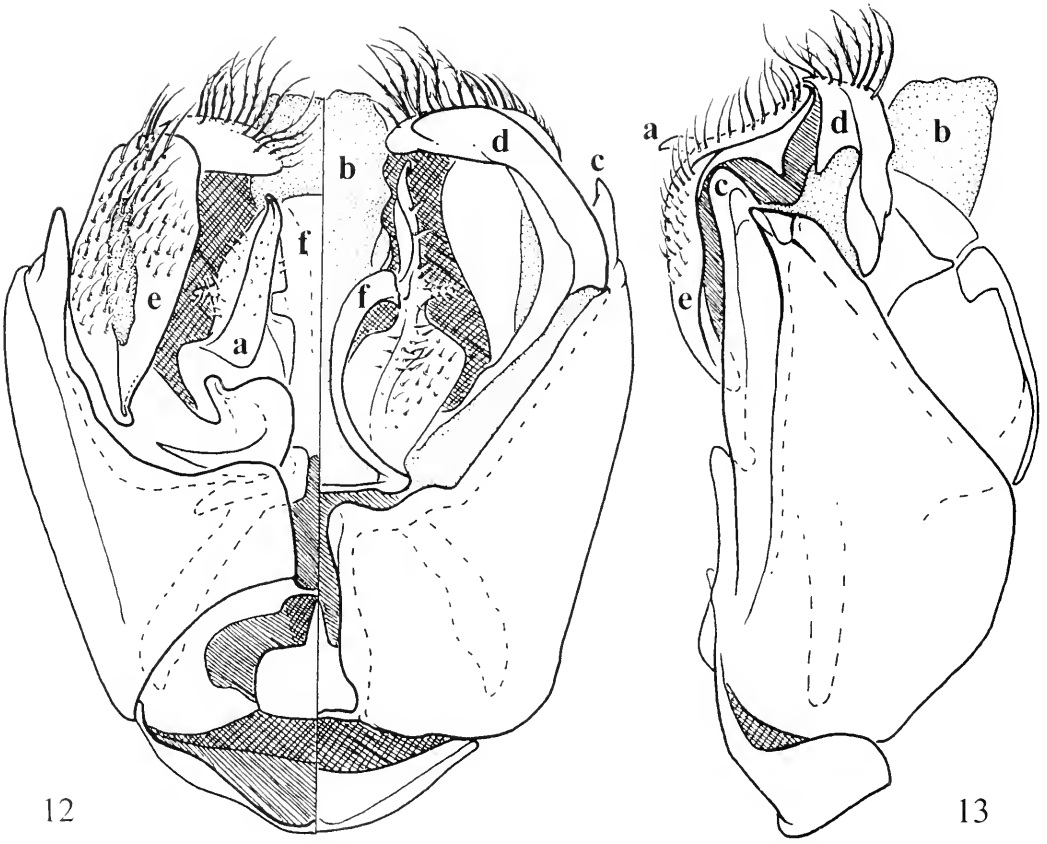
Material examined.—**MEXICO:** ***Jalisco***: 1♀, Chamela, 13 July 1990 (R. Ayala) [Chamela]. ***Chiapas***: 1♂, Agua Azul, N of Ocosingo, 23 April 1993 (F. Noguera) [Lawrence]; 1♀, Parque Laguna Belgica, 19.3 km N of Ocozocoautla, 1560 m, 12 June 1991 (J. Ashe) [Lawrence]. **GUATEMALA:** 1♀, Zarapa, 3.5 km SE of La Union, 1500 m, 23 Jun. 1993 (J. Ashe, R. Brooks) [Lawrence]. **HONDURAS:** ***Atlantida***: 1♀, Lancetilla Botanical Garden, Tela, 10 m, 15°46'N, 87°27'W, 22 June 1994 (J. Ashe, R. Brooks, methyl salicylate and eucalyptus oil attractants) [Lawrence]. *Cortez*: 3♂, 3♀, Parque Nacional Cerro



Figs. 8–11. Male internal sterna. 8–9, *Rhathymodes acutiventris* (Friese): 8, Eighth sternum. 9, Seventh sternum. 10–11, *Rhathymus bicolor* Lepeletier and Serville: 10, Eighth sternum. 11, Seventh sternum.

Azul-Meambar, Los Pinos, 800 m, 14°42.4′N, 87°54.7′W, 10–16 May 2002 (S. Peck) [Lawrence]. **NICARAGUA:** ***Granada***: 3♀, Volcan Mombacho, Santa Ana 2, 15 May 1998, malaise trap (J. M. Maes) [Lawrence]. 1♀, Volcan Mombacho, Santa Ana 2, 21 June 1998, malaise trap (J. M. Maes) [Lawrence]. **COSTA RICA:** ***Alajuela***: 1♀, Caño Negro, 20 m, 10–19 March 1993 (K. Martinez) [Heredia]. ***Guanacaste***: 1♀, Maritza Biological Station, 550 m, 22 May 1993 (J. & A. Ashe) [Lawrence]. 1♀, Parque Nacional Guanacaste, Est. Pitilla, 9 km S of Est. Cecilia, 700 m, 19 May–3 June 1993 (P. Ríos) [Heredia]. ***Puntarenas***: 1♀, Fila Moras, Buenos Aires, A. C. Amistad, 1000m, 19 May 1993 (M. A. Zumbado, S. Rojas) [Heredia]. **PANAMA:** ***Chiriquí***: 1♀ [type of *R. acutiventris*, in Budapest, examined]. ***Panamá***: 2♀, Cerro Campana (Capira), 825 m, 8°44′N, 79°57′W, 1–5 June 1995 (J. Ashe, R. Brooks) [Lawrence]. ***Colón***: 3♀, 14 km N of junction of Escobal and Pina roads, 30 m, 2 June 1996 (J. Ashe, R. Brooks) [Lawrence]; 2♂, Barro Colorado Island, 29 May 1977 (R. B. & L. S. Kimsey) [Lawrence]. **SURINAME:** ***Brokopondo***: 1♀, Brownsberg Nature Preserve, Witi Creek Trail, 80 m, 4°56′55″N, 55°10′53″W, 23–25 June 1999 (Z. Falin, A. Gandadin, H. Hiwat) [Lawrence]. **BRAZIL:** ***Para***: 1♂, Estado do Para, Vbidos (Rio Branco), VIII.1912, Ducke [Berlin]. ***Pernambuco***: 1♀, Caruaru, 900 m, April 1972 (M. Alvarenga) [New York]. ***Minas Gerais***: 1♂, Barbacena, 14.12.1905, Ducke [lectotype of *R. friesei*, Berlin, see below]. ***São Paulo or Paraná***: 1♂, Rio Paraná, Süd-Brasil, 1904 [description and photograph, Friese 1912: 225, examined, Berlin].

Lectotype designation.—Several specimens of *R. friesei* are located in the Friese



Figs. 12–13. *Rhathymodes acutiventris* (Friese), male genitalia. 12, Ventral (left) and dorsal (right) views. 13, Lateral view. Lettering as in Figs. 6–7.

collection [Berlin] and many bear his characteristic "typus" labels. As is unfortunately not rare for specimens bearing such labels, many are not part of the original type series (e.g., several were collected at localities not mentioned in Ducke's original account or, worse yet, were collected years after the publication of the species!). However, among the material is at least the specimen collected by Ducke at Barbacena in Minas Gerais (the other specimens mentioned by Ducke are not in Berlin), and this is assuredly one upon which he based his description. For the express purpose of nomenclatural stability we hereby designate and label this individual as lectotype. LECTOTYPE: 1♂, Brazil, Estado de Minas Ger., Barbacena, 14.12.1905, Ducke [Berlin].

Comments.—Just over half of the specimens were collected by flight intercept traps set up in forests. Frequently used by coleopterists, such traps prove to be useful in collecting forest bees rarely seen by bee collectors.

Rhathymodes bertonii (Schrottky), new combination

Figs. 1–5

Rhathymus bertonii Schrottky 1920: 217. Holotype [San Lorenzo], compared.

Diagnosis.—Similar to *R. acutiventris* except as follows: Mandible shorter than minimum distance between compound eyes (Fig. 3), suggesting mandible of male of *R. acutiventris*. Third submarginal cell markedly shorter than others (Fig. 4). Me-

soscutum with mesal yellow stripes fused so that surface appears yellow with two black stripes (as in the male) and very narrow black anterior margin (Figs. 1, 3) (male also with minute black triangle at posterior margin). Propodeum entirely yellow, without black median stripe (Fig. 1). T3–T6 black (with black bands in male), T3 and T4 with apical margins brownish translucent (Fig. 1); preapical part of pygidial plate reddish yellow, otherwise plate black.

The inner metatibial spurs appear broken apically, alike on the two sides, the truncate apices slightly darkened suggesting that the truncation is normal or that breaking occurred during the life of the insect. The spurs of the male holotype are not truncated, having typical, pointed apices, furthering the suggestion that the truncation of the female is the result of breakage.

Variation.—The following feature is variable within *R. acutiventris* but is recorded here for our specimen of *R. bertonii*: scutellum strongly bituberculate with ascending dorsal surface measured to apices of tubercles about two-thirds as long as declivitous surface.

Material examined.—Aside from the male holotype from Puerto Bertoni, Paraguay [San Lorenzo], this species is known from one female as follows: **PARAGUAY:** Paraguari, Parque Nacional de Ybycui [ca. 26°S, 57°W], 300 m elevation, December 13–18, 1989 (M. Cooper) [Lyme Regis].

Comments.—This species was described from a male from Paraguay, preserved in the Museo Nacional de Historia Natural del Paraguay. In the Martin Cooper collection is one female that agrees in several respects with the male and that we regard as *R. bertonii*. The above diagnostic remarks are based on the female with some parenthetical notes derived from the original description of the male.

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A New Species of *Oozetetes* DeSantis (Hymenoptera: Chalcidoidea: Eupelmidae) Attacking Oothecae of *Nyctibora acaciana* Roth (Orthoptera: Blattellidae)

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Abstract.—***Oozetetes nyctiboraphagus* Gibson, new species,** an egg predator in the oothecae of *Nyctibora acaciana* Roth, is described from Costa Rica and Nicaragua. The description of the male is the first for the genus. The species is assigned to the *bucheri* species group of *Oozetetes* and a key is provided to distinguish females of the five described species of this group. Basal regions of the forewing differentiated by convex or concave folds and sometimes setal lines are compared with putatively homologous forewing veins and cells of other Hymenoptera, and a comprehensive set of names is applied to these based on homology and historical usage in chalcid literature.

Oozetetes was established by De Santis (1970) for a single species, *O. bucheri* De Santis, which was reared from oothecae of *Pseudoischnoptera lineata* (Olivier) (Orthoptera: Blattellidae). Gibson (1995) subsequently transferred five species into *Oozetetes* from other genera and recognized two species groups, the *bucheri*- and *compressicornis*-groups, based on structures of the scape and face of females. The *bucheri*-group consists of species with females having a more or less tubular scape (Figs. 13, 14), a distinct parascrobal region along the inner orbit so that the scrobal depression extends to the anterior ocellus (Figs. 1–4), and the interantennal region flat or even slightly depressed above the level of the toruli (Fig. 1). The primary feature characterizing *compressicornis*-group females is a strongly compressed scape, which is correlated with a different structure of the scrobal depression and parascrobal region than for *bucheri*-group females (see discussion and figures in Gibson 1995). Classified in the *bucheri*-group are *O. bucheri* from Argentina, *O. magniclavatus* (Ashmead, 1904) and *O. splendens* (Walker, 1862) from Brazil, and *O. testaceicornis* (Cameron, 1884) from Panama. *Oozetetes compressicornis* (Cameron, 1884) and *O. gigas* (Cameron, 1884), both from Panama, are the only two species classified in the *compressicornis*-group. Males are unrecognized for any of these species. Host information is also lacking for any described species other than the type species, though I saw a female and male of an undescribed species from the ootheca of an unidentified cockroach (Gibson 1995). The same parasitoid species was subsequently reared from a new species of cockroach and information concerning its rearing and possible oviposition behavior was given when the cockroach was described as *Nyctibora acaciana* Roth (Orthoptera: Blattellidae) by Deans and Roth (2003). The rearing of two of seven described species of *Oozetetes* from cockroach oothecae suggests that all members of the genus might use cockroaches as hosts. I have seen females representing numerous species of the genus from tropical and subtropical regions of the New World, as far north as Florida (Gibson 1995). The purpose of this paper is to provide a name for the new species reared

from *N. acaciana* in order to facilitate ongoing behavioral studies. A key to differentiate females of the five described *bucheri*-group species is also provided as an impetus for future taxonomic studies of this potentially important group of parasitoids for biological control of cockroaches.

MATERIALS AND METHODS

This study is based on specimens from the Natural History Museum, London, England (BMNH); Canadian National Collection of Insects, Ottawa, ON, Canada (CNCI); Illinois Natural History Survey, Urbana, IL, USA (INHS); University of California, Davis, CA, USA (UCDC); and National Museum of Natural History, Washington, DC, USA (USNM). Paratypic material is also deposited in the Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica (INBIO) and Museo de Insectos, Universidad de Costa Rica, San José, Costa Rica (MUCR).

All measurements except body length are relative and, unless stated otherwise, comparable based on length of the scape of the female and male both being assigned a base measurement of 10; measurements were taken with a Nikon SMZ-U microscope fitted with an ocular grid having 100 divisions. Length of the costal cell is measured from where the membrane of this cell joins the submarginal vein (basally) to where it joins the base of the marginal vein (apically) (Fig. 17, lcc); head width and interorbital distance are measured in dorsal view.

Terminology follows Gibson (1995, 1997) except as follows for the forewing. Gibson (1997, fig. 5) illustrated a composite chalcid forewing and stated the basal cell is delimited posteriorly by the cubital fold/setal line and apically by an oblique basal fold/setal line. This is an oversimplification of the structure in many chalcids. The structure is often more complex, the forewing basally being subdivided by several regions by setal lines or by convex and concave folds. The regions, folds and setal lines are analogous, if not homologous, to cells and distinct veins in other Hymenoptera as illustrated by Huber and Sharkey (1993, figs. 17–20), and discussed in part by some previous authors (e.g., Burks 1938, Bucher 1948). Because of species-specific differences in setal patterns of the regions within *Oozetetes*, a more precise description of the regions and terminology is needed than is provided by Gibson (1997). The terms used are largely adapted from Huber and Sharkey (1993) except two terms widely used in chalcid literature, basal cell and basal vein/fold/setal line, are retained for the sake of simplicity and stability. I also use 'vannal' instead of 'claval' (see Nichols 1989) to avoid possible confusion with the antennal clava. Synonymous terms used by Huber and Sharkey (1993) are provided in parentheses. In *Oozetetes*, a **basal cell** (= Radial cell) (Fig. 17, **bc**) is differentiated posteriorly by a longitudinal convex fold, the **mediocubital fold** (= M+Cu) (Fig. 17, **mcf**), and apically by an oblique convex fold, the **basal fold** (= M+Rs) (Fig. 17, **bf**), that extends obliquely toward the **submarginal vein** (= Sc+R) (Fig. 17, **smv**). In many chalcids, eupelmids included, the mediocubital fold initially curves toward the submarginal vein and forms part of the basal fold prior to being recurved posteriorly and bifurcating into a longitudinal convex fold in the posterior quarter of the wing, the **cubital fold** (= Cu) (Fig. 17, **cuf**), and a longitudinal concave fold nearer the middle of the wing, the **medial fold** (= M) (Fig. 17, **mdf**). Consequently, a triangular region is differentiated between the two recurved portions, which for simplicity I term the **mediocubital notch** (Fig. 17, **mcn**). The mediocubital fold also forms the anterior margin of an inclined **cubital area** (= 1Cu, First cubital cell) (Fig. 17, **cua**) behind the basal cell. A concave fold parallel to the mediocubital fold, the **vannal fold** (= claval fold) (Fig. 17, **vnf**), further differentiates

the cubital area from the posteriormost basal region of the wing, the **vannal area** (= claval area) (Fig. 17, **vna**), which is reflexed so as to be subhorizontal or inclined relative to the cubital area. Although only inconspicuously developed in *Oozetetes*, many chalcids have another longitudinal convex fold near the posterior margin of the wing. This fold apparently is not homologous with a vein, but can be termed the **subcubital fold** (Fig. 17, **scf**) because, if present, it extends along the **subcubital setal line** *sensu* Gibson (1997, fig. 5). The convex subcubital fold results in the posterior margin of the forewing being curved down and it is this portion onto which the dorsally curved hamuli of the hind wing hook. Because of the various longitudinal folds the surface of the wing is pleated behind the basal cell, often being more or less M-like as if viewed in cross-section (Fig. 17, insert).

Oozetetes De Santis

Oozetetes De Santis 1970: 32–33. Type species: *Oozetetes bucheri* De Santis, by monotypy and original designation.

Diagnosis.—Mandible bidentate, with small ventroapical tooth and broad dorsoapical margin. Eye bare or superficially glabrous, at most only very sparsely and inconspicuously microsetose (Figs. 1–4). Male antenna with pedicel only slightly longer than broad and without row of setae ventrally (Fig. 15); flagellum compact-filiform with short seta and numerous multiporous plate sensilla in several rows (Fig. 16); clava not conspicuously enlarged, only about as long as combined length of apical two funicle segments (Fig. 15). Female propodeum (Fig. 7) with plical region conspicuously sculptured and with callar region convex and almost always largely or entirely sculptured and setose. Female gaster (Fig. 9) dark or yellowish to orange, but without subbasal white band if light-colored; Gt_1 with posterior margin emarginate but Gt_2–Gt_5 with posterior margins straight transverse or only very slightly emarginate; syntergum with apical margin reflexed into transverse flange.

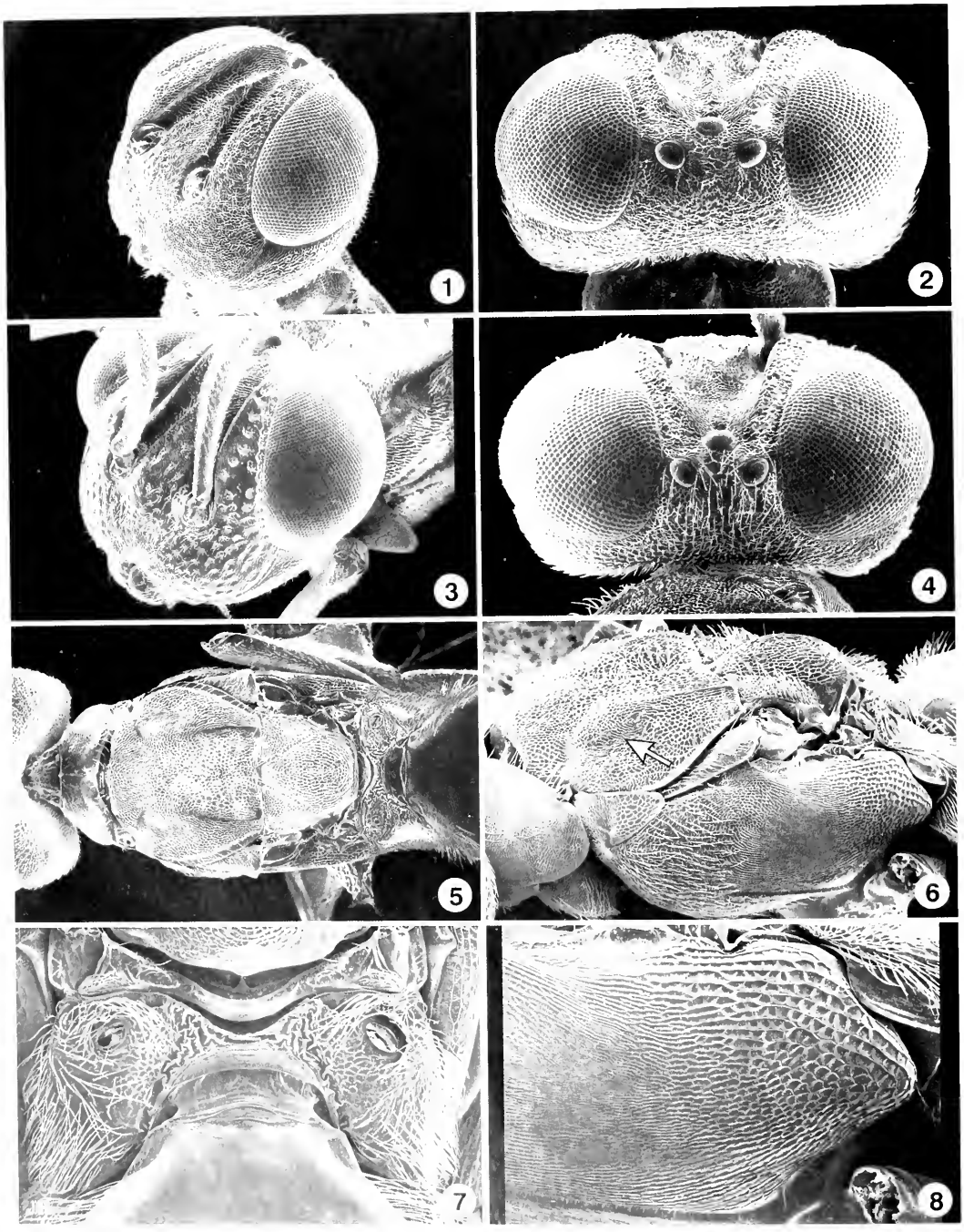
Remarks.—Females of *Oozetetes* can be differentiated from other eupelmine females using Gibson's (1995) key to genera based on females. As for other Eupelminae, the sexes of *Oozetetes* are highly dimorphic and the single male then known was keyed together with males of *A.* (*Anastatus*) Motschulsky because of their similar bidentate mandibles and similar antennal structures. *Anastatus* is a speciose, cosmopolitan genus whose members usually are primary endoparasitoids of eggs of several insect orders. Gibson (1995) suggested that apically broad, bidentate mandibles in Eupelminae may be indicative of an endoparasitoid of eggs. Further, *Oozetetes* may represent a monophyletic lineage having a specialized host relationship with cockroach eggs that renders *Anastatus* paraphyletic. This latter possibility is indicated because the males of the two genera are morphologically very similar, but several features differentiate females of the two taxa. Association of the sexes of species other than *O. nyctiboraphagus*, particularly those of the *compressicornis* group, is necessary prior to determining whether there are reliable features to differentiate males of *Oozetetes* from those of *Anastatus* (see discussion in Gibson 1995).

Oozetetes nyctiboraphagus Gibson, new species

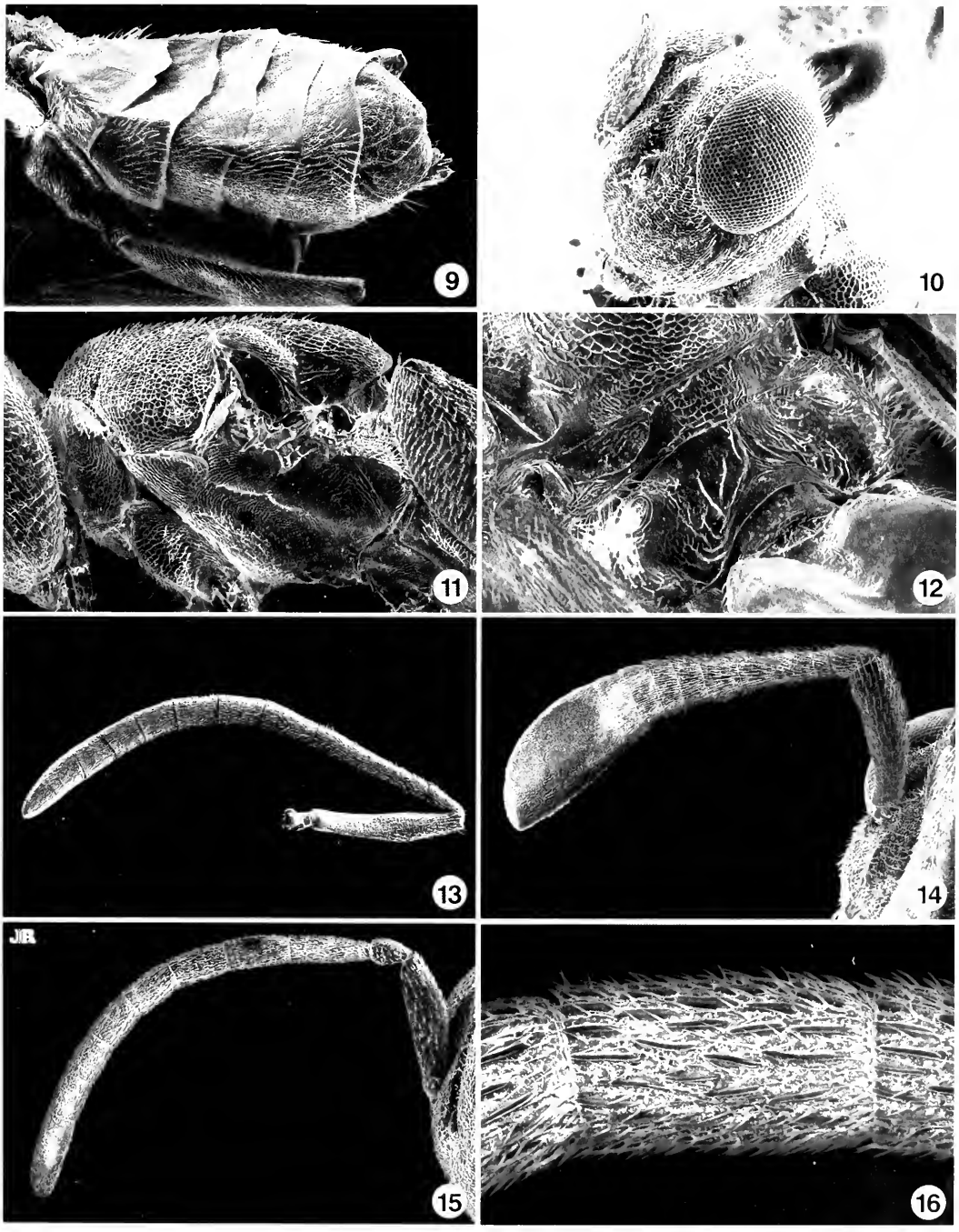
(Figs. 1, 2, 5–13, 15, 16, 18, 19)

Etymology.—The species name is derived from the Greek *phagos* (to eat) and the generic name of its only known host cockroach, *Nyctibora*. *Oozetetes* is masculine and means 'egg searcher' or 'seeker'.

Type material.—**Holotype female:** "COSTA RICA: Guanacaste, Parque Nacional Santa Rosa, Rd to Nicaragua, 1 km N main Rd"; "A.R. Deans, dry forest, coll. 30.VI.2001, em. 18.VII.2001, ex. *Nyctibora* sp. egg case on ant acacia tree" (CNCI Type No. 22872). **Allotype male:** same



Figs. 1–8. *Oozetetes* spp. 1–4, Head (×). 1 and 2, *O. nyctiboraphagus*. 3, *O. splendens*. 4, *O.* sp. nr *O. nyctiboraphagus*. 5–8, *O. nyctiboraphagus* (×). 5, Mesosoma (dorsal). 6, Mesosoma (dorsolateral) (arrow points to parapsidal band). 7, Apex of scutellum to base of gaster (dorsal). 8, Posterior half of acropleuron (lateral).



Figs. 9–16. *Oozetetes* spp. 9–13, *O. nyctiboraphagus*. 9, Gaster (♀, dorsolateral). 10, Head (♂, frontolateral). 11, Mesosoma (♂, lateral). 12, Apex of scutellum to base of gaster (♂, posterolateral). 13, Antenna (♂). 14, *O. testaceicornis*, antenna (♂). 15–16, *O. nyctiboraphagus* (♂). 15, Flagellum. 16, Third flagellar segment.

data as holotype (CNCI). **Paratypes** (108♀, 15♂): COSTA RICA: same data as holotype (16♀, 1♂); same data as holotype except emerged 13.VII.2001 (13♀, 2♂). Guanacaste P.N. Santa Rosa Sect. Santa Rosa, Acacia 005, 1.5 km E. Area Administrativa, 25.VI.2001, Andy Deans, coll. under bird nest, emerged 13.VII.2001, ootheca of *Nyctibora acaciana* n. sp. Roth (22♀, 5♂). Guanacaste, Santa Rosa National Park, Area Administrativa, A.R. Deans, ex. *Nyctibora acaciana* (Blattellidae) ootheca glued to *Acacia collinsii* (Fabaceae), ootheca collected VI.2001, ootheca dissected VIII.2002 (13♀, 6♂). Guanacaste Prov. Guanacaste Nat. Pk., sector Santa Rosa, 10°51'N 85°37'W, 250–300m, D. Janzen & I. Gauld [pk. hdqts, young scrubby woodland, 17–27.IV.1985, H-1–0 (1♀); 13.IV-4.V.1986, H-4-C (1♀); 27.IV-11.V.1985, H-3–0 (2♀); 4–24.V.1985, H-1–0 (1♀), H-2-C (2♀); 11.V-1.VI.1985, H-1–0 (4♀), H-3–0 (1♀); 1–22.VI.1985, H-2-C (1♀); 13.VII-3.VIII.1985, H-2-C (4♀), H-4-C (2♀), H-6-C (2♀); 3–24.VIII.1985, H-2-C (2♀); 5–26.X.1985, H-1–0 (1♀)] [Bosque San Emilio, clearing, deciduous forest, 27.IV-11.V.1985, SE-5–0 (1♀); 11.V-1.VI.1985, SE-5–0 (2♀), SE-7–0 (3♀), SE-8-C (2♀); 13.VII-3.VIII.1985, SE-5–0 (1♀); 5–26.X.1985, SE-6-C (1♀)]. Prov. Guanacaste, Guanacaste, Parque Ntl. Sta. Rosa, ex. cockroach eggs on *Acacia*, 9.IV.1977, L.D. Gomez (1♀, 1♂). Guanacaste, Sta. Rosa N.P., D.H. Janzen, MT, 22.VI-13.VII.85, SE-5–0 (1♀), SE-8–0 (1♀); 13.VII-3.VIII.1985, H-3–0 (4♀). Gste. Pr., NW Volcan Orosi, Cerro el Hacha, 300m, 1988 (2♀). NICARAGUA: San Juan del Sur, 11°15'N 85°52'W, 3.V.1988, L.J. Clark, MT (1♀). Paratypes are deposited in BMNH, CNCI, INBIO, INHS, MUCR, UCDC and USNM.

Holotype female.—Length 4.4 mm; length of head: mesosoma: metasoma = 10: 26: 26. Head metallic green with slight cupreous luster under some angles of light, the cupreous luster most distinct adjacent to ocelli, medially within scrobal depression below anterior ocellus and over interantennal region and clypeus; width: height = 19: 16; in dorsal view as in Fig. 2, with interorbital distance 0.32 times head width; OOL 0.7 and POL 1.8 times minimum diameter of posterior ocellus; eye height: eye width: malar space = 11: 7.4: 7.4; scrobal depression bell-shaped, extending to anterior ocellus and reticulate-rugulose to strigose (Fig. 1); lower face granulate to microreticulate and parascrobal region more reticulate-rugulose with setiferous punctures minute and obscure (Fig. 1); face with short, relatively inconspicuous white setae except upper parascrobal regions from about level of apex of interantennal region and vertex with setae dark and distinctly longer than ventrally. Mandibles and palpi dark red to brown. Antenna with scape yellow except brownish dorsoapically, pedicel and flagellum dark brown without metallic luster, but clava with light-colored microsetose region along ventral length; in lateral view (Fig. 13) length of scape (excluding radicle): pedicel: funicular segments: clava = 10: 2.7: 1.5: 3.6: 3.4: 3.8: 2.9: 2.7: 2.3: 2.1: 6.7; flagellum only slightly widened apically, the clava only about 1.6 times as wide as first funicular segment. Pronotum metallic green except for mediolongitudinal white membranous band, and lateral panel brownish ventrally and posteriorly, the dorsal surface with white setae (Fig. 5). Mesoscutum (Figs. 5, 6) metallic green, reticulate-rugulose with reticulations becoming larger and more distinct posteriorly between smooth paralateral ridges, and uniformly setose with white setae except longitudinal parapsidal bands granulate and bare. Scutellar-axillar complex darker than mesoscutum, with purple luster under some angles of light, and with dark setae; slightly wider than long, width: length = 9.7: 8.0; axilla punctate-reticulate; scutellum low convex, longitudinally cristate-strigose centrally. Tegula brown with white setae, coriaceous. Prepectus brown, bare, reticulate. Mesopleurosternum ventrally dark between trans-

episternal lines, otherwise metallic green except microreticulate medial region of acropleuron dark with slight cupreous luster under some angles of light and acropleuron posteriorly dark with slight metallic green or blue luster; acropleuron bare, but mesopleurosternum otherwise with white setae anterior to and ventrally between acropleural sulci; acropleuron (Fig. 6) reticulate-rugulose anteriorly but with region of minute-reticulate to granular sculpture medially below base of wings and with sculpture increasing in coarseness posteriorly to posterodorsal margin of acropleuron where reticulate-punctate (Fig. 8). Forewing with cc: mv: pmv: stv = 15.0: 8.4: 3.6: 2.4; stigmal vein apically curved in same direction as postmarginal vein, about apical half of its anterior margin subparallel with postmarginal vein, and evenly tapered without distinctly differentiated uncus; costal cell with ventral surface setose except along submarginal vein, dorsal surface largely bare except near parastigma, but with single row of scattered setae near submarginal vein over about apical half; basal cell, cubital area and mediocubital notch completely setose but vannal area bare basal to level where mediocubital fold curves into basal fold (Fig. 18); submarginal vein with scattered setae more or less distinctly aligned into 2 or 3 rows basal to more densely setose parastigma; forewing with brown infuscation basally for distance about equal to half length of submarginal vein, including costal cell, cubital and vannal areas, and distinctly infuscate medially between about base of parastigma and apex of postmarginal vein, with brown regions having dark setae and hyaline regions having white setae, except dark setae of cubital area narrowly continuous with dark seta of disc and separating slender longitudinal band of white setae along posterior margin of wing (apical portion of vannal area) from larger region of white setae behind about apical half of submarginal vein excluding parastigma; dark setae of brown regions slightly thicker than white setae and quite dense, with their apices overlapping. Coxae dark brown or with metallic green luster under some angles of light, remainder of legs dark brown with following yellowish: extreme bases and apices of tibiae, the metatibia only inconspicuously so, and trochanter, trochantellus and base of metafemur dorsobasally; metacoxa with exterior surface entirely setose except for concave ventral portion above trochanter. Metanotum (Fig. 7) dark brown; metapleuron brown to metallic green depending on angle of light. Propodeum (Fig. 7) very short medially, with plical region brown, bare and smooth along foramen but otherwise rugulose-strigose; callus metallic green or with bluish luster under some angles of light, reticulate-rugulose and with white setae except bare along oblique band behind spiracle. Metasoma with setal pattern as in Fig. 9, primarily dark brown but lighter brown basally and posterior terga with slight metallic green luster over more coarsely sculptured regions, and with syntergal flange and ovipositor sheaths yellowish; basal gastral terga coriaceous, but sculpture more distinct over posterior terga; hypopygium extending only about two-thirds length of gaster.

Allotype male.—Length 2.5 mm. Head with color and setal pattern similar to female, the following dark with cupreous luster under some angles of light: apex of interantennal region and scrobal depression medially, ocellar triangle and vertex posterior to ocelli; width: height = 22: 20; in dorsal view interorbital distance 0.48 head width; OOL equal to and POL 2.7 times minimum diameter of posterior ocellus; eye height: eye width: malar space = 11.2: 8.4: 8.0; scrobal depression transversely strigose-reticulate and separated from anterior ocellus by about one ocellar diameter, but with short median furrow extending to ocellus (Fig. 10); lower face punctulate-reticulate but interantennal region and parascrobal regions more retic-

ulate-rugulose. Antenna dark brown except scape with metallic luster under some angles of light and first funicular segment yellowish; in lateral view (Fig. 15) ratio of scape (excluding radicle): pedicel: funicular segments: clava = 10: 2.6: 1.0: 5.0: 4.2: 3.2: 3.6: 3.0: 3.0: 6.6. Mesosoma in dorsal view primarily dark with slight cupreous luster under some angles of light except following more distinctly metallic green to bluish: pronotum laterally, convex lateral portion of mesoscutum, and propodeum; mesoscutum with inconspicuous whitish setae and scutellar-axillar complex with dark setae; propodeum with callus setose lateral to level of spiracle and with a few setae between spiracle and bare plical region (Fig. 12). Mesosoma in lateral view metallic green to bluish except following dark without metallic luster: acropleuron, femoral depression, upper portion of mesepisternum and oblique transepisternal line. Forewing hyaline with cc: mv: pmv: stv = 19.6: 9.6: 8.0: 4.4; stigmal vein conspicuously curved and tapered, similar to female; costal cell setose ventrally and bare dorsally except for 4 setae near anterior margin medially; basal cell setose and with continuous line of setae along mediocubital and cubital folds, the two folds only slightly angulate relative to each other; cubital and vannal areas bare; disc with distinct lunate bare region beyond basal cell but region closed posteriorly by line of setae along cubital fold. Legs dark brown with metallic green to blue luster except the following white: trochantelli, knees and apices of tibiae of fore and middle legs, and basal 3 tarsal segments of middle and hind legs (protarsi brownish-white). Metanotum overlain by apex of scutellum (Fig. 11), band-like and coriaceous to reticulate (Fig. 12). Propodeum reticulate-coriaceous with inverted Y-like median carinal complex and with a few oblique rugae extending from posterior margin (Fig. 12). Metasoma in dorsal view primarily dark brown but with metallic green luster basally on Gt_1 and on apical tergum under some angles of light, shiny, and only very finely coriaceous.

Variation and species limits.—Deans and Roth (2003) provided a lateral habitus photograph (fig. 4E) of a female and male. Males I include in the type series are all very similar to one another, except for one reared individual (emerged 13.VII.2001, CNCI). This individual has the head and antenna of a female, but the remainder of the body of a male except the mesopleuron is somewhat "feminized", having a much larger acropleuron and less concave femoral depression than other males.

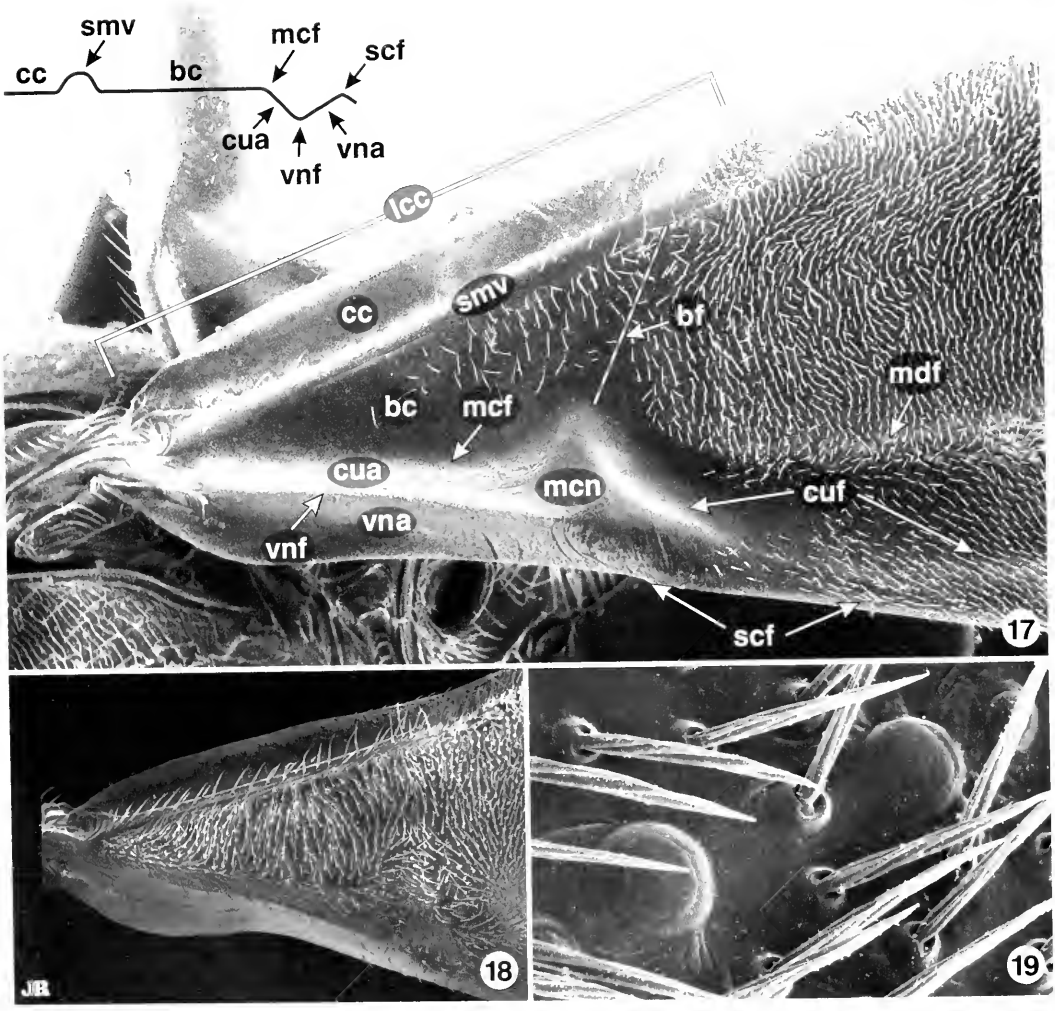
The female reared from the unidentified species of cockroach has Fl_6–Fl_8 yellowish and the other flagellar segments only light brown (left flagellum also misshapen, with Fl_5–Fl_7 fused and constricted near middle). All other females I include in the type series are very similar to the holotype, having the pedicel and flagellum brown as well as the interorbital distance 0.30–0.33 times the width of the head (n = 10, x = 0.31), a short but distinct OOL (Fig. 2), and similar forewing setal and acropleural sculpture patterns. Several females from Belize, Brazil, Costa Rica, Ecuador, Guatemala, Peru and Venezuela are similar to females I recognize as *O. nyctiboraphagus*, but are excluded from the type series based on different combinations of features, including the relative width of the interorbital distance and OOL (e.g. Fig. 4), the extent to which the cubital and vannal areas are setose, the length of the postmarginal vein relative to the stigmal vein, and sculpture of the acropleuron posteriorly. I believe *O. nyctiboraphagus* forms part of a species complex of several very similar species that differ from each other by different combinations of relatively subtle features. Additional rearings and specimens collected from diverse locations are required to test this hypothesis.

Biology.—Deans and Roth (2003) reared *O. nyctiboraphagus* from the oothecae of *Nyctibora acaciana* Roth. Based on the unsystematic arrangement of wasp pupae

within the oothecae, they suggested the wasp larva was mobile and feeds on many rather than just a single egg, that is, it acts more like a predator than a true parasitoid. The wasps emerged about 2–3 months earlier than the cockroaches, from mid-August to late September, with about 25–30 wasps emerging per ootheca through 1–3 holes chewed by emerging adults (Deans and Roth 2003, fig. 4D). Deans was unsuccessful in inducing reared female wasps to oviposit into the oothecae of *N. acaciana*, either by confining females with free oothecae, females with oothecae still attached to female *N. acaciana*, or by placing female wasps on a newly deposited oothecae on an ant-acacia inhabited by *Pseudomyrmex spinicola* (Emery) (Hymenoptera: Formicidae). In one replicate of the latter experiment, a female antennated the ootheca but jumped away at the first contact with an ant. Although oviposition was never observed, the authors suggested *O. nyctiboraphagus* probably oviposits into the ootheca while this is still attached to the female cockroach so as to avoid the hostile ant-protected environment. They noted that *Anastatus floridanus* Roth and Willis oviposits into the ootheca of *Eurycotis floridana* Rehn (Orthoptera: Blattidae) while this is attached to the female and can not locate the ootheca if it is covered by sand or sawdust. The oviposition behavior and preferred time and place of oviposition for *O. nyctiboraphagus* remains to be determined. Deans and Roth (2003) noted that other common cockroach oothecal inhabitants are unknown for *N. acaciana* and suggested this species derives significant protection by developing on ant-acacias. However, if *O. nyctiboraphagus* is the only species that attacks the oothecae, this may indicate it is the only species able to escape ant predation and successfully oviposit into oothecae attached to acacias protected by ants. Gibson (1986) commented on the prodigious jumping ability of female Eupelminae. He correlated this and the extreme sexual dimorphism that characterizes the subfamily with a highly derived mesosomal skeletomusculature in females. Jumping in female Eupelminae does not appear to be for movement from place to place and Gibson (1986) postulated it probably evolved as a rapid escape mechanism from predators, possibly ants and spiders. The ant-wasp interaction noted by Deans demonstrates the ability of *O. nyctiboraphagus* to escape ant predation.

KEY TO FEMALES OF DESCRIBED *BUCHERI*-GROUP SPECIES

1. Flagellum conspicuously clavate (Fig. 14), funicle with apical 4 segments strongly transverse, and clava about as long as combined length of apical 6 segments and about 2.5 times as wide as Fl_1 ..... ***O. magniclavatus* (Ashmead)**
– Flagellum not conspicuously clavate (Fig. 13), funicle with apical 4 segments subquadrate to elongate, and clava shorter than combined length of apical 4 segments and less than twice as wide as Fl_1 2
2. Fore- and middle legs beyond coxae yellowish orange; forewing (De Santis 1970, fig. 1) with following bare: costal cell dorsally except apically near parastigma, basal cell basally and posteriorly, cubital area, mediocubital notch, and vannal area (Fig. 17) ..... ***O. bucheri* De Santis**
– Fore- and middle legs largely dark beyond coxae, brown or with metallic luster; forewing with costal cell sometimes more extensively setose than above, but otherwise only vannal area bare 3
3. Antenna entirely dark, the scape with distinct bluish-purple luster; fore- and hind legs dark, the femora with distinct bluish-purple luster, but middle leg with femur and tibia yellowish-orange; lower face and parascrobal region smooth to finely coriaceous with



Figs. 17–19. *Oozetetes* spp. 17, *O. bucheri*, ♀ holotype forewing, with schematic cross-section (insert) (abbreviations: **bc,** basal cell; **bf,** basal fold; **cc,** costal cell; **cua,** cubital area; **cuf,** cubital fold; **lcc,** length of costal cell; **mcf,** mediocubital fold; **mcn,** mediocubital notch; **mdf,** medial fold; **scf,** subcubital fold; **smv,** submarginal vein; **vna,** vannal area; **vnf,** vannal fold). 18–19, *O. nyctiboraphagus* (♀). 18, Base of forewing. 19, Setae of forewing in region around campaniform sensilla of uncus.

distinct, scattered, setiferous punctures (Fig. 3); interorbital distance about 0.2 times head width; costal cell dorsally with complete band of setae along anterior margin; gaster dark dorsally, but laterally bright metallic green to bluish under some angles of light; forewing uniformly light brown from near base of parastigma to apex . . . . . ***O. splendens* (Cameron)**

– Antenna either with scape or flagellum yellowish; all legs mostly dark; lower face and parascrobal region reticulate-rugulose with only indistinct, shallow setiferous punctures (Fig. 1); interorbital distance at least 0.3 times head width; costal cell either entirely setose or mostly bare; gaster brownish with only slight metallic luster posteriorly (gaster missing beyond G_1 for *O. testaceicornis*); forewing obviously more hyaline apically so as to have distinct medial brownish region 4

Forewing (Fig. 18) with costal cell largely bare dorsally except near parastigma, vannal

area apically and mediocubital notch both setose, and basal cell with about apical half having white setae; interorbital distance at least 0.30 times head width (Fig. 2); acropleuron reticulate-strigose medially to distinctly reticulate posteriorly (Fig. 8) ..... ***O. nyctiboraphagus*** **Gibson**

– Forewing with costal cell entirely setose dorsally, vannal area and mediocubital notch bare (hence with large bare region between basal cell and disc), and basal cell with dark setae except along extreme apical margin (also small region of white setae immediately beyond basal fold and recurved portion of cubital fold); interorbital distance 0.22 times head width; acropleuron coriaceous ventrally to punctulate medially or punctulate-coriaceous posteriorly ..... ***O. testaceicornis*** **(Cameron)**

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A New *Chilicola* Spinola from Colombian Páramo (Hymenoptera: Colletidae: Xeromelissinae)

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Abstract.—***Chilicola (Anoediscelis) paramo* Gonzalez and Michener, n. sp.,** from a Páramo in the Eastern Andes of Colombia is described. The new species is not a close relative of other known species and is not considered a member of the primarily Andean group of *C. ashmeadi*. *Chilicola paramo* differs from other species in such a way that Michener's (2002) key to Andean subgenera of *Chilicola* requires modification; a new key is therefore provided here. Aspects of the nesting biology of the new species are also given.

Resumen.—***Chilicola (Anoediscelis) paramo* Gonzalez and Michener, n. sp.,** es descrita de un Páramo de la cordillera Oriental de Colombia. La nueva especie no esta relacionada a ninguna otra especie conocida y no es considerada un miembro del grupo principalmente andino de *C. ashmeadi*. *Chilicola paramo* es bien diferente de las otras especies del grupo de tal manera que la clave de Michener (2002) para los subgéneros andinos de *Chilicola* necesita ser modificada; una clave nueva es presentada aquí. También se presentan notas sobre la biología de nidificación de la especie.

Recently, Michener (2002) revised the tropical Andean species of *Chilicola* Spinola, that is those that occur from Perú to Venezuela above 1000 m. Such Andean species were grouped in three subgenera: *Anoediscelis* Toro and Moldenke, *Hylaeosoma* Ashmead and *Oroediscelis* Michener; the Andean species of the first consisting of the group of *C. ashmeadi* (Crawford). This paper is a supplement to that revision since the new species described herein differs considerably from other known species in such a way that Michener's (2002) key to Andean subgenera requires modification. Therefore, one objective is to correct that key. Aspects of the nesting biology for the new species are also discussed.

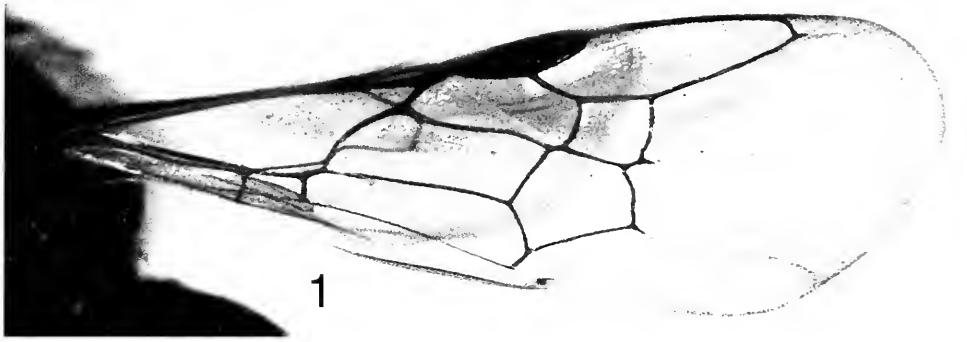
MATERIAL AND METHODS

Morphological terminology follows Michener (2000, 2002). Abbreviations used in descriptions are F, S, OD, and T for flagellar segment, metasomal sternum, ocellar diameter, and metasomal tergum, respectively. Photomicrographs were prepared by Prof. Michael S. Engel using a Microptis ML-1000 Digital Imaging System. Type specimens are deposited in the following institutions:

IAVH Instituto Alexander von Humboldt, Villa de Leyva, Boyacá, Colombia (J. E. Castillo).

SEMC Entomology Division, Natural History Museum, University of Kansas, Lawrence, KS 66045–7523, USA (Z. Falin).

The field work was done by V.G. with the help of Paula Montoya. All nests of the new species were collected during cold, cloudy weather when the bees should have been in their nests, at the locality indicated below after the description, on August 23, 2003. This is during the transition from the rainy to the dry season.



Figs. 1–2. *Chilicola paramo*. 1, Forewing (photo of a paratype). 2, Face, holotype male.

Mean values are given with standard errors.

Chilicola (Anoediscelis) paramo Gonzalez and Michener, n. sp.

Figs. 1–8

Diagnosis.—Except as indicated under Group Characters below, this species agrees with the characterization of the *C. ashmeadi* group by Michener (2002). It differs from members of that group by the distal stigmal perpendicular crossing submarginal cells near first submarginal crossvein (Fig. 1) and especially by the long, swollen scape (Fig. 2) and the swollen hind femur of the male (Fig. 3).

Male.—Body length 5.5 mm; forewing length 4.0 mm. **Coloration (paratype in parentheses):** Black, clypeus with small pale yellow spot (Fig. 2), larger than ocellus, on middle of lower clypeal margin (pale area extending nearly full width of lower margin of clypeus and in middle, up as acute point to two fifths of length of clypeus); mandible brown (pale yellow) except for narrow black base and black apex; flagellum black (under surface dark brown); tegula with vague brownish black

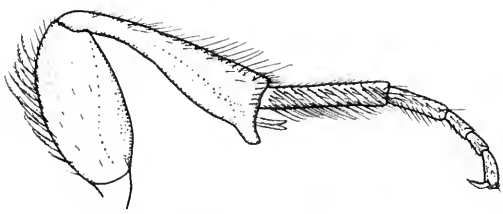
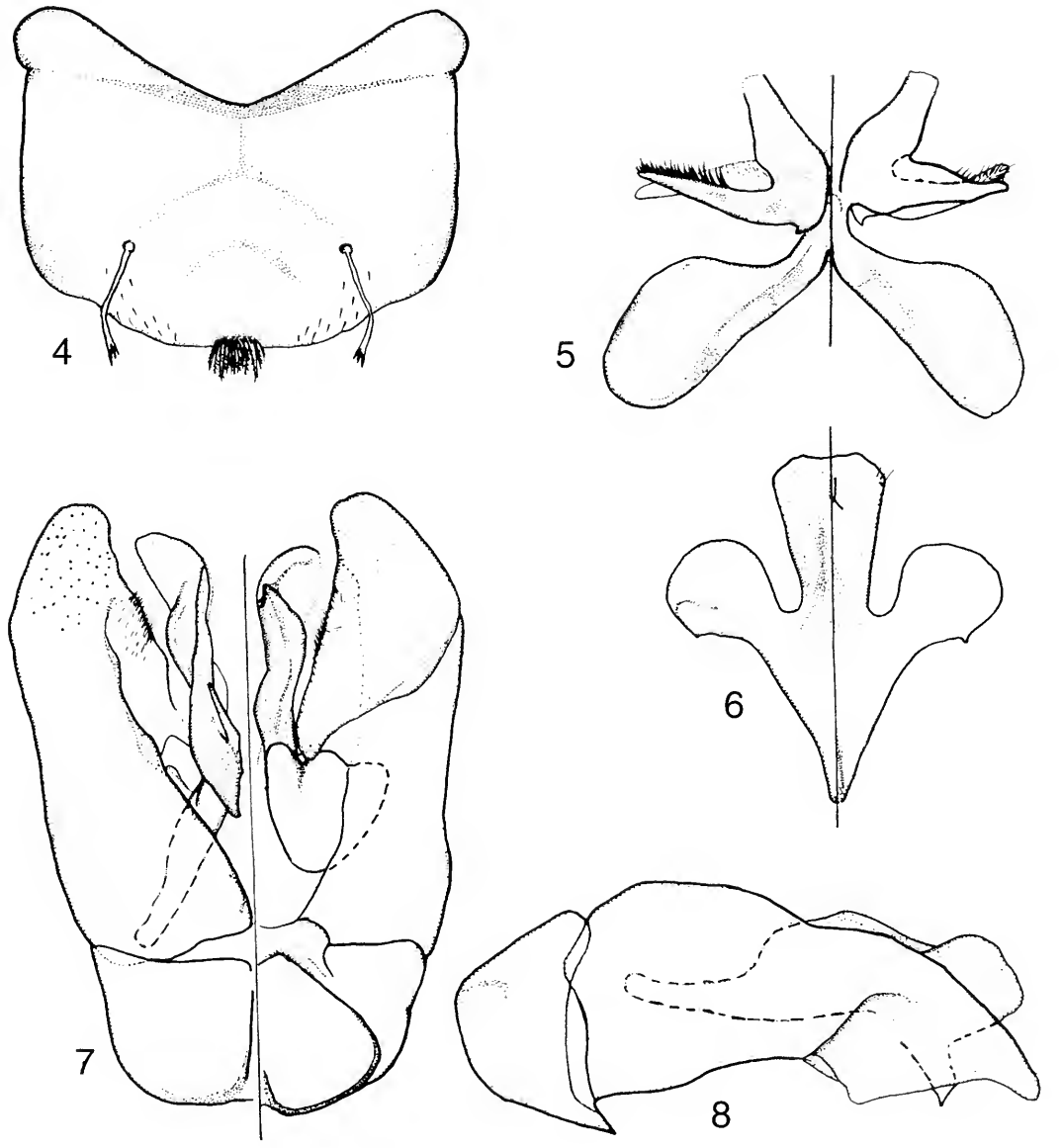


Fig. 3. *Chilicola paramo*. Hind leg, male.

area posterolaterally; apex of front femur and area on distal third (half) of anterior surface of front femur brownish yellow; outer surface of front tibia brownish yellow; small areas at apex of mid femur and base of mid tibia dark brown (brownish yellow); base of hind tibia blackish brown (brownish yellow); hind tibia with inner apical projection black (brown); tibial spurs testaceous; front and middle tarsi partly brownish; wings faintly smoky, veins and stigma black; posterior margins of T1 to T5 translucent brownish black. **Sculpturing:** Surface of head and thorax throughout dulled by micropunctuation, the same on yellow clypeal area as on adjacent black areas; metasoma dulled by transverse lineolation. Punctures of clypeus, scutum, scutellum, and sides of thorax small, weak, mostly separated by two or three puncture widths, those of scutum, scutellum, and sides of thorax considerably smaller and weaker than in *C. ashmeadi*; punctures coarser and closer on rest of head, on frons as close as possible; punctures nearly absent or unrecognizable on metasoma; dorsal surface or basal area of propodeum granular with several irregular longitudinal carinae on anterior half (two fifths), posterior margin of dorsal surface marked by transverse arcuate ridge, reduced medially, that is largely smooth and shiny; posterior part of tegula partly smooth and shiny; marginal zones of T1 to T5 more shiny than discs but none the less transversely lineolate. **Pubescence:** Short, sparse, dull whitish, setae often dusky when viewed against white background; setae longest, 3OD or more, on scape, paraocular area and frons near antennal base, and lower mesepisternum; pedicel covered with short setae; setae rather long, 2OD, on vertex, genal area, propleura, coxae, hind femur, outer surface of hind tibia, upper part of side of propodeum where setae are rather dense and plumose, sides of metasomal terga where setae are denser along posterior margins and form weak, scarcely noticeable apical fasciae laterally, and on posterior margins of metasomal sterna; apical fringe of S2 with setae of median part coarse, distal parts bent strongly posteriorly and branched. **Structure:** *HEAD:* Face as long as broad; interocellar distance subequal to ocellocular distance, about two OD; ocelloccipital distance about 1.5 OD; scape swollen (Fig. 2), thicker than distal part of flagellum and about twice width of F4, longer than clypeus and reaching middle of anterior ocellus; pedicel subcylindrical, about 1.5 times as long as broad; flagellum much slenderer than in *C. ashmeadi*, F1 slightly shorter than pedicel, about 1.5 times as long as broad, F2 shorter than others, F4 and subsequent segments progressively broader and longer, all except F11 about 1.5 times as long as broad. *THORAX:* Legs robust, hind femur swollen, about twice as long as broad, hind tibia with apical half somewhat enlarged (Fig. 3), with inner apical projection extending distad; hind tarsus longer than tibia, hind basitarsus parallel-sided. *METASOMA:* Sterna scarcely modified, S2 with basomedian tumescence, apical margin of S2 more convex than transverse margins of S3 and S4; S6 with posterior margin rounded, apicomedian fringe consisting of erect setae much longer than shown in Fig. 4 because much foreshortened in drawing, large sublateral seta easily broken off; S7, S8, and genitalia as in Figs. 5–8; S7 with distal lobe trifid, suggesting that of *C. venezuelana* Michener but with setae on only one branch (Fig. 5, compare with Fig. 8a of Michener, 2002).

Female.—Agrees with description of male except for usual sexual characters



Figs. 4–8. *Chilicola paramo*, male. 4, S6. 5, S7. 6, S8. 7 and 8, Genitalia. In divided figures, dorsal view is shown on left, ventral on right.

and the following: **Coloration:** Black except under side of flagellum dark brown; basal half of front tibia with brownish yellow on outer and sometimes anterior surfaces; extreme apex of front femur sometimes brownish yellow; tibial spurs testaceous. **Sculpturing:** Punctuation even weaker than in male, punctures of scutum, scutellum, and sides of thorax so inconspicuous as to be easily described as merely seta bases, on frons separated by about one puncture width and micropunctuation conspicuous. **Pubescence:** Setae of scape and adjacent face less conspicuously long than in male, but generally setae longer and denser than in male, especially scopal setae of hind femora and metasomal sterna, the latter not forming fringes

as in male but wide spread, as usual for Chilicolinae those of S2 especially long and plumose. Pedicel with only scattered small setae. **Structure:** Face very slightly longer than broad; scape normal, not swollen, about as wide as F2 and thinner than distal part of flagellum, shorter than clypeus, not reaching anterior ocellus; pedicel nearly twice as long as broad; F1 and F2 about as long as broad, subsequent segments progressively wider, broader than long until F8 and F9 which sometimes appear about as broad as long or even slightly longer than broad. Legs unmodified, not swollen.

Holotype.—Male. COLOMBIA: Boyacá: Arcabuco Prov., Santuario de Fauna y Flora de Iguaque, Camino de la Laguna, 5° 70′ N, 73° 46′ W, 3400–3600 m, in dry flower stems of *Espeletia argentea*, 23-VIII-2003 (V. Gonzalez & P. Montoya) [IAVH No. 4117].

Paratypes.—One male and four females with same data as the holotype, the male and two females in SEMC, the other two females at IAVH. No. 4118-9

Etymology.—The specific name is a noun in apposition; the word Páramo is the name for a well known vegetation type of high altitudes (3500–4100 m) in the northern Andes, dominated by the asteraceous genus *Espeletia* Mutis ex Humb. & Bonpl., which provided the nesting sites for *Chilicola paramo.*

GROUP CHARACTERS

The new species, *C. paramo*, is a member of the subgenus *Anoediscelis* in the sense of Michener (2000, 2002). It agrees with the characterization of the *C. ashmeadi* group by Michener (2002) except as follows: Size larger (over 5 mm in body length). HEAD: Upper orbital tangent of male passing through upper part of median ocellus; emargination of inner eye margin rather strong in male, not margined by smooth strip; lower interocular distance more than half of upper interocular distance; interalveolar distance nearly equal to alveolocular distance; subantennal sutures subparallel; labrum about four times as wide as long; maxillary palpus nearly three fourths as long as prementum, segments progressively longer and more slender from base to apex, so that distal segment is the longest and most slender; labial palpus extending well beyond glossa, second segment nearly twice as long as broad, others subequal. THORAX: Pronotal collar nearly as wide as maximum width of flagellum; stigma about two thirds as long as length of marginal cell on costa; *distal stigmal perpendicular crossing submarginal cells near first submarginal crossvein* (Fig. 1); dorsal surface of propodeum about as long as scutellum; posterior tibia of male much longer than femur, almost four times as long as apical width, widest at apex because of inner apical projection (Fig. 3). METASOMA: T1 slightly longer than broad in male, slightly broader than long in female; marginal zones of terga only narrowly smooth at extreme apices of terga, otherwise transversely lineolate like tergal discs although more shiny than discs; penis valves with single dorsoapical diverging membranous processes (Fig. 7) (as in *C. ashmeadi*).

KEY TO THE TROPICAL ANDEAN SUBGENERA OF *CHILICOLA*

The problem, mentioned above, in the key to the subgenera of the tropical Andes (Michener, 2002: 8), is a result of the venational character italicized in the section on Group Characters in listing differences between *C. paramo* and the description of the *C. ashmeadi* group. The distal stigmal perpendicular crosses the submarginal cells near the first submarginal crossvein (Fig. 1), so that according to the first character of the first key couplet, *C. paramo* would be a species of the subgenus *Oroediscelis*. Other characters, however, show that *C. paramo* is not otherwise similar to *Oroediscelis* but is a species of *Anoediscelis*. The following is a corrected key:

1 Malar space one third as long as broad or more; S4 of male with pair of tubercles or projections; hind tibia and usually basitarsus of male swollen and modified ..... *Oroediscelis*
– Malar space linear (= absent), rarely nearly one third as long as broad; S4 of male simple or nearly so; hind tibia and basitarsus of male slender, not modified, or distal part of tibia slightly enlarged and produced as in *C. paramo* (Fig. 3) 2
2 Head above antennal alveolus with depression (sometimes evanescent) extending up toward ocellocular region; S8 of male with apical process deeply bifid; body length usually 4.0 to 5.5 mm but as little as 3.0 mm in *C. smithpardoi* Michener ..... *Hylaeosoma*
– Head without depression above antennal alveolus; S8 of male with apical process truncate (Fig. 6); body length usually 3.0 to 3.8 mm, but 5.5 mm in *C. paramo* ..... *Anoediscelis*

NESTING BIOLOGY

As described for *C. espeleticola* Michener (Michener, 2002), nests of *C. paramo* were found in dead, dry, broken, pithy flowering stems of living plants of the Páramo species, *Espeletia argentea* Humb. & Bonpl. (Asteraceae). The stems containing nests had diameters of 5.5 to 7.0 mm (X = 6.4 ± 0.6, n = 8) and were in varying positions from almost horizontal, lying on the ground, to erect and with the nest entrance 70 cm above the ground level. All occupied stems had broken ends where the bees had entered the pith. Nests consisted of unbranched tunnels through the axes of the stems. Tunnel diameters ranged from 2.5 to 3.5 mm (X = 2.8 ± 0.29, n = 7); the variation in diameter suggests that at least some nests were probably in tunnels made by other insects. One tunnel, not included in the above statistics and not considered a nest, was 1.9 mm in diameter; it contained only a single female probably resting during cold weather. Lengths of four nests measured from entrances to the upper ends of the cells, i.e., lengths of open tunnels above the cells, were 8, 17, 50, and 60 mm. The cell series often occupied the lower ends of the tunnels, but in other cases the empty burrow extended below the cells. All the cells contained provisions or small larvae, no large larvae or pupae. The cells were cylindrical and averaged 6.4 mm in length (± 1.2, n = 10) and about 3 mm in diameter. The cell membrane was similar to that of many other colletids, translucent and slightly whitish, and was in contact with the pith walls of the tunnel except where it formed the ends of the cells and thus the partitions between cells. Cells in series were separated only by such partitions; spaces between cells were absent. The semiliquid food masses were dark brown and occupied about one third of the cell length; lengths of pollen masses X = 2.2 mm ± 0.3, n = 4. Five of the collected nests contained 1, 3, 3, 5 and 6 cells each. The shortest nest tunnel (8 mm) led to one cell. Two old nests were recognized by fragments of cell membrane; each contained an adult male *C. paramo*. Active nests (with cells) each contained also a single adult female. All the adults had unworn wings.

One female of the subgenus *Oroediscelis* was found in the same area but in a dead stem of *Rubus* Linnaeus (Rosaceae). In the absence of males, the species is not identified.

DISCUSSION

In view of the numerous characters differentiating *C. (Anoediscelis) paramo* from the species placed in the *C. ashmeadi* group, we believe that it should be excluded from that group. It does not, however, show a close relationship to any of the remaining (Chilean) species of the subgenus; for illustrations and descriptions of these species see Toro and Moldenke (1979) and for commentary see Michener (2002: 10, 11).

The new species is another example of a probably apomorphic taxon from the

high Andes which does not have an obvious affinity to any other known species, showing again the distinctiveness of the Andean fauna and perhaps the existence of more species groups within the Andean *Chilicola* fauna.

The nesting biology reported here for *C. paramo* does not differ significantly from that of other *Chilicola* species. According to what is known from other species, it is likely that *C. paramo* nests in diverse pithy sticks and branches available in the Páramo and is not likely to be specialized to *Espeletia argentea* inflorescences.

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Torymus Dalman (Torymidae: Hymenoptera) Associated with Coniferous Cones, with Descriptions of Three New Species

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Abstract.—Eight species of *Torymus* Dalman are associated with coniferous cones, including three new species described herein: ***Torymus pseudotsugae* Hobbs**, from cones of *Pseudotsuga menziesii* in the United States (California, Idaho) and Canada (British Colombia); ***Torymus hobbsi* Grissell**, from cones of *Picea sitchensis* (Bongard) Carriere in the United States (California, Oregon, Colorado); and ***Torymus ezomatsuanus* Kamijo**, from larvae of cecidomyiid in seeds of *Picea glehnii* (F. Schmidt) Masters and *P. jezoensis* (Siebold and Zuccarini) Carriere in Japan (Hokkaido). The previously described species are: *T. azureus* Boheman (Holarctic), *T. caudatus* Boheman (Holarctic), *T. festivus* Hobbs (Nearctic), *T. janetiellae* Graham and Gijswijt (Palearctic), and *Torymus tsugae* (Yano) (Palearctic). Of the eight known species, five are reported attacking Cecidomyiidae (Diptera) in coniferous cones, but specific hosts are unknown for the other three. *Torymus tsugae* is recognized and redescribed for the first time since its description in 1918. *Torymus caudatus* is reported for the first time from Japan (Hokkaido, ex cones of *Picea jezoensis*, new host plant) and from the New World (New York, USA, ex cones of *Picea abies* (L.) Karsten); *T. azureus* is reported for the first time from Japan (Hokkaido, ex seeds of *Picea glehnii*). An illustrated key to all species is given.

The hymenopterous family Torymidae contains a number of species associated with coniferous cones. Most of these belong to the genus *Megastigmus* Dalman and are phytophagous within seeds (Grissell 1999). Less well known are species of *Torymus* Dalman that inhabit cones. Although little specific host data are available for these species, it is probable that all are parasitoids of cone-inhabiting gall flies of the family Cecidomyiidae (Fig. 31). It is possible, though unlikely based on known host records for the genus, that some species may be seed-feeders or might be attacking seed-feeding *Megastigmus*. Basically little is known about these *Torymus* other than they occur in coniferous cones. Though they appear to be of little economic importance, they likely play some role in the natural control of cone-infesting cecidomyiids, which in some cases account for loses of up to 80% in seed production (Masters 2003).

In this paper we review the world's known cone-inhabiting *Torymus*, which total eight species, including three new ones described herein. What specific host data are available are discussed under each species and a summary host/parasitoid list is given at the end of this paper. This list encapsulates what is known about host plant, host insect, and the *Torymus* associated with them. We provide distribution and economic data for each species as well as an illustrated key. We report the first New World occurrence of *Torymus caudatus* Boheman, and the first occurrence of that species and *T. azureus* Boheman in Japan.

METHODS

Our concepts of described Palearctic species are based on specimens determined by Graham and Gijswijt (1998) who designated neotypes for several species (*T. azureus*, *T. caudatus*) and to M. J. Gijswijt who loaned specimens for examination (*T. caudatus*, *T. janetiellae* Graham and Gijswijt). Examples of these specimens and of type material of *T. festivus* Hobbs are housed in the National Museum of Natural History, Washington, D.C. The senior author has examined specimens of all taxa, including the new species described herein, and those for the redesciption of *T. tsugae* Yano.

Plant nomenclature and distribution was checked using the *Germplasm Resources Information Network* (GRIN 2000) and *The PLANTS Database* (USDA, NRCS, 2001). *Torymus* names and hosts were determined using Grissell (1995), Graham and Gijswijt (1998), and Noyes (2002). Cecidomyiid host names were checked by Dr. Raymond Gagné, Systematic Entomology Laboratory. The authors' names for all plant and insect hosts are given in the Host Plant/*Torymus* list at the end of this paper.

The following abbreviations are used: OOL = ocellocular distance, POL = postocellar distance, OD = lateral ocellus diameter; square brackets [ ] are used for label data indicating that the information is not on the label and has been added from other sources. The key provides technical morphological characters with which to identify species, but these are often difficult to see, even with series of specimens in excellent condition. Females are the more reliable sex upon which to base determinations.

KEY TO CONE-INFESTING SPECIES OF *TORYMUS* DALMAN

1 Female: basal cell open behind, cubital vein without setae (Fig. 28, arrow). Both sexes: metacoxa without setae along outer dorsal margin (as in Figs. 10, 11) ***and*** lateral ocellus subequal in length to ocellocular length (Fig. 5); (ex *Tsuga*; Palearctic) ..... ***tsugae* Yano**

– Female: basal cell partially (Fig. 27) to completely (Fig. 26, arrow) closed behind, cubital vein with 2 or more setae. Both sexes: either metacoxa with setae along outer dorsal margin (Figs. 8, 9) ***or*** metacoxa without setae (Figs. 10, 11) and lateral ocellus 0.7× or less length of ocellocular distance (Figs. 1, 23) 2

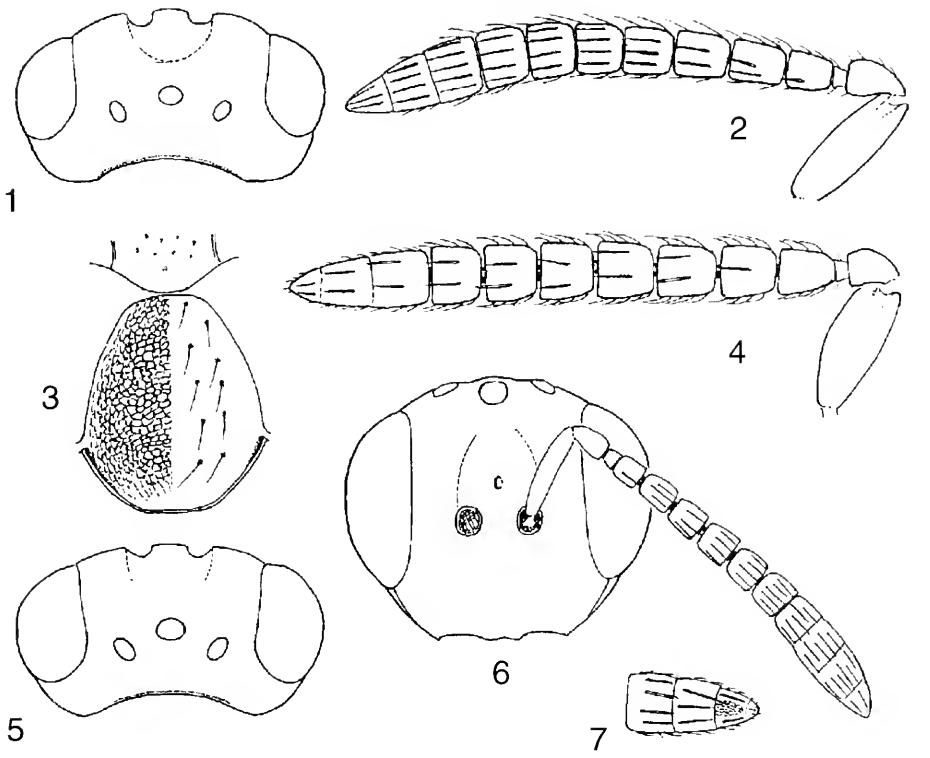
2 Metacoxa without setae along outer dorsal margin (Figs. 10, 11); frenal area of scutellum with (Fig. 3) or without setae 3

– Metacoxa with short setae along outer dorsal margin (Figs. 8, 9) [note that these are different from longer setae arising on posterior side of coxa in ventral half]; frenal area of scutellum with setae (as in Fig. 3) 5

3 Frenal area of scutellum without setae, glabrous and shiny; area polished compared to anterior of scutellum; interocular distance about 1× eye height in facial view (as in Fig. 6); postgenal area in side view narrow, less than 0.3× eye width. Female: metacoxa narrowly elongate, nearly parallel-sided, over 3× as long as wide (Fig. 10); club without area of ventral micropilosity on any segment; (ex *Picea*; Holarctic) ..... ***azureus* Boheman**

– Frenal area of scutellum sparsely setose, with at least a few setae (Fig. 3) or if setae not apparent then entire scutellum heavily reticulate; interocular distance about 1.5× eye height in facial view (Fig. 17); postgenal area in side view wide, 0.5–0.7× eye width (Fig. 21). Female: metacoxa not elongate, about 2.5–3× as long as wide (as in Figs. 8, 9, 11); at least one club segment with ventral area of micropilosity (as in Fig. 7) 4

4 Toruli 1.5–2× own diameter above ventral eye margin (as in Figs. 6, 16); venter of forewing basal cell essentially bare, with few or no setae. Female: club segment 3 with ventral area of micropilosity (as in Fig. 7); (ex *Picea*; Palearctic) .... ***ezomatsuanus* Kamijo, n. sp.**



Figs. 1–7. *Torymus* spp. 1–4, *T. ezomatsuanus*. 5–7, *T. tsugae*. 1, 5, Female, head, dorsal view. 2, Female, antenna. 3, Female, scutellum. 4, Male, antenna. 6, Female, head, front view. 7, Female, clava, ventral view.

– Toruli less than own diameter above ventral eye margin (Fig. 17); venter of forewing basal cell evenly covered with short setae (Fig. 27). Female: club segments 2 and 3 with ventral area of micropilosity; (ex *Abies*; Nearctic) ..... ***hobbsi* Grissell, n. sp.**

5 Propodeal spiracle about 3 to 4× its own length from posterior margin of propodeum, ca. 0.3× median length of propodeum (Fig. 13). Female: ovipositor 7× length of metatibia (sometimes curling and distorting when dry so that it cannot be measured); (ex *Picea*; Holarctic) ..... ***caudatus* Boheman**

– Propodeal spiracle less than 3× its own length from posterior margin of propodeum, ca. 0.5 to 0.7× median length of propodeum (Fig. 12). Female: ovipositor not more than 4× length of metatibia 6

6 Funicle segments (Fig. 14) at apex without transverse row of outstanding perpendicular setae (cf. Figs. 14, 15); female pro- and metafemora slender, over 4× as long as wide; profemur of male about 3.5× as long as wide. Female: ovipositor less than 3× as long as metatibia. Male: setae on funicle segments recurved above surface, dense (ca. 3–4 rows), obscuring multiporous plate sensilla (Fig. 14) 7

– Funicle segments (Fig. 15; best seen in profile with backlighting) at apex with transverse row of bristles clearly projecting at nearly right angles; female pro- and metafemora slightly enlarged, less than 3.5× as long as wide; profemur of male enlarged, less than 3× as long as wide. Female: ovipositor at least 4× as long as metatibia (but usually distorted and difficult to measure). Male: setae on funicle segments appressed to surface, sparse (ca. 2 rows), multiporous plate sensilla apparent as white, flattened bands (Fig. 15); (ex *Pseudotsuga*; Nearctic) ..... ***pseudotsugae* Hobbs, n. sp.**

7 Female: metacoxa (Fig. 9) with single row of setae (about 5 or fewer) along outer dorsal margin, reaching 0.2–0.3× length of coxa and creating a gap between them and longer setae at apical 0.3 of coxa. Male: venter of scape barely sculptured, burnished similar to face, which is bright metallic green (ex *Chamaecyparis*; Palearctic) ..... ***janetiellae*** **Graham and Gijswijt**

– Female: metacoxa (Fig. 8) with several setal rows (about 10 or more setae total) along outer dorsal margin, reaching at least 0.5× length of coxa and meeting longer setae at apical 0.5 of coxa. Male: venter of scape with granulose, coarse sculpture similar to that on face, which is matt blackish green; (ex *Chamaecyparis, Thuja*; Nearctic) .... ***festivus*** **Hobbs**

Torymus azureus Boheman
Figs. 10, 26

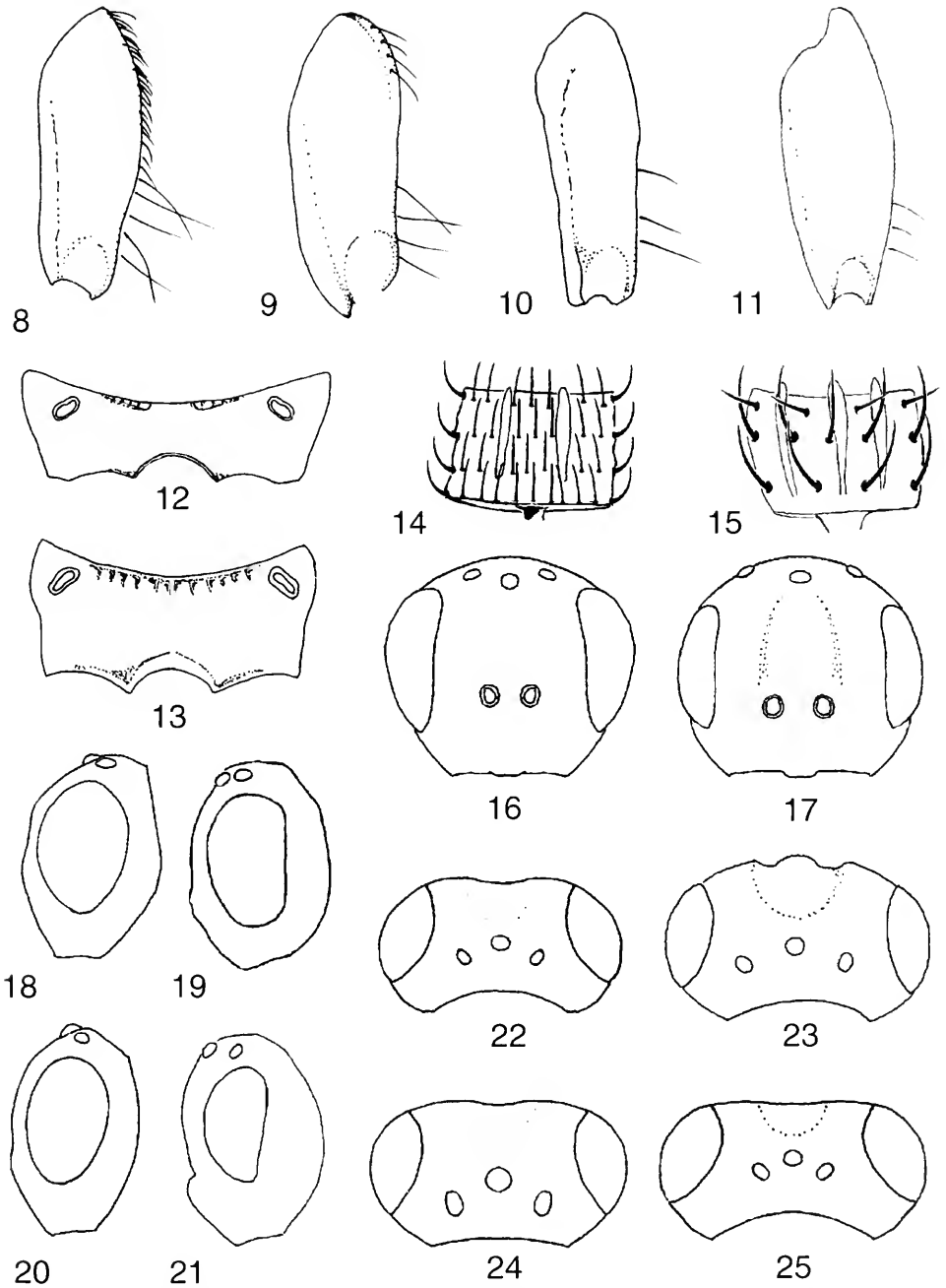
Torymus azureus Boheman 1834: 369–370.

Distribution and hosts.—*Torymus azureus* is known from western Russia (Nikol'skaya 1952) and eastern Europe (Graham and Gijswijt 1998). The species was reared from *Kaltenbachiola strobi* and *Plemeliella abietina* (Diptera: Cecidomyiidae), both from *Picea abies* (Norway spruce) cones (Bakke 1955, 1963; Graham and Gijswijt 1998). [Bakke (1955) did not specify the *Picea* species, but based on his summary work published in 1963 it may be assumed that he worked only with *Picea abies* in Norway.] Norway spruce is endemic to the Palearctic Region (USDA, NRCS 2001). We have seen 1♂ from Sweden reared from cones of *Picea excelsa* (= *P. abies*). We report *T. azureus* here for the first time from Japan (1♀, Ashoro, Hokkaido, 1956, K. Kamijo; 1♀ Hokkaido (exact locality unknown), 1956, K. Kamijo; 1♀, Tomakomai, Hokkaido, 1956, K. Kamijo). These specimens were reared from *Picea glehnii* (new host record), which is endemic to the Palearctic (Japan and Russia; GRIN 2000).

Bakke (1955) provided a detailed historical overview of *Torymus azureus*, including both its taxonomic confusion with *T. caudatus* (see next species discussion), and its biological habits. According to Bakke (1963) *T. azureus* was common in the lowlands and southern areas of Norway, whereas *T. caudatus* was more common in the higher elevations and northern districts. Bakke (1955) summarized published records of rearings made from *Picea* cones containing *Laspeyresia strobilella* L. (Lepidoptera: Olethreutidae) and proved conclusively that cecidomyiids were the actual host.

This species was first reported in the New World by Grissell (1976) from cones of endemic *Picea engelmannii* in Montana and New Mexico. The origin of *T. azureus*, whether Holarctic or introduced from one region to the other, is not known. It is possible that *T. azureus* shifted from introduced Norway spruce to endemic Englemann's spruce, but so far there are no records of the species from Norway spruce in the New World. The Palearctic cecidomyiid hosts are not known from the New World (Gagné, pers. comm.).

Discussion.—This species would be placed in the *varians*-group by Grissell (1976) and in its own species-group by Graham and Gijswijt (1998). Other species known from coniferous cones are members of the *bedeguaris*- or *cingulatus*-groups of *Torymus*. *Torymus azureus* is distinguished from species in these groups based on the following species-group characters: the frenal area is indicated by an absence of setae (remainder of scutellum with sparse, elongate setae) and being almost smooth compared to anterior of scutellum and dorsum of mesosoma, which is feebly aciculate; there is no frenal line. Additional characters that aid in identification are: the metacoxa distally has long setae on the inner (flat) surface, but from an outer (i.e., normal) view these



Figs. 8–25. *Torymus* spp. 8–12, Metacoxa, outer view. 8, *T. festivus*. 9, *T. janetiellae*. 10, *T. azureus*. 11, *T. hobbsi*. 12–13, Propodeum. 12, *T. pseudotsugae*. 13, *T. caudatus*. 14–15, Funicle segment 5. 14, *T. janetiellae*. 15, *T. pseudotsugae*. 16–17, Head, frontal view. 16, *T. pseudotsugae*. 17, *T. hobbsi*. 18–21, Head, side view. 18, *T. festivus*. 19, *T. pseudotsugae*. 20, *T. janetiellae*. 21, *T. hobbsi*. 22–25, Head, dorsal view. 22, *T. pseudotsugae*. 23, *T. hobbsi*. 24, *T. janetiellae*. 25, *T. festivus*.

are usually visible only distally (Fig. 10); there are no setae along the dorsal margin; in females the metacoxa is elongate and parallel-sided being 3 to 3.5× as long as wide (Fig. 10); and the ovipositor is about 4.5 to 5.5× as long as the metatibial length. The body color for both sexes is metallic blue green, sometimes with purplish reflections.

Torymus caudatus Boheman
Fig. 13

Torymus caudatus Boheman 1834: 365–366.

Distribution and hosts.—*Torymus caudatus* is widespread in eastern Europe (Graham and Gijswijt 1998) where it has been reared from *Kaltenbachiella strobi* in cones of *Picea abies* (Bakke 1955). In Sweden it has been reared from cones of *Picea excelsa* (= *P. abies*). We report the species for the first time from Japan (2♀, 2♂, Asahikawa, Hokkaido, em. 27-VI-1990, K. Kamijo; specimens in Laboratory of Systematic Entomology, Hokkaido University, Sapporo, Hokkaido), where it was reared from cones of *Picea jezoensis* (new host record).

The species is herein reported in the New World for the first time reared from cones of *Picea abies* containing the cecidomyiid *Dasineura* [now = *Kaltenbachiola*] *canadensis* (Felt). The only known locality is New York (8♀, 8♂, Syracuse, Onondage Co., coll. 13-XII-1979, em. 12-I to 25-III-1980, P. J. Sedwick; specimens in National Museum of Natural History, Washington, DC). Because *Picea abies* is a Palearctic tree species introduced into the Nearctic (USDA, NRCS 2001), the single known population of *T. caudatus* from New York was most likely introduced.

Discussion.—Bakke (1955, 1963) reviewed the taxonomic history and biology of this species, especially with reference to its early and consistent confusion with *T. azureus*. This species is placed as a member of the *bedeguaris*-group as defined by Grissell (1976) and Graham and Gijswijt (1998). It cannot be placed in the key of Grissell (1976) because the key treated only western Nearctic species. It is distinguished from other cone-associated species based on the following set of characters: a frenal area is not apparent but has setae and reticulate sculpture similar to the anterior of the scutellum; a frenal line is barely indicated laterally but is medially obscure except at some angles of view; metacoxa has many short, recurved setae along the angled dorsal margin where the outer face meets the dorsal surface (as in Fig. 8) and there are a few elongate setae visible in the basal portion (in both sexes the metacoxa is not noticeably parallel-sided); the propodeal spiracle is about 3 to 4× its own greatest length from the posterior margin of the propodeum and about 1/4 the median propodeal length (Fig. 13); and the ovipositor is about 7× as long as the metatibial length, but it is usually so distorted that the length is difficult to measure. The body color is metallic green for both sexes.

Torymus ezomatsuanus Kamijo, new species
Figs. 1–4

Female.—Body length 1.9–2.6 mm. Ovipositor sheaths about 2.4–2.5× length of metatibia. Dark blue to blue violet: propodeum often purplish. Antenna blackish. Coxae concolorous with mesosoma, remainder dark brown, with pro- and metafemora with metallic reflections. Wings almost hyaline with veins brownish yellow. Head in dorsal view (Fig. 1) about 1.9× as wide as long; temples about 0.3× as long as eye; occiptal carina not strong; ocelli small, POL 1.8–2.3× OOL, OOL 1.3–1.5× OD. Head in front view 1.2–1.3× as wide as high, genae roundly converging to mouth. Eyes separated by about 1.3× their height, with inner orbits subparallel; malar space about 0.4× eye height; in lateral view genal area about 0.5× eye width. Torulus slightly more than own diameter above ventral eye margin. Clypeus with lower margin almost truncate. Head irreg-

ularly, finely reticulate, face with sparse, indistinct piliferous punctures. Antenna (Fig. 2) weakly clavate; scape not reaching median ocellus, about 2.9× as long as wide; combined length of pedicel and flagellum 1.2–1.3× width of head; pedicel nearly 1.5× as long as wide; anellus distinctly transverse; F1 much shorter than pedicel, slightly longer than wide to quadrate; F2 as long as pedicel, a little longer than wide; F4 subquadrate; F7 1.3–1.4× as wide as long; clava nearly as long as F5–F7 combined; sensilla disposed in 1 row on each segment; C3 with a small tuft of micropilosity beneath (as in Fig. 7). Mesosoma 1.6–1.8× as long as wide, in profile propodeum sloping at about 60 degrees. Midlobe of mesoscutum densely reticulate, transversely so anteriorly, with piliferous punctures minute. Scutellum nearly 1.3× as long as wide, moderately convex, with sculpture as in posterior part of mesoscutal midlobe, becoming weaker and shiny on frenal area, often smooth at extreme apex but without frenal line; setae on scutellum (Fig. 3) sparse, usually absent medially, piliferous punctures a little larger than on mesoscutum; flange very narrow, not trabeculate. Propodeum polished, with superficial alutaceous sculpture, smoother medially and with a row of very small fovea along base. Lower mesepimeron small, 1.5× as high as wide. Metacoxa twice as long as wide, dorsally without hairs in basal half, outer side weakly reticulate; metafemur 4.9× as long as wide; metatibia with longer spur about as long as width of tibia, shorter spur about half of longer one. Forewing 2.4× as long as wide; costal cell on upper surface with a row of setae in apical half; basal vein with about 6 setae; basal cell with 1–9 setae, widely open below; speculum of moderate size, narrowly open below; relative lengths of M:PM:ST = 31:9.5:4; ST petiolate. Metasoma a little longer than mesosoma; hypopygium reaching 0.7 to 0.8 of gaster. Ovipositor sheaths as long as metasoma plus half of mesosoma.

Male.—Differs from female as follows: Body length 1.7–2.3 mm. Frons and face, and sometimes mesosoma with coppery reflections. Legs more extensively darker. Head in dorsal view fully twice as wide as long. Antenna (Fig. 4): scape 2.3× as long as wide; combined length of pedicel and flagellum 1.3–1.4× width of head; pedicel slightly longer than wide; F1 a little longer than pedicel, slightly longer than wide or quadrate; F2–F5 equal in length, quadrate to slightly longer than wide; F6–F7 usually slightly transverse; clava shorter than F5–F7, C3 without ventral micropilosity; flagellum with rather short decumbent setae. Mesosoma more slender, about 1.8× as long as wide. Scutellum fully 1.3× as long as wide, with scattered setae all over scutellum except on frenal area. Forewing less than 2.3× as long as wide. Metasoma shorter than mesosoma.

Etymology.—From "ezomatsu", the Japanese name of *Picea jezoensis,* and the suffix *-anus.*

Type material.—Holotype ♀: Chitose (near Shikotsu-ko), Hokkaido, Japan, em. III-1992, ex cecidomyiid larva in seed of *Picea jezoensis,* K. Kamijo (deposited in Laboratory of Systematic Entomology, Hokkaido University). Paratypes: 15♀, 10♂ with same data as holotype; 2♀, Asahikawa, Hokkaido, em. V-1983, ex cecidomyiid larvae in seeds of *P. jezoensis,* F. Komai; 4♀, 1♂, Akan, Hokkaido, em. V-1983, ex cecidomyiid larvae in seeds of *P. glehnii,* F. Komai (deposited in Laboratory of Systematic Entomology, Hokkaido University, Biabi, Hokkaido, and National Museum of Natural History, Washington, DC).

Distribution.—Japan (Hokkaido). The host tree is endemic to the Palearctic and is found in China, Japan, and the Russian Federation (GRIN 2000).

Host.—Reared from cecidomyiid larvae in seeds of *Picea glehnii* and *P. jezoensis.*

Discussion.—*Torymus ezomatsuanus* belongs to the *cingulatus*-group of Graham

and Gijswijt (1998) or to the *bedeguaris*-group of Grissell (1976), whose definition includes the *cingulatus*-group. This species belongs to the group of species without setae on the dorsum of the metacoxa and is similar in size and color to *T. azureus* from which it differs in having the frenal area sparsely setose (Fig. 3) and sculptured about as for the remainder of the scutellum (i.e., not nearly polished as in *T. azureus*); in females having the metacoxa less than about 2.5× as long as wide (as in Fig. 11, not over 3× as in *T. azureus*, Fig. 10) and antennal club segment 3 with an area of ventral micropilosity (as in Fig. 7). Females have the ovipositor about 2.5× the length of the metatibia. In both sexes the color is metallic blue to blue violet or purplish.

Torymus festivus Hobbs
Figs. 8, 14, 18, 25

Torymus festivus Hobbs 1950: 173–175.

Distribution and hosts.—This species was reared from *Dasineura* sp. (Diptera: Cecidomyiidae) in seeds of nearctic endemic western red cedar (*Thuja plicata*) and Port Orford cedar (*Chamaecyparis lawsoniana*) (Hobbs 1950). It is known from Oregon, Alaska, and the Northwest Territories (Grissell 1976). As these trees are native to the northwestern Nearctic (USDA, NRCS 2001), *Torymus festivus* should be considered an endemic Nearctic species. Currently this species and *T. pseudotsugae* are the only two species associated with coniferous cones that are thought to be endemic to the New World.

Discussion.—*Torymus festivus* is placed in the *bedeguaris*-group based upon Grissell (1976). It is phenotypically similar to *T. janetiellae* in characters associated with the antenna, metafemur, propodeum, and metacoxa, but may be distinguished from it by the few characters given in the key. Additionally, *T. festivus* is known only from the Nearctic whereas *T. janetiellae* is known only from the Palearctic. Females have the ovipositor about 2.7 to 3× as long as the metatibia. In both sexes the body color is metallic blue.

Torymus janetiellae Graham and Gijswijt
Figs. 9, 20, 24

Torymus janetiellae Graham and Gijswijt 1998: 115–116.

Distribution and hosts.—This species was reared in the Netherlands from cones of *Chamaecyparis lawsoniana* containing *Janetiella siskiyou* (Diptera: Cecidomyiidae) (Graham and Gijswijt 1998). *Chamaecyparis lawsoniana* is an endemic tree native to southern Oregon and northern California (GRIN 2000) and the host cecidomyiid is native to Oregon (Gagné 1989). The fly is introduced and well established in Europe (Gagné 1989), as is the tree. It is likely that *T. janetiellae* is also introduced (Graham and Gijswijt 1998). *Torymus festivus* was reared from *C. lawsoniana* in California and is extremely similar to *T. janetiellae*, suggesting an additional affinity of the latter species to the Nearctic fauna. Graham and Gijswijt (1998) also suggested that *T. janetiellae* could have been introduced from Japan but gave no reasons for this.

Discussion.—This species is listed as a member of the *bedeguaris*-group in Graham and Gijswijt (1998) and would key to that group as recognised by Grissell (1976). It is distinguished from its most phenotypic congenitor, *T. festivus*, by characters given in the key. In females the ovipositor is less than 2.5× the length of the metatibial length. In both sexes the body is metallic green.

Torymus hobbsi Grissell, new species
Figs. 11, 17, 21, 23, 25, 27, 29, 30

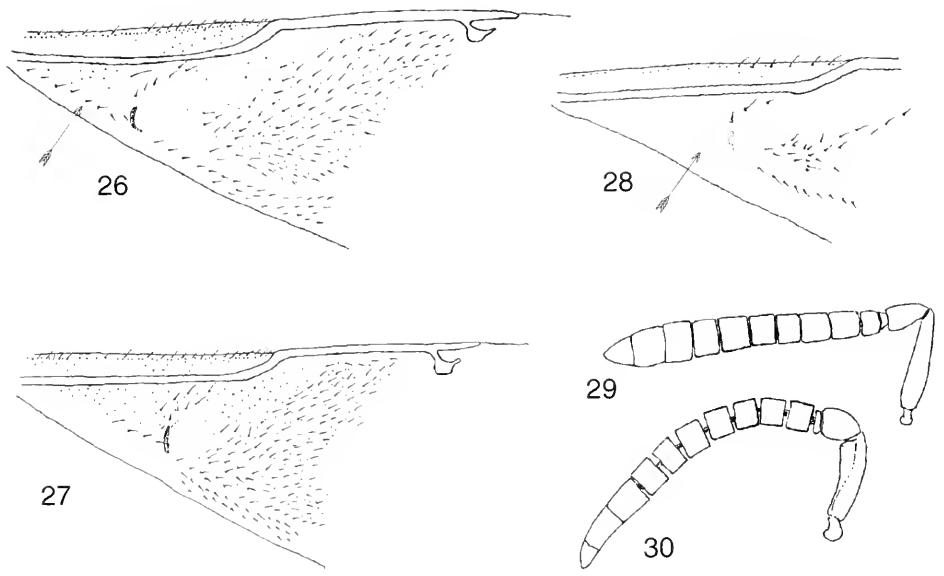
Female.—Body length 2.0–2.5 mm; ovipositor sheaths about 4× length of metatibia. Metallic blue black except following weakly brownish yellow: antenna, legs, wing veins, ovipositor sheaths; wings hyaline. Head in dorsal view (Fig. 23) about

1.8× as wide as long; temple about 0.5× as long as eye; occipital carina weak; POL 2.0× OOL, OOL 1.5× OD, lateral ocellus small, about 2.0× own longest diameter from occipital carina (Fig. 23). Head in front view (Fig. 17) about 1.1× as wide as high, with genae roundly converging to mouth; intermalar distance about 2.5× malar distance. Eyes separated by about 1.4× own height, with inner orbits ventrally diverging; malar space about 0.4× eye height; in lateral view eye appearing reduced (Fig. 21) with genal area at widest point about 0.6× eye width. Torulus less than own diameter above ventral eye margin (Fig. 17). Clypeus with lower margin essentially truncate. Head irregularly, finely reticulate. Antenna weakly clavate (Fig. 29); scape not reaching median ocellus, about 3× as long as wide; combined length of pedicel and flagellum about equal to width of head; pedicel in lateral view about 1.2× as long as wide; anellus distinctly transverse; F1 slightly shorter than pedicel, quadrate; F2 slightly longer than pedicel, a little longer than wide; F4 slightly wider than long; F7 about 1.5× as wide as long; clava equal to or longer than F5–F7 combined; sensilla arranged in 1 row on each segment; C3 without micropilosity beneath. Mesosoma ca 1.8× as long as wide, in profile propodeum sloping at about 60 degrees. Entire dorsal surface densely reticulate (transversely so just posterior to pronotum); lateral surfaces in most specimens nearly similarly sculptured (including acropleuron, upper and lower epimeron, and metapleuron), but some nearly smooth on lateral surfaces (see "Variation", below). Scutellum about as long as wide, moderately convex, without frenal line; setae sparse (about as in Fig. 3) to absent; scutellar flange narrow (barely perceptable), with no trace of pits. Propodeum nearly as reticulate as scutellum, with row of small fovea along anterior margin. Lower mesepimeron about 1.8× as high as wide. Metacoxa about 3–3.5× as long as wide, dorsally without setae in basal half (Fig. 11), outer face reticulate; metafemur about 4× as long as wide; metatibia with longer spur about as long as width of tibia, shorter spur about 0.6× as long as longer one. Forewing about 2.5× as long as wide; upper and lower anterior margin of costal cell (Fig. 27) with setal row, apical half of costal cell with 3 or 4 rows setal rows below; basal vein with 1 to 2 rows of setae; basal cell below almost uniformly covered with wide-spaced setae, above with only a few setae, cubital vein beneath basal cell with few setae apically (i.e., mostly open below); speculum apparent on upper surface, but with setae on lower; approximate relative lengths of marginal:postmarginal:stigmal veins 30:9:4; stigmal vein petiolate. Metasoma slightly longer than mesosoma; hypopygium about 0.7× length of gaster. Ovipositor sheaths as long as body.

Male.—Body length 1.9–2.9 mm. Differing from female as follows: Antenna (Fig. 30): scape about 6× as long as wide; pedicel nearly 2× as long as wide; F1 shorter than pedicel, about as long as width of pedicel; F2–F7 wider than long; clava ventrally flattened, longer than F5–F7, C3 without ventral micropilosity; flagellum with short decumbent setae.

Variation.—This species appears to be highly variable in sculpture. In one rearing (Newport) 2 female and 2 males are lightly sculptured and 2 males are heavily sculptured. In an August rearing at Crescent City, 1 female and 1 male are lightly sculptured and 2 females are heavily sculptured, but an October rearing from the same locality has 1 female and 4 males all heavily sculptured. All other characters for these specimens appear to be consistent. In all specimens the torulus varies from slightly to much less than its own diameter above the ventral eye margins (Fig. 17), but this variation appears to be due to slight distortions of the head. (See also discussion section, below.)

Etymology.—This species is named in honor of Kenneth R. Hobbs who, long



Figs. 26–30. *Torymus* spp. 26–28, Forewing, basal portion, arrow points to cubital vein. 26, *T. azureus*. 27, *T. hobbsi*. 28, *T. tsugae*. 29–30, *T. hobbsi*, antenna. 29, Female. 30, Male.

ago, played a major role in its describer's pursuit of the torymids. Sadly, Kenny passed away before he could see the publication of this paper.

Type material.—Holotype ♀: Crescent City, [Del Norte Co.], California, 17-VIII-[19]14, Paterson, Hopkins No. 12557g, [ex cones] *Picea sitchensis* (deposited in National Museum of Natural History, Washington, DC). Paratypes: 2♀, 1♂, same data as holotype [1♂ Hopkins No. 12577g]; 1♀, 4♂, same data except 3-X-[19]13, P. D. Sergent, Hopkins No. 10850k, [ex cones] *Picea sitchensis* **Colorado**: 1♀, 2♂, Glenwood Springs, [Garfield Co.], 25-X-[19]13, reared IV-[19]14, Hopkins No. 10859e, [ex cones] *Picea sitchensis*. **Oregon**: 2♀, 4♂, Newport, [Lincoln Co.], reared 12-X-[19]15, J. M. Miller, Hopkins No. 13305a, [ex cones] *Picea sitchensis* (all specimens deposited in National Museum of Natural History, Washington, DC).

Distribution.—California, Oregon, and Colorado. According to GRIN (2000) the host tree is endemic to the Nearctic and is found in Alaska, British Columbia, Washington, Oregon, and northern California, but no mention is made of Colorado. It is possible that the latter host tree was misidentified.

Host.—Reared from cones of *Picea sitchensis*.

Discussion.—*Torymus hobbsi* is somewhat difficult to place within a species group. Following Grissell (1976) some specimens would fall within the *varians*-group based on the apparent absence of setae in the frenal area. The setae are sparse at best and may simply be missing. The frenal area is not delimited and the scutellum is heavily sculptured. In the Nearctic key (Grissell 1976) this species runs to couplet 3 in the species group where it could then run either to couplet 4 based on the small ocelli, or couplet 5 based on the higher than wide epimeron. Its round face (Fig. 17), reduced eyes (Fig. 21), and basal cell with numerous setae beneath distinguish it from all four species involved in these two couplets. In the key to Palearctic species (Graham and Gijswijt

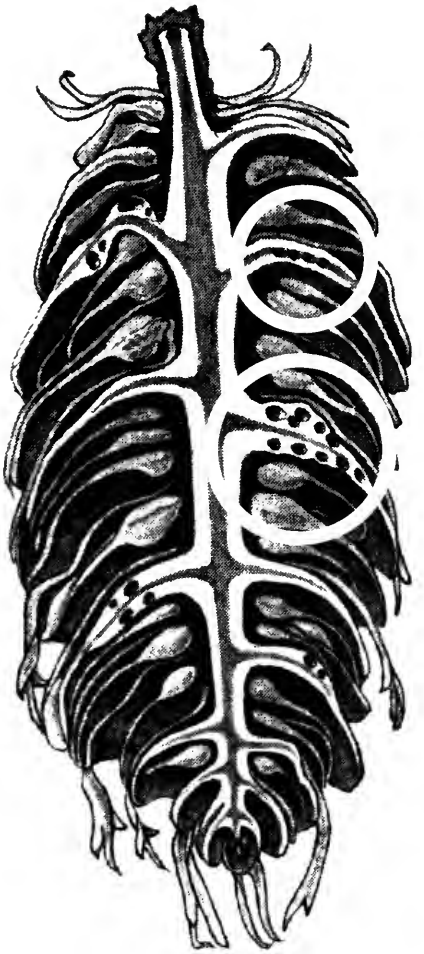


Fig. 31. *Pseudotsuga menziesii* cone. Cross section showing scale galls (white circles) of *Contarinia oregonensis* (Cecidomyiidae) (modified from Gagné 1989, Fig. 356, reprinted by permission).

1998) *T. hobbsi* runs to couplet 4 where it fits neither of the two treated species.

Torymus hobbsi differs from other species of *Torymus* reared from cones based upon the basal cell and parastigmal areas, which are nearly uniformly setose on the under side (Fig. 27). It also differs in part in the following respects [exceptions are noted in brackets]: the torulus is less than its own diameter above the ventral eye margin (Fig. 17) [also *ezomatsuanus*, *caudatus*, and *azureus*, especially when the head is collapsed]; the postgenal area is about 0.6–0.7× the eye width in lateral view (Fig. 21); the interocular distance is about 1.5× the eye height [also *ezomatsuanus*]; female and male *T. hobbsi* have the antennal club equal to or greater in length than the preceeding 3 segments (Figs. 29, 30); male *T. hobbsi* have the club somewhat flattened ventrally and distinctly acuminate at the apex (Fig. 30). Some specimens of *T. hobbsi* differ based upon the heavily sculptured acropleuron, upper and lower epimeron, metapleuron, and propodeum (all other species are essentially polished in these areas). Unfortunately the expression of sculpture in these areas is not consistent on all specimens, even in a single rearing, so that the above characters must be used in combination. In females, the ovipositor is about 4× as long as the metatibia. In both sexes the color is bluish black.

Four specimens reared from the series collected in Crescent City appear to represent either extreme variations of *Torymus hobbsi*, or a different species entirely. These have setae on the dorsum of the metacoxa and on the frenal area, both characters that indicate assignment to a different species group. It will require collection and analysis of new material in excellent condition to determine if more than one species is living in the cones of *Picea sitchensis*.

Torymus pseudotsugae Hobbs, new species

Figs. 12, 15, 16, 19, 22

Holotype female.—Body length 2.0 mm; ovipositor sheaths abut 4× length of metatibia. Metallic blue with purple reflections under indirect light, including pedicel, anellus, head, thorax and abdomen; following light amber: scape, except apical 2/3 of dorsal surface dark blue, trochanters, femora at bases and apices, dorso-lateral surfaces of tibiae metallic blue fading to brown on ventral and mesolateral surfaces; protarsal segments nearly uniform brown, mesotarsal segments similar with

basitarsus lighter brown, metabasitarsus off white with each segment increasingly brown distally; wing veins light brown basally becoming darker distally, stigmal vein prominently petiolate; areas between postmarginal vein and stigmas vein light brown. Face and dorsal aspects of thorax bearing closely appressed white setae about as long as distance between them; clypeal and apical scutellar hairs twice this length; metacoxa with dorsal setae. Head in dorsal view 1.7× as wide as long; temple 0.3× as long as eye; occipital carina developed; POL 2.5× OOL, OOL 1.6× OD, lateral ocellus 1.7× own longest diameter from occipital carina (Fig. 22). Head in front view (Fig. 16) 1.1× as wide as high, with gena roundly converging to mouth; intermalar distance 2.7× malar distance. Eyes separated by about own height, with inner margins ventrally slightly diverging; malar space 0.3× eye height; in lateral view eye not appearing reduced (Fig. 19; cf Fig. 21, *hobbsi*) with genal area at widest point 0.5× eye width. Torulus about 1.5–2× own diameter above ventral eye margin (Fig. 16). Clypeus with lower margin truncate, slightly recessed relative to ventral margin of head (Fig. 16). Antenna cylindrical (as in Fig. 4), scape not reaching median ocellus, about 4× as long as wide; combined length of pedicel and flagellum about much greater than width of head; pedicel in lateral view 2× as long as broad, anellus quadrate tapering basally, ratio pedicel:anellus:F1 through F7:club as 7:3:4:5:5:5:5:6:3 (Fig. 29); anterior 3/4 of pronotum transversely aciculate, posterior 1/4 finely reticulate as in remainder of dorsal surface of scutum and scutellum; forewing (Fig. 27) relatively bare basally, costal cell in basal 1/4 and apical 1/3 with upper and lower setal rows, lower surface with additional scattered setae behind setal row, basal cell with several setae paralleling submarginal vein, basal vein with 1 or 2 setae, cubital vein entirely setose; frenum and frenal line absent. Mesosoma about 1.6× as long as wide, propodeum sloping at about 60 degree angle, smooth medially, this area interrupting anterior row of minute pits (Fig. 12); laterally with longitudinally oriented reticulation; propodeum narrowed medially, distance between inner margin of spiracles 3× median propodeal length (Fig. 12). Mesosoma evenly reticulate over dorsal surface. Metasoma finely, distinctly reticulate laterally and dorsally except Mt2 smooth, Mt2–Mt5 medially deeply emarginate [best seen on paratype specimens], ovipositor longer than body.

Male.—Length 1.5–2.5 mm. Differing from female only in having more metallic green color; ocellocular and ocelloccipital distances equal to lateral ocellus diameter; and epimeron about 0.7× as wide as high.

Variation.—Females vary in length from 1.8 to 2.5 mm. with the ovipositor from 2.1 to 2.3 mm. Females are uniform blue with some purple reflections. The males tend to be more green, however, some are nearly as blue as females.

Etymology.—This species is named for the association with its host plant, *Pseudotsuga menziesii.*

Type material.—Holotype ♀: Oregon, [Coos Co.], Two Mile Road west of Highway 101 south of Bandon, 23-IX-1998, C. Hobbs, B. Baugh and S. Brown coll., reared from cones of *Pseudotsuga menziesii*, emerged in lab 2-II-1999 (deposited in National Museum of Natural History, Washington DC). *Paratypes*: 73♀, 59♂ (in USNM unless otherwise noted): 2♀, 8♂, same data as holotype. USA: **California**: 6♀, 1♂, Santa Cruz Co., Bonnie Doon, 1/2 mi. ne 4600 Smith Grade Road, 23-IX-1998, B. Hobbs, C. Hobbs, K. Hobbs, reared from cones of *Pseudotsuga menziesii*, emerged 8-I to 2-II-1999; 3♀, 1♂, [Siskiyou Co.], Happy Camp, Klamath National Forest, 27-VII-[19]54, Hopkins No. 34018d, *Pseudotsuga taxifolia* (now = *menziesii*); 1♀, Siskiyou Co., Etna, XI-1957, T. W. Koerber, Hopkins No. 34097a, *Pseudotsuga menziesii*; 4♀, 1♂, [Humboldt Co.], Orleans, 12-26-VIII-[19]54, Hopkins No. 34091d, *Pseudo-*

tsuga taxifolia (now = *menziesii*); 13♀, 6♂, Humboldt Co., Orleans, T. W. Koerber, Hopkins No. 37500a, *Pseudotsuga menziesii*; 4♀, Trinity Co., Salyer, IX-1957, T. W. Koerber, Hopkins No. 37504a, *Pseudotsuga menziesii*. **Idaho**: 5♀, 6♂, Shoshone Co., 9 mi. nw Kellog, ex cones *P. menziesii*; 18♀, 14♂, Idaho Co., ca. 1.8 mi sse Graves Butte, US Hwy. 12, mi. marker 139. ex. cones *P. menziesii* (specimens deposited in Natural History Museum, London; Canadian National Collection, Ottawa); 7♀, 5♂, Boise Co., 1 mi. e Lowman, T9N, R&E, Sec. 35, 19-VIII-1972, R. W. Clausen, ex cones *P. menziesii*; 1♀, 1♂, McCall, [Valley Co.], 12-VIII-1971, J. Dale, Hopkins No. 14280f, ex Douglas-fir cones. **Oregon**: 1♀, 7♂, [Jackson Co.], Mistletoe, 25-VIII-[19]16, J. E. Patterson, *Pseudotsuga taxifolia* (now = *menziesii*). CANADA: **British Columbia**: 8♀, 9♂, southern Vancouver Island, VIII-1994, R. Bennetem. Spring 1995, ex cones *P. taxifolia* (now = *menziesii*).

Distribution.—This species is widely distributed from northern California to southern British Colombia.

Hosts.—This species has been reared from seeds and cones of *Pseudotsuga menziesii*. Douglas-fir is endemic to the western United States and Canada (GRIN 2000) and so far has only a single known cecidomyiid species (*Contarinia oregonensis* Foote) that feeds in the cone scales (Fig. 31). It is possible that a seed-feeding cecidomyiid could also be present, but none has been reported (Gagné 1989 and personal communication).

Discussion.—*Torymus pseudotsugae* is a member of the *bedeguaris* species group as defined by Grissell (1976) and Graham and Gijswijt (1998). Among western Nearctic *Torymus*, the species would run to *T. coloradensis* (Huber) in the key by Grissell (1976); in the Palearctic Region it would run to *T. hylesini* Graham in Graham and Gijswijt (1998) (neither of these species is associated with coniferous cones). It is distinguished from cone-associated species by the following set of characters: the scutellum has no frenal area, is evenly covered with reticulate sculpture and sparse setae, and has no frenal line; the metacoxa is not elongate but is parallel-sided, with a few long setae distally and many short, recurved setae along the angled dorsal margin where the outer face meets the dorsal surface; the propodeal spiracle is less than 3× its own greatest length from the posterior margin of the propodeum and about 1/2 to 1/3 the median propodeal length (Fig. 12). In males the funicular segements have 2 rows of appressed setae that do not obscure the multiporous plate sensilla (Fig. 15), and in both sexes there is a single row of bristles that project at nearly right angles (Fig. 15). In females the ovipositor is about 4× as long as the metatibial length. In both sexes the body varies from metallic green, blue, or purple, with combinations of blue-green to bluish purple.

Interestingly *Torymus pseudotsugae* has not, until now, been recognized even though Douglas-fir seeds are a valuable crop (Masters 2003) and have been the object of much study (Johnson and Hedlin 1967, Hedlin et al. 1980, Hermann and Lavender 1990, Ministry of Forestry 2003). According to Hermann and Lavender (1990) the most destructive insects include: the Douglas-fir seed chalcid (*Megastigmus spermotrophus* Wachtl) (Hymenoptera), the Douglas-fir cone moth (*Barbara colfaxiana* Kearfott) and the fir cone worm (*Dioryctria abietivorella* Grote) (Lepidoptera), and the Douglas-fir cone gall midge (*Contarinia oregonensis* Foote) and cone scale midge (*C. washingtonensis* Johnson) (Diptera). According to Hedlin et al. (1980) any of these insects may effectively destroy a cone crop in a given location; Masters (2003) reported that cecidomyiid cone gall midges can cause a reduction of up to 80% in seed production. There are at least 5 described species of Cecidomyiidae (Diptera) (Gagne 1989) on *Pseudotsuga*, and it is one or more of these species that is the likely host of *Torymus pseudo-*

tsugae. If *Torymus pseudotsugae* is parasitizing one or more of the cecidomyiids, as is most likely based on the other cone-infesting *Torymus* examined in our study, then its value as a biological control agent has been overlooked completely.

Torymus tsugae (Yano)

Figs. 5–7, 28

Callimome tsugae Yano [in Yano and Koyama] 1918a: 44–45; 1918b: 373.

This species was originally described from specimens reared from seeds of Japanese hemlock, *Tsuga sieboldii*. Yano did not give any other data for the types. Nothing has been published on *T. tsugae* since its description, and we have been unable to locate specimens of this species for comparison. Information about types was requested from Dr. Akihiko Shinohara, National Science Museum, Tokyo, and Dr. Tikahiko Naito, Kobe University, Kobe; both replied that Yano type material is not housed at these institutions. Kamijo (1962), writing of the type material of *Megastigmus cryptomeriae* Yano, *M. inamurae* Yano, and *M. thuyopsis* Yano, stated that it had been "destroyed by fire." Because *Torymus tsugae* was described in the same paper (Yano and Koyama 1918a) as these *Megastigmus*, it is likely that the types of this species were destroyed in the same fire. The following redescription is based on specimens reared from Japanese hemlock, the original host plant, which is native to Japan and Korea (GRIN 2000).

Female.—Body length 1.8–2.3 mm; ovipositor sheaths about 3.9× as long as metatibia. Dark blue with a violet or a greenish tinge in places. Scape testaceous, darker apically; pedicel and flagellum blackish. Legs testaceous: coxae and metafemur dark blue; pro- and mesofemora and metatibia medially darkened, usually with metallic reflections. Wings hyaline, with veins yellowish testaceous. Head in dorsal view (Fig. 5) about 1.9× as wide as long; frontal carina not strong. POL 2.2–2.27× OOL, OOL 0.95–1.2× OD. Head in front view (Fig. 6) rounded, 1.16–1.18× as wide as high. Eyes separated by 1.1× their height, with inner orbits subparallel. Malar space about one third height of eye; genae roundly converging towards mouth; in lateral view genal area about 0.3× eye width. Torulus about 1.5× own diameter above ventral eye margin. Clypeus with lower margin truncate or very shallowly emarginate. Both mandibles tridentate. Vertex and frons irregularly, densely reticulate, somewhat granulate, with sparse, rather distinct piliferous punctures. Face finely reticulate; setae on face short, with piliferous punctures indistinct. Antenna (Fig. 6): scape not reaching median ocellus, 3.4× as long as wide; pedicel plus flagellum about 1.3× width of head; pedicel 1.7–1.9× as long as wide, a little longer than F1; flagellum distinctly clavate; anellus slightly transverse to almost as long as wide; F1 quadrate to slightly longer than wide; F2 and F3 equal in length, a little longer than wide; F6 and F7 transverse; clava as long as F5–F7 combined, 2.0–2.25× as long as wide: C3 with a small tuft of micropilosity beneath (Fig. 7); sensilla disposed in 1 row on each funicle segment. Mesosoma nearly 1.7× as long as wide; in profile, propodeum sloping at about 60 degrees. Mid lobe of mesoscutum transversely reticulate, more or less imbricate in anterior half; setae moderately dense, with piliferous punctures shallow and indistinct. Scutellum 1.2× as long as wide, flat in longitudinal axis, reticulate, very densely so anteriorly; frenum indicated by very weak, almost smooth sculpture but frenal line absent; setae on scutellum about as in Fig. 3, with piliferous punctures distinct. Propodeum longitudinally, weakly sculptured, with a row of very small fovea along base. Lower mesepimeron small, 1.5× as high as wide. Metacoxa about 2.5× as long as wide, very weakly sculptured, dorsally with a carina and without setae in basal half; metafemur 4.4–4.7× as long as wide, with

sparse, elongate piliferous punctures; metatibia with longer spur as long as width of tibia, shorter spur longer than half of longer one. Forewing 2.5× as long as wide; costal cell on upper surface with a row of setae apically; basal cell bare, open below (Fig. 28); basal vein with a few setae; speculum moderately large, narrowly open below; relative lengths of marginal: postmarginal: stigmal veins = 31:7:3.1; ST petiolate. Metasoma a little longer than mesosoma, compressed; hypopygium reaching about 0.7 of gaster. Ovipositor sheaths slightly longer than body.

Male.—Differs from female as follows. Body length 1.6–2.1 mm. Antenna: scape about 2.4× as long as wide; pedicel plus flagellum about 1.4× width of head; pedicel 1.3× as long as wide, a little shorter than F1; anellus distinctly transverse; F1–F2 subquadrate; distal funicle segments weakly transverse; clava without visible tuft of micropilosity. Mesosoma slender, 1.8–1.9× as long as wide. Scutellum 1.3× as long as wide or more, with scattered setae all over scutellum except on frenal area. Metasoma usually shorter than mesosoma.

Specimens examined.—6♀, 6♂, Shiga-Kogen, Nagano Pref., Honshu, Japan, em. 10.iv.–4.v.1957, ex seeds of *Tsuga sieboldii*, K. Kamijo (5♀, 5♂, in Laboratory of Systematic Entomology, Hokkaido University; 1♀, 1♂, National Museum of Natural History, Washington, DC).

Distribution.—Japan (Honshu). The host tree is endemic to the Palearctic and is known only from Japan and South Korea (GRIN 2000).

Host.—Reared from seeds of *Tsuga sieboldii.*

Discussion.—This species would be placed in the *bedeguaris*-group by Grissell (1976) and Graham and Gijswijt (1998). *Torymus tsugae* is recognized in females by having a few setae on the frenal area (as in Fig. 3), the ovipositor sheaths less than about 4× as long as hindtibia (4.5 to 5.5× as long in *azureus*), the metacoxa about 2.5× as long as wide and not parallel-sided (about 3.5× as long and parallel-sided in *azureus*), and the absence of setae on the basal vein and along the posterior margin of the basal cell (Fig. 28). In males, there may be a few setae along the basal vein (as in male *T. azureus*), but the speculum is open posteriorly (i.e., there are no setae on the poximal part of the cubital vein, thus leaving a bare path from the speculum to the posterior wing margin (Fig. 28). Other species generally have setae in the area posteriad of the speculum (e.g., Figs. 26, 27). Both sexes of *T. tsugae* are metallic blue to violet with some green tinges.

HOST PLANT/*TORYMUS* LIST

(All species reared from coniferous cones. Insect hosts, when known, are Cecidomyiidae (Diptera) in cones or seeds.)

Chamaecyparis lawsoniana (A. Murray) Parlatore (Port Orford cedar)
- *Dasineura* sp.: *Torymus festivus* Hobbs
- *Janetiella siskiyou* Felt: *Torymus janetiellae* Graham and Gijswijt

Picea abies (L.) Karsten (Norway spruce)
- *Kaltenbachiola canadensis* (Felt): *Torymus caudatus* Boheman
- *Kaltenbachiola strobi* (Winnertz): *Torymus azureus* Boheman, *Torymus caudatus* Boheman
- *Plemeliella abietina* Seitner: *Torymus azureus* Boheman

Picea engelmannii Parry ex Engelmann (Engelmann spruce)
- unknown host in cones: *Torymus azureus* Boheman

Picea glehnii (F. Schmidt) Masters (Sakhalin spruce)
- cecidomyiid in seed: *Torymus azureus* Boheman, *Torymus ezomatsuanus* Kamijo

Picea jezoensis (Siebold and Zuccarini) Carriere (ezo spruce)
- cecidomyiid in seed: *Torymus ezomatsuanus* Kamijo

Picea sitchensis (Bongard) Carriere (Sitka spruce)

unknown host in cones: *Torymus hobbsi* Grissell

Pseudotsuga menziesii (Mirbel) Franco (Douglas-fir)

unknown host in seeds and cones: *Torymus pseudotsugae* Hobbs

Thuja plicata Donn ex D. Don (western red cedar)

Dasineura sp.: *Torymus festivus* Hobbs

Tsuga sieboldii Carriere (Japanese hemlock)

unknown host in seeds: *Torymus tsugae* (Yano)

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Behavioral Interactions Among Females of *Acamptopoeum submetallicum* (Spinola) and *Nolanomelissa toroi* Rozen (Hymenoptera: Andrenidae)

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Abstract.—We present the results of circle tube experiments performed upon a solitary panurgine bee *Acamptopoeum submetallicum* (Spinola) and the enigmatic *Nolanomelissa toroi* Rozen. As expected for a solitary species, females of *A. submetallicum* generally avoided one another. In contrast, *N. toroi* exhibited high levels of aggression, as generally found among bees with a reproductive division of labor. However, dissection and phenological data on *N. toroi* are incompatible with either eusocial or semisocial behaviors. Furthermore, no acts of cooperation were observed in the behavioral experiments suggesting that *N. toroi* is not communal. The extremely female biased sex ratio and low levels of mandibular wear among mated, reproductively active females in this species remain difficult to explain.

Social behavior in bees varies greatly, ranging from solitary with one female per nest to eusocial with up to tens of thousands of individuals per nest (Michener 1974). A solitary bee constructs her own nest and provides stored food for her offspring, while eusocial bees (sensu Michener 1974) have a reproductive division of labor, cooperative brood rearing, and more than a single generation of adults in their nests at some point in the colony cycle. Communal behavior is a separate type of social organization in which two or more females share a nest without a reproductive division of labor. To classify the behavior of bees formally, nest excavations at various times during the nesting cycle accompanied by dissections of bees are usually needed to examine the extent of their reproductive division of labor, if any (Bell and Hawkins 1974; Brothers and Michener 1974; Wcislo et al. 1993). However, such studies are time consuming and impossible to perform in cases where nests cannot be found (Packer et al. 2003). A technique that may have the ability to quickly discriminate and classify bee social behavior without the need for detailed and laborsome nest studies, is circle tube experiments. This experimental method, introduced by Breed et al. (1978), simulates nest tunnels using clear plastic tubing, where interactions among females can be observed. Circle tube arenas were originally used to study interactions among different castes of eusocial bees (Breed et al. 1978; Pabalan et al. 2000) and to compare behaviors of species with different social organizations (Kukuk 1992; Wcislo 1997). More recently it has been used to help predict the social organization of species whose behavior is not known (Packer 2000; Packer et al. 2003).

Interactions in the circle tube apparatus are initiated when two bees encounter one another head-to-head within one body length of each other, referred to as a frontal encounter (FE). Behavioral interactions in circle tubes can usually be classified as aggressive, cooperative, or avoidance. Aggressive interactions include one or both bees nudging, lunging or biting one an-

other. Cooperative interactions involve bees passing one another, by rotating their body in such a way that they pass venter-to-venter. Lastly, avoidance interactions involve one or both bees turning away from a FE. The relative frequency of these categories of interactions in a species seems to correspond to its social organization (McConnell-Garner and Kukuk 1997; Paxton et al. 1999; Packer et al. 2003). Intraspecific interactions among solitary bee species often result in avoidance interactions occurring at the highest frequency [e.g. *Lasioglossum figueresi* Wcislo (Wcislo 1997), *L. platycephalum* (Rayment), *L.* (*Ctenonomia*) sp. (McConnell-Garner and Kukuk 1997) and *Penapis toroi* Rozen (Packer unpublished)]. In contrast, intraspecific interactions among individuals of a communal species result in a high frequency of cooperative interactions [e.g. *Lasioglossum hemichalceum* (Cockerell) (McConnell-Garner and Kukuk 1997), *Ruizantheda mutabilis* (Spinola) (Packer unpublished) and *Panurgus calcaratus* Scopoli (Paxton et al. 1999)]. These observations intuitively agree with the behaviors expected from the above two social organizations: females in a communal nest must share the nest entrance, and thus a high level of cooperation is required, whereas solitary bees generally do not interact with other females in their nest tunnels, and thus may lack the behavioral repertoire needed for cooperation. Intraspecific interactions among individuals of eusocial bees are more complex, as different castes (queens, guards, and foragers) interact differently with each other. For example, forager-forager interactions often result in a higher frequency of cooperation, than guard—guard interactions [e.g. *Lasioglossum zephyrum* (Smith) (Breed et al. 1978)]. While queen—queen interactions often result in a high frequency of cooperative and aggressive interactions [e.g. *Halictus ligatus* Say (Pabalan et al. 2000)]. Similarly, queen-forager interactions may be cooperative, or aggressive presumably to assert dominance [e.g. *Halictus ligatus* (Pabalan et al. 2000) and *Lasioglossum zephyrum* (Breed et al. 1978)].

The behavioral repertoire of bees within the circle tube apparatus has been commonly reported for halictids (Breed et al. 1978; Smith and Weller 1989; Kukuk 1992; McConnell-Garner and Kukuk 1997; Wcislo 1997; Pabalan et al. 2000; Packer 2000; Packer et al. 2003), as they are the most behaviorally diverse bee family (reviewed by Packer 1997; Wcislo and Danforth 1997). In comparison, the behavioral repertoire of bees within the family Andrenidae, has been studied only once using these methods (Paxton et al. 1999). Although most andrenid species are solitary, some are communal (Paxton 1999; Michener 2000), while none are known to be semisocial or eusocial. Using the circle tube apparatus, social interactions between pairs of conspecific females of two communal andrenids, *Andrena scotica* Perkins and *Panurgus calcaratus* Scopoli were described by Paxton et al. (1999). *P. calcaratus* displayed highly cooperative behavior, while *A. scotica* displayed lower levels of cooperation but both displayed very low levels of aggression.

Nolanomelissa toroi Rozen, a recently described genus and species from the southern border of the Atacama Desert in Chile (Rozen 2003), has defied the attempts of several melittologists to find its nest in places where it is abundant. Furthermore, it has an extremely female biased sex ratio: only three males have been seen after extensive collecting, whereas hundreds of females have been observed. This study was conducted to examine if circle tube experiments could help establish whether *N. toroi* is a communal species, with perhaps few nest entrances per female and intranidal mating, thereby explaining the biased sex ratio. Communal behavior is well known in the subfamily Panurginae [e.g. *Macrotera texana* (Cresson) (Neff and Danforth 1992), *Perdita portalis* Timberlake (Danforth 1991), *Perdita*

opuntiae Cockerell (Custer 1928), *Panurgus calcaratus* (Scopoli) (Knerer 1980), *Panurginus albopilosus* Lucas (Rozen 1971) and *Melitturgula braunsi* Friese (Rozen 1968)], and also in halictids [e.g. *Lasioglossum hemichalceum* (= *L. erythrurum*) (Kukuk and Schwartz 1987; Kukuk and Crozier 1990) and some species of *Agapostemon* (Janjic and Packer 2003)]. On the assumption that *N. toroi* is communal, we hypothesize that its behavior in circle tubes should be consistent with this type of social organization: interacting females should show comparatively high levels of cooperation and little aggression. *Acamptopoeum submetallicum* (Spinola), a predominantly solitary andrenid (Rozen and Yanega 1999), was also studied for comparative purposes. *Acamptopoeum submetallicum* occurs in the same subfamily as *N. toroi*, the Panurgine (Ruz 1987), with the former belonging to tribe Calliopsini Robertson, and the latter belonging to the tribe Nolanomelissini Rozen and Ascher, which appears to be the sister group to all other Panurginae (Rozen 2003, Ascher in Rozen 2003). We expect avoidance, with little cooperation, to be the common mode of interaction between *A. submetallicum* females.

METHODS

Acamptopoeum submetallicum females were collected over a nesting aggregation near Parque National Fray Jorge, Region IV, Chile (S30°38'W71°36'), on Nov. 13, 2002, from 11:00 AM to 1:30 PM. *Nolanomelissa toroi* females were collected as they visited the flowers of *Nolana rostrata* (Lindley), located approximately 9 km north of Vallenar, Region III, Chile (S28°31'W70°44'), on Nov. 17, 2002, between 11:00 AM and 1:00 PM.

Circle tube experiments were conducted on collected pairs of females of *A. submetallicum* and *N. toroi*, within 5 minutes of their capture. In an outdoor shaded area, bees were placed in 20 cm long clear plastic tubes (internal diameter 5mm) joined end-to-end to form a circle such that bees are forced to repeatedly interact with one another (Breed et al. 1978). The bees were unmarked, as marking has been shown to influence behavior (Packer submitted). The behaviors of two pairs of bees were simultaneously recorded for 15 minutes, following their introduction into the tubes. All trials were recorded using a digital camera (Sony DCR-TRV25) and interactions were scored from the resulting video. After each trial the tubes were discarded and new ones were used for the next set of trials, preventing possible pheromone contamination among pairs of bees (Smith and Weller 1989). The paired bees were then preserved in Kahle's solution for dissection. A total of 10 trials were conducted for each species. A behavioral interaction was only recorded for those interactions that followed a FE. Interactions were classified as avoidance, if one or both bees turned or backed away from a FE, cooperative if the bees passed each other or aggressive if one or both bees nudged, lunged, bit, or fought one another. Fights involved continued contact for several seconds, and in some instances, several minutes, during which a series of aggressive interactions occurred successively. Every FE ended either in a pass or avoidance interaction. In instances where a FE was followed by an aggressive interaction, and ended in a pass, both interactions were scored separately. However, if the aggressive interaction was ended by one or both bees backing away, only the aggressive interaction was scored. The proportion of the three categories of behavioral interactions was calculated as the frequency of that behavior divided by the total number of FEs during a circle tube trial.

Bees preserved in Kahle's solution were dissected using a dissection microscope (at 64 x magnification) to compare ovarian development among females, and determine whether or not they had mated. Ovarian development was established by scoring each of the six ovarioles as a fraction of a fully developed oocyte (a fully

Table 1. Frequency of occurrence of different behavioral interactions in *Acamptopoeum submetallicum* and *Nolanomelissa toroi*.

Species	Behavior	Pair									
		1	2	3	4	5	6	7	8	9	10
A. submetallicum	Aggressive	1	1	2	2	1	2	1	0.0	0.0	1
	Avoidance	5	4	12	11	13	4	12	6	0.0	3
	Cooperative	0.0	0.0	1	0.0	0.0	1	0.0	0.0	0.0	0.0
% of total	Aggressive	16.7	20.0	13.3	15.4	7.1	28.6	7.7	0.0	0.0	25.0
	Avoidance	83.3	80.0	80.0	84.6	92.9	57.1	92.3	100.0	0.0	75.0
	Cooperative	0.0	0.0	6.7	0.0	0.0	14.3	0.0	0.0	0.0	0.0
N. toroi	Aggressive	4	2	22	1	14	2	17	13	22	21
	Avoidance	4	1	15	0.0	11	6	8	9	11	8
	Cooperative	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% of total	Aggressive	50.0	66.7	59.5	100.0	56.0	25.0	68.0	59.1	66.7	72.4
	Avoidance	50.0	33.3	40.5	0.0	44.0	75.0	32.0	40.9	33.3	27.6
	Cooperative	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

developed oocyte was scored 1), following standard methods. Each female's spermatheca was examined to determine whether they contained spermatozoa. The spermatheca of a mated female appears opaque, while in unmated females it is clear and glass-like (Packer 2000).

The head width of each female was measured as an estimator of body size (at 40 x magnification). Wing wear was measured by counting the number of nicks in the margin of one forewing, as an estimator of combined age and activity, following Ordway (1965). Bees with the entire margin abraded were given a score of 20. Mandibular wear, also an estimator of combined age and activity, was measured (at 16 x magnification) by giving a score from 0 to 10: 0 for unworn mandibles, to 10 for mandibles worn to short stumps (Ordway 1965). While it is more normal in studies of halictine bees for mandibular wear to be scored only from 0 to 5, the abrasion of mandibles close to their bases, as found here, has not been reported for these bees, hence the expanded scale.

Significant differences in circle tube behavior between *A. submetallicum* and *N. toroi* were detected using the Mann-Whitney U test with a sequential Bonferroni adjustment, used for correcting multiplicity in statistical tests (Rice 1989). Differences in mean ovarian development, mandibular wear, and wing wear between the two species were examined using the Wilcoxon test. To assess if physiological differences (ovarian development) or morphological differences (size and wear) in interacting bees affect their behavior in the circle tube trials, we correlated the absolute difference in the measured parameters between the two bees participating in a trial versus the proportion of aggressive and avoidance interactions per trial for each species, using the Spearman rank correlation test.

Finally, circle tubes are usually conducted on ground nesting bees, and it is not yet certain as to whether the social organization of non-ground nesting bees could also be predicted using this same apparatus. As *N. toroi* nests have never been found, we assume it nests in the ground similar to all known species of Andrenidae (Michener 2000).

RESULTS

Acamptopoeum submetallicum.—Frontal encounters were observed at least once in 9 of the 10 trials with *A. submetallicum*. Th

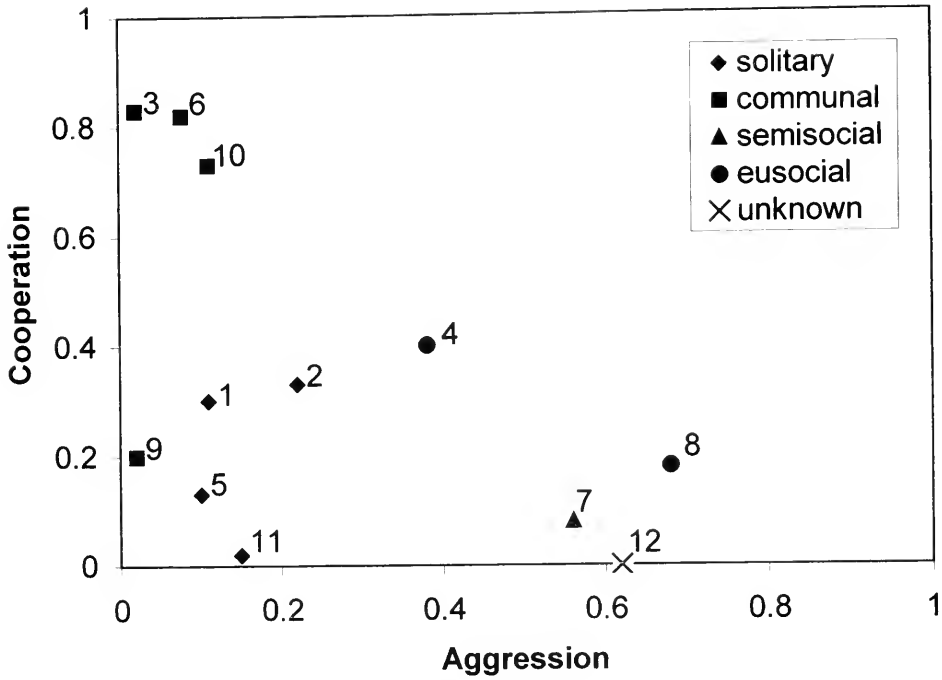

Fig. 1. Plot of the average proportion of cooperation versus aggressive interactions, grouped by social organization for the following species: 1. *Lasioglossum platycephalum*, 2. *L. (Ctenonomia) sp.*, 3. *L. hemichalceum*, 4. *L. pauxillum* (Smith and Weller 1989), 5. *Penapis toroi*, 6. *Ruizantheda mutabilis* (Spinola), 7. *Corynura chloris* (Spinola) (Packer unpublished), 8. *Halictus lanei* (Moure) (Packer et al. 2003), 9. *A. scotica*, 10. *P. calcaratus* (Paxton et al. 1999), 11. *A. submetallicum*, and 12. *N. toroi* (This study).

trial without a FE was excluded from further analysis. In total, 83 FEs were recorded in 9 trials, with an average of 9.22 FEs per trial (SD = 4.01). Females would often stay in a FE for prolonged periods of time before an interaction was observed, ranging from several seconds to well over a minute and then either lunge, bite, or back away from the opponent. The duration of FEs was quite variable, ranging from a second to over 3 minutes, in which case a series of bites and a mandibular hold, where the mandibles of both bees are clasped together in what appears to be a prolonged bite, were observed. A sum- of the occurrence of aggressive, co- and avoidance interactions be- *ubmetallicum* females is present- 1. Most of their interactions (83%) (Fig. 1), usually in- volving only one female backing out of a frontal encounter. 15% of all behavioral interactions were aggressive, during which bites, lunges, nudges or fights were observed. Only 2% of the interactions were cooperative passes (Fig. 1).

Mean ovarian development was 2.18 (SD = 0.60, n = 16), and all females (n = 16) were mated (Table 2). 15 of the 16 females contained at least one fully developed oocyte within an ovariole, and the remaining female contained developing oocytes. The mean head width for *A. submetallicum* females was 3.37mm (SD = 0.14, n = 16). Wing wear was highly variable: 8 females with ≤ 2 nicks on the forewing margin, 6 with a score of 20 (wherein the margin of the wing was heavily eroded, and nearly half the wing was worn off) and the remaining two each with 5 nicks.

Table 2. Dissection and body measurement averages for *A. submetallicum* (n = 16), and *N. toroi* (n = 20) females. Note: OD = ovarian development, MW = mandibular wear, WW = wing wear, HW = head width and WL = wing length.

Bee species	OD	Mated	MW	WW	HW (mm)	WL (mm)
A. submetallicum	2.18 ± 0.59	all mated	3.09 ± 3.27	8.5 ± 9.32	3.37 ± 0.14	7.17 ± 0.33
N. toroi	1.22 ± 0.46	all mated	0.3 ± 0.66	0.25 ± 0.64	3.03 ± 0.17	7.16 ± 0.36

Similarly, mandible wear was also highly variable, with 9 females with a score ≤ 1, 4 with a score of 5 (wherein half the mandible was abraded), and 2 with a score of 10 (the mandible worn to a short stump). Differences in all the measured physiological/morphological parameters between interactants in a circle tube were not significantly correlated with the relative proportions of aggressive or avoidance interactions (Spearman rank correlation, $p \geq 0.129$ for all tests). Note that two bees from separate trials escaped during transferring attempts into Kahle's solution, and thus, could not be dissected and measured.

Nolanomelissa toroi.—Frontal encounters for *N. toroi* were frequent, occurring 193 times in 10 trials, with an average of 19.3 FEs per trial (SD = 13.0). FEs would quickly result in a bee either backing away from or acting aggressively towards its opponent. Most females were very active, consistently moving throughout the circle tube arena. A summary of the proportion of behavioral interactions between pairs of *N. toroi* females is presented in Table 1. All of the interactions were either aggressive (62%) or avoidance (38%) (Fig.1). Aggressive interactions included lunging, biting or fighting. In five instances, prolonged periods of fighting occurred, ranging from 1 to 3 minutes, during which a series of bites were observed.

Of the 20 females used in circle tube trials, 14 contained at least one fully developed oocyte within an ovariole, and 6 contained developing oocytes (Table 2). The mean ovarian development was 1.22 (SD = 0.46, n = 20), and all females were mated. The mean head width for *N. toroi* females was 3.03mm (SD = 0.17, n = 20). In contrast to *A. submetallicum*, wing wear measurements showed that the majority of bees were unworn, with 17 females with 0 nicks on the forewing margin, and 3 with 1–2 nicks on the forewing margin. Likewise, mandibular wear measurements revealed that 16 females had unworn mandibles, and 4 had their mandibles slightly worn. Similar to *A. submetallicum*, differences in all the measured physiological/morphological parameters in *N. toroi* females were not significantly correlated with aggression or avoidance interactions in the circle tube (Spearman rank correlation, $p \geq 0.201$, for all tests).

Interspecific comparisons.—*Nolanomelissa toroi* females interacted in the circle tube more often than *A. submetallicum*. On average, *N. toroi* females had twice the number of frontal encounters as *A. submetallicum* females ($t = -2.164$, $df = 17$, $p = 0.045$). The circle tube behavior of *N. toroi* was significantly more aggressive than that of *A. submetallicum* when using the Mann-Whitney U test and the sequential Bonferroni adjustment ($Z = -3.056$, $df = 8$, $p = 0.002$). However, the frequency of avoidance ($Z = -0.287$, $df = 8$, $p = 0.774$) and cooperative interactions ($Z = -1.534$, $df = 8$, $p = 0.125$) did not differ significantly between the two. *Acamptopoeum submetallicum* females participating in the circle tube experiments had significantly higher levels of ovarian development (Wilcoxon signed-rank test, $s = 433$, $z = 4.356$, $p < 0.0001$), mandibular wear (Wilcoxon signed-rank test, $s = 411$, $z = 3.935$,

$p < 0.0001$), and wing wear (Wilcoxon signed-rank test, s = 403, z = 3.802, $p = 0.0001$).

DISCUSSION

The interactions of *A. submetallicum* females in the circle tube arena agree with evidence of solitary nesting; more than 80% of frontal encounters were classified as avoidance, and very little aggression or cooperation was observed (Fig. 1). Also it seemed that *A. submetallicum* females avoided initiating interactions in the circle tube as supported by the comparatively low number of frontal encounters per trial (avg. 9 FEs in 15 min.). On the other hand, *N. toroi* interacted more frequently in the circle tube (avg. 19 FEs in 15 min.), with ~60% of all interactions being aggressive, and ~40% avoidance (Fig. 1). Morphological comparisons, with regard to wing and mandibular wear revealed that females of *N. toroi* were younger, or at least had been much less active in flight and nest excavation than those of *A. submetallicum*. This might suggest that bees are more aggressive early in the nesting cycle. However, no significant relationship was found between the frequency of aggressive behavior and relative age in either species [Spearman rank correlation: $p \geq 0.129$ (*A. submetallicum*) and $p \geq 0.201$ (*N. toroi*) for all tests].

Due to the difficulties associated with finding nests and the highly female biased sex ratio throughout its activity period, we had hypothesized that *N. toroi* might be a communal species. However, the majority of interactions among females of this species were aggressive, with not one instance of cooperative behavior observed. Such high levels of aggression are more suggestive of a reproductive division of labor. However, this species is active at most once a year (only in years in which there has been adequate winter rainfall) precluding a standard eusocial colony cy- with spring gy and summer work- As all females were mated and almost all had developed ovaries it seems unlikely that it is a semisocial species either.

The following is a list of the facts pertinent to the biology of *N. toroi*. 1) It appears to have an extremely female biased sex ratio, with approximately 100 females being found on flowers for every male encountered. 2) Its nests are unusually difficult to locate. 3) All females found on flowers are mated and have at least some ovarian development. 4) Considering that females foraging for pollen with developed oocytes are expected to have already excavated a nest, this species exhibits surprisingly little mandibular wear. 5) It exhibits high levels of aggressive behavior in the circle tube apparatus. 6) It is active only in spring in years in which there has been sufficient winter rainfall.

What can we conclude regarding the social biology of *N. toroi*? First, based on evidence from circle tube experiments, *N. toroi* does not exhibit a communal organization—this species clusters on the opposite behavioral spectrum to known communal andrenids and halictids (Fig. 1). Second, the presence of developed ovaries accompanied by a short activity period suggests that *N. toroi* does not have a complex social organization despite the high levels of aggression observed. It is worthwhile to note that *N. toroi* females exhibit a peculiar pygidial plate and modified hind basitibial plates (Rozen 2003), structures that are usually consistent in ground nesting bees (Rozen personal communication). This fact, accompanied by the extremely female biased sex ratio in combination with low mandibular wear and difficulty in finding nests are suggestive of perhaps an unusual choice of nest site and/or an unusual mating system.

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Report on a Collection of Bethylidae (Hymenoptera) from Central Florida, USA, with Description of a New Species of *Lepidosternopsis* Ogloblin

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Abstract.—Sixty species of Bethylidae of the genera *Acrepyris* Kieffer, *Allobethylus* Kieffer, *Apenesia* Westwood, *Anisepyris* Kieffer, *Bakeriella* Kieffer, *Cephalonomia* Westwood, *Dissomphalus* Ashmead, *Epyris* Westwood, *Goniozus* Förster, *Holepyris* Kieffer, *Laelius* Ashmead, *Lepidosternopsis* Ogloblin, *Plastanoxus* Kieffer, *Prorops* Waterston, *Prosierola* Kieffer, *Pseudisobrachium* Kieffer, *Rhabdepyris* Kieffer, and *Sclerodermus* Latreille were collected, primarily in Malaise traps, at 12 sites in Orange Co., 3 in Seminole Co., one in Osceola Co. and one in Volusia Co., Florida, USA. *Lepidosternopsis* is recorded for the first time from the Nearctic Region and ***Lepidosternopsis irradiata* Lanes and Azevedo, sp. nov.**, is described and illustrated. The male of *Lepidosternopsis* is described for the first time. Taxonomic comments for some species are included.

There are about 2,000 species of Bethylidae worldwide, 204 of which are recorded from the Nearctic Region. The few species whose biologies have been investigated are idiobiont, or incipient koinobiont, ectoparasitoids (Finnamore and Gauld 1995). They parasitize larvae of Coleoptera or Lepidoptera that live in cryptic situations. Most Bethylinae parasitize microlepidopterans, whereas most Pristocerinae and Epyrinae attack beetles, especially those inhabiting wood or seeds (Evans 1964).

In the United States, Florida possibly has the richest bethylid fauna. Beginning in 1990, biologists at the University of Central Florida surveyed the arthropod fauna of the campus (Evans and Fullerton 1997) and other adjacent sites. Evans and Fullerton (1997) studied an assemblage of 52 species of Bethylidae, based on approximately 3,000 specimens from Central Florida. We have studied an equally large second assemblage of Bethylidae in order to better understand the fauna of this state.

Our goal was to survey the Bethylidae of Florida, to establish range extensions and to analyze the taxonomic variation of the studied species. The specimens we studied represent 60 species, 18 of which are different from the 52 recognized by Evans and Fullerton (1997). Five genera: *Allobethylus* Kieffer, *Cephalonomia* Westwod, *Lepidosternopsis* Ogloblin, *Plastanoxus* Kieffer, and *Prorops* Waterston were not observed by Evans and Fullerton (1997). Some species occurred in remarkable numbers, for example 739 males of *Pseudisobrachium flaviventre* (Kieffer). *Lepidosternopsis* is recorded for the first time from the Nearctic Region based on a new species, which we describe in this paper.

TERMINOLOGY

Terminology generally follows Evans (1964). The nomenclature of integument sculpture follows Harris (1979). The terminology of wing cells and veins follows Gauld and Bolton (1988). Abbreviations used for the description of the new species are: DAO, diameter of anterior ocellus,

measured in frontal view; HE, height of eye, measured in lateral view, across its maximum height; LFW, length of fore wing; LH, length of head, measured in frontal view, from the vertex crest to the median apical margin of the clypeus; OOL, ocello-ocular line, measured in latero-dorsal view, the shortest distance from the eye top to the posterior ocellus; VOL, vertex-ocular line, measured in lateral view, the distance from the eye top to vertex crest; WF, width of frons, measured in frontal view, its minimum width; WH, width of head, measured in frontal view, its maximum width including the eyes; WOT, width of the ocellar triangle, measured in frontal view, the maximum width, including the ocelli.

COLLECTION SITES

The material examined is deposited at the Entomological Collection of the University of Central Florida, Orlando (Stuart M. Fullerton). It was collected using Malaise traps, pit fall traps, UV light traps, and sweeping between 1997 and 2000 in 18 sites in Central Florida in Orange, Seminole, Osceola, Sarasota and Volusia Counties. The collection sites are referred to by number in the list that follows.

1. Seminole Co., Econ Wilderness Area. Scrub Oak/Saw Palmetto (burned).
2. Seminole Co., Econ Wilderness Area. Scrub Oak/Saw Palmetto (unburned).
3. Seminole Co., Oviedo.
4. Orange Co., LK Tibet- Butler Preserve/Scrubby Flatwoods.
5. Orange Co., Orlando, Tibet Preserve Myrtle Oak Scrub.
6. Orange Co., Walt Disney World. C- 4 Stout Site S15, 16 T24S R27E. Xeric Oak/Flatwoods.
7. Orange Co., Walt Disney Wolrd. MW-5 (unburned) S16 T24S R27E. Sand Pine/Oak Scrub.
8. Orange Co., Walt Disney World. MW-7 (unburned) S22 T24E. Sand Pine/Oak Scrub.
9. Orange Co., Orlando. UCF, Mackay Tract, Swgrass Marh. Red Maple.
10. Orange Co., Orlando. UCF, Cypress Forest.
11. Orange Co., Orlando. UCF, Long Leat Pine Sand Pine Turkey Oak.
12. Orange Co., Orlando. UCF, Long Leat Pine Saw Palmetto.
13. Orange Co., Orlando. UCF, Maidencane Marsh.
14. Orange Co., Orlando. UCF, Pond Pine Comm. Dahoon Holly.
15. Orange Co., Orlando. UCF, Sand Pine Rosemary Scrub.
16. Osceola Co. Walt Disney World. World Drive/US 192 S01 T25S R27E. Sand Pine/Rosemary Scrub.
17. Sarasota Co., MCC-Venice Campus. Long Leaf Pine-Saw Palmetto.
18. Volusia Co., Daytona Beach. Urban-Beachside, Halifax-River.

LIST OF SPECIES

Eight species of Bethylidae are recorded for the first time from Florida. These are indicated with an asterisk (*). Listing of genera follows Evans (1978), with species of each genus listed alphabetically.

Subfamily Bethylinae

Goniozus columbianus Ashmead. 56♀, 1♂. Sites 1, 6, 9, 10, 11, 13, 14.

* *Goniozus complanatus* Evans. 3♀. Site 15.

Goniozus electus Fouts. 2♀. Site 13.

Goniozus flavipes Fouts. 20♂. Sites 1, 2, 6, 9, 16.

Goniozus floridanus (Ashmead). 5♀. Sites 9, 10, 11.

Goniozus fratellus Evans. 1♂. Site 13.

Goniozus gracilicornis (Kieffer). 2♂. Site 11.

Goniozus hortorum Brues. 130♀, 2♂. Sites 2, 6, 9, 10, 11, 13, 14, 15, 16.

Goniozus hubbardi Howard. 16♀, 2♂. Sites 9, 13, 14, 18.

Goniozus nigrifemur Ashmead. 98♀, 6♂. Sites 1, 2, 6, 8, 9, 10, 11, 13, 14, 16.

Prosierola bicarinata (Brues). 3♀. Sites 1, 4.

Subfamily Epyrinae

Allobethylus floridanus Evans. 7♀. Sites 9, 11.

Anisepyris analis (Cresson). 100♀, 39♂. Sites 1, 2, 6, 8, 9, 10, 11, 12, 14.

Anisepyris columbianus (Ashmead). 34♀, 26♂. Sites 6, 8, 9, 10, 11, 12, 14.
Anisepyris grandis (Ashmead). 25♀, 211♂. Sites 4, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16.
Anisepyris subviolaceus Kieffer. 15♀. Sites 6, 8, 10, 11.
Bakeriella mira Evans. 6♂. Sites 9, 11.
Cephalonomia hyalinipensis Ashmead. 20♀, 2♂. Sites 1, 9, 10, 11, 14.
Cephalonomia perpusilla Evans. 11♂. Sites 9, 11, 14.
* *Cephalonomia quadiceps* Evans. 1♀. Site 6.
* *Cephalonomia conophthori* Evans. 2♀. Site 9.
Epyris californicus (Ashmead). 19♂. Sites 9, 11, 14, 16.
* *Epyris corticinus* Evans. 19♀. Sites 9, 10, 11.
Epyris deficiens Krombein. 6♀, 77♂. Sites 9, 10, 11, 12, 14.
Epyris festivus Evans. 27♀, 10♂. Sites 9, 11, 12.
Epyris oriplanus Kieffer. 1♂. Site 6.
Epyris rufipes (Say). 18♀, 35♂. Sites 1, 11, 12, 14.
Epyris spissus Evans. 42♀, 33♂. Sites 6, 8, 9, 10, 11, 13, 14, 16.
Epyris tricostatus Evans. 7♀. Sites 9, 11.
* *Holepyris catalinae* Evans. 2♀. Sites 10, 11.
Holepyris floridanus (Ashmead). 12♀, 9♂. Sites 9, 10, 11, 12, 14, 17.
Holepyris graminis Evans. 28♂. Sites 2, 6, 10, 11, 12, 14, 16.
Holepyris habilis Evans. 7♀. Sites 9, 10, 14.
Holepyris lautus Evans. 1♀, 62♂. Sites 2, 6, 9, 10, 11, 12, 14, 15, 16.
Holepyris micidus Evans. 12♀. Sites 2, 9, 10, 11, 14, 15.
Holepyris subtilis Evans. 19♂. Sites 6, 10, 11, 12, 14.
Laelius centratus (Say). 13♀, 1♂. Site 7, 9, 10, 11, 13, 14.
Lepidosternopsis irradiata Lanes and Azevedo sp. nov. 3♂, 4♀. Site 9, 10, 11, 13, 14.
* *Plastanoxus laevis* (Ashmead). 1♂. Site 1.
* *Prorops absoleta* Evans. 2♂. Sites 9, 14.
* *Prorops nasuta* Evans. 6♀, 3♂. Sites 9, 10, 11.
Rhabdepyris amabilis Fouts. 55♂. Sites 6, 10, 11, 14, 16.
Rhabdepyris caroliniana Evans. 12♂, 2♀. Sites 8, 9, 11, 14, 15.
Rhabdepyris muesebecki Evans. 5♀, 80♂. Sites 9, 10, 11, 14.
Scleroderma macrogaster Ashmead. 24♀. Sites 3, 9, 11, 13, 14.

Subfamily Pristocerinae

Acrepyris armifera (Say). 2♀, 35♂. Sites 8, 9, 10, 11, 12, 14.
Acrepyris atra Klug. 3♂. Sites 1, 2, 11.
Acrepyris bridwelli Evans. 17♂. Sites 8, 11, 12, 14.
Acrepyris fraterna Evans. 2♀, 45♂. Sites 8, 9, 10, 11, 12, 14.
Apenesia parapolita Evans. 5♀, 130♂. Sites 6, 8, 9, 10, 11, 12, 14, 16.
Dissomphalus apertus Kieffer. 311♂. Sites 8, 9, 10, 11, 14.
Dissomphalus barberi Evans. 10♂. Sites 9, 11, 14.
Dissomphalus evansi Azevedo. 34♂. Sites 6, 8, 9, 10, 11, 12, 13, 14, 16.
Dissomphalus kansanus Evans. 2♂. Sites 6, 10, 11.
Dissomphalus krombeini Azevedo. 3♂. Sites 11, 14.
Pseudisobrachium arenarium Evans. 75♂. Sites 2, 5, 6, 7, 8, 11, 12, 14, 16.
Pseudisobrachium ashmeadi Evans. 10♂. Sites 11, 12, 16.
Pseudisobrachium carolinianum Evans. 77♂. Sites 6, 7, 16.
Pseudisobrachium flaviventre (Kieffer). 739♂. Sites 4, 6, 7, 8, 9, 11, 12, 14, 16.
Pseudisobrachium rufiventre (Ashmead). 25♂. Sites 1, 6, 7, 8, 11, 12, 14, 16.

NOTES ON INDIVIDUAL SPECIES

Some individuals of species in the new series from Florida presented previously unknown variation. In these cases, we comment upon them below in order to help better understand morphological variation within the species.

Acrepyris armifera (Say): males may have eyes with minute setae.

Anisepyris analis (Cresson): antennal segments III+IV can be 3.0X as long as thick.

Anisepyris columbianus (Ashmead): this species is similar to *A. williamsi* Evans in the color of legs and sculpture of the females, but the lower fovea of the mesopleuron of the former species is divided by a conspicuous septum, whereas in *A. williamsi* the lower fovea is not divided. Males of *A. columbianus* and *A. williamsi* have this septum top-flatted.

Anisepyris grandis (Ashmead): the septum of the lower fovea of the mesopleuron varies from narrow to thick in the females. The frons also varies in width. Males can have the head with green or

blue reflections, and some with reddish legs.

Cephalonomia conophthori Evans: the propodeal disc is 1.25X as long as wide.

Cephalonomia hyalinipennis Ashmead: some females are light castaneous and the head varies in length, some have the head longer or with side parallel behind the eyes.

Cephalonomia quadriceps Evans: this species was known from 3 males from Massachusetts, Maryland and North Carolina, USA.

Epyris corticinus Evans: this species was known from Virginia, Maryland and Pennsylvania, USA. In this series, some females have small scutellar pits.

Epyris deficiens Krombein: males can have poorly defined longitudinal striae.

Epyris rufipes (Say): some females can have the propodeal disc evenly striate and the median transverse vein not strongly oblique.

Goniozus columbianus Ashmead: males can have the head weakly coriaceous.

Goniozus complanatus Evans: this species was known only from Texas, USA.

Goniozus hortorum Brues: female heads vary in length, punctures size, frons texture, clypeus length, sculpture, and height of median carina of clypeus. Males can have the cubital vein 2.5X as long as wide.

Goniozus hubbardi Howard: the third antennal segment can be 1.5X as long as thick.

Goniozus nigrifemur Ashmead: females can have the antennae as short as in *G. emigratus*. Males can have the antennae reaching the vertex crest, the third antennal segment as long as thick, or the posterior carina of the propodeal disc well-indicated.

Holepyris catalinae Evans: this species was known only from Arizona, USA.

Holepyris graminis Evans: males can have the posterior groove of the pronotal disc weakly developed.

Laelius centratus (Say): females can have legs light castaneous.

Plastanoxus laevis (Ashmead): this widespread species is recorded for the first time from Florida.

Prorops obsoleta Evans: this species was known only from 2 males and 1 female from Trinidad.

Prorops nasuta (Say): in the Nearctic Region this species was known only from 1 male from California.

Pseudisobrachium arenarium Evans: the width of the male frons ranges from 1.30 to 1.40× height of eye and propodeal disc from 1.60 to 1.70× as long as wide.

Pseudisobrachium ashmeadi Evans: length of propodeal disc in the males can be shorter than in the type series, 1.26× as long as wide.

Pseudisobrachium flaviventre (Kieffer): in males the head varies from dark castaneous to black, the antennae from light to dark castaneous, the diameter of the anterior ocellus varies from 0.17 to 0.23× the width of the frons, and the mesopleuron with callus ill defined.

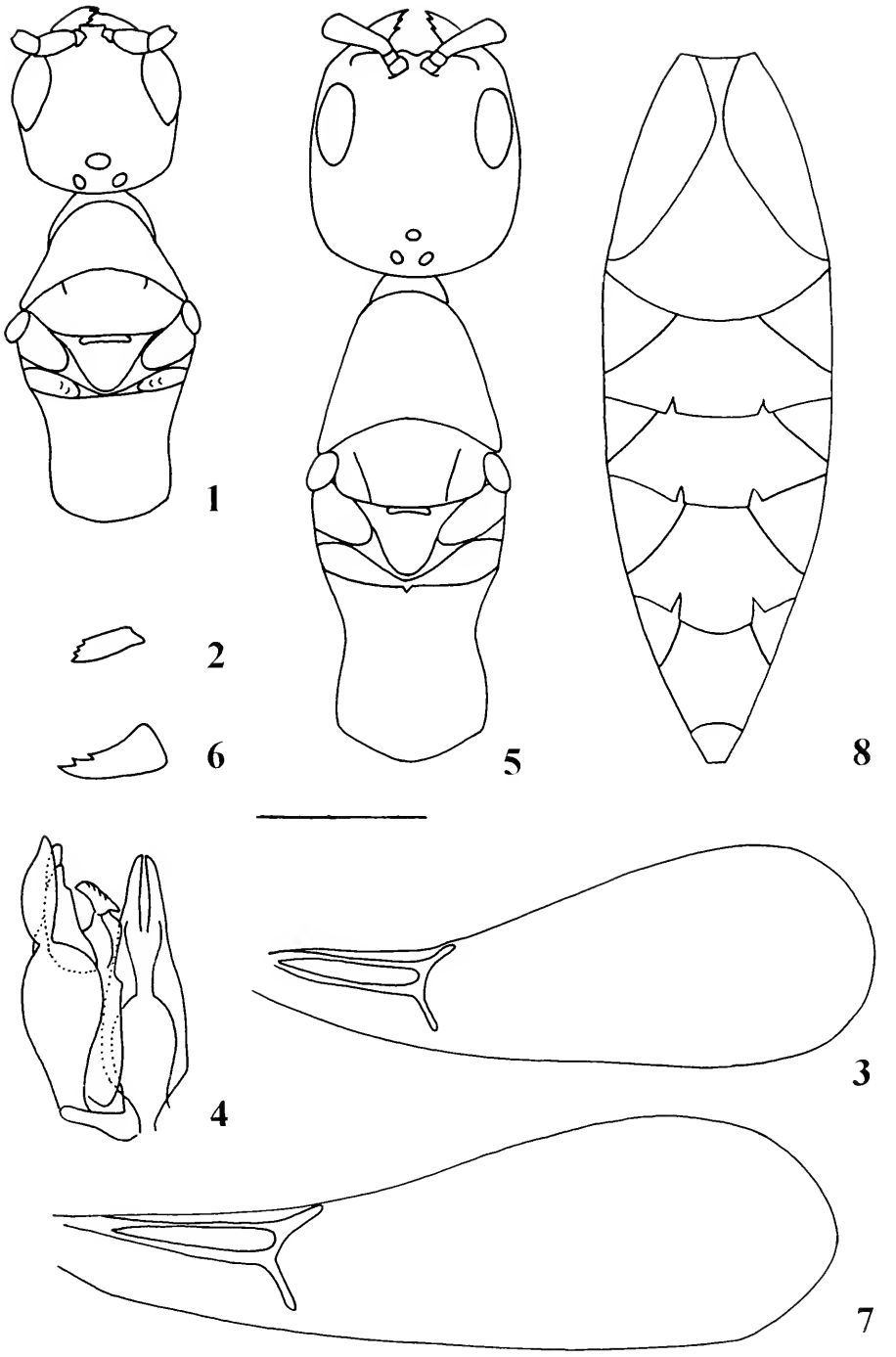
Psedisobrachium rufiventre (Ashmead): this species is very similar to *P. flaviventre*, differing by having the discoidal vein slightly conspicuous, the antennae with segments slightly longer and propodeal disc slightly longer. Males can have the mesopleuron with callus well defined.

Scleroderma macrogaster Ashmead: the pattern of body coloration shows a large range of variation, but with the metasoma constantly dark castaneous. The head can be dark castaneous, distinctly darker than the thorax; the thorax can be distinctly darker at the mesoscutum and mesopleuron, and the head and thorax can be evenly light castaneous.

Lepidosternopsis irradiata Lanes and Azevedo, sp. nov.

Figs. 1–8

Male holotype.—Body length 2.4 mm; LFW 1.6 mm. Color: Dark castaneous; an-



Figs. 1–8. *Lepidosternopsis irradiata* sp. nov. 1–4, Male. 5–8, Female. 1, Head and mesosoma, dorsal. 2, Mandible, frontal. 3, Forewing, dorsal. 4, Genitalia, ventral. 5. Head and mesosoma, dorsal. 6, Mandible, frontal. 7, Forewing, dorsal. 8, Metasoma, ventral. (Scale bars = 0.32 mm).

tenna, mandible, legs and palpi castaneous; wings hyaline, veins castaneous. Head (Fig. 1): Mandible with 4 apical teeth, the lower one relatively bigger and sharper (Fig. 2). Clypeus with truncate median lobe, with median carina concave in profile. First four antennal segments in ratio of 12:6:3:4; segment III 0.8× as long as thick; segment XI 1.6× as long as thick; antennal sockets closed to each other, separated by 0.3× their diameter. Eye with sparse, short setae. Frons weakly coriaceous, shinning, with small, very sparse punctures, with shallow and small groove between the antennal sockets. LH 1.08× WH; WF 0.58× WH; WF 1.12× HE; OOL 0.85× WOT; DAO 0.41× WOT; frontal angle of ocellar triangle acute; posterior ocellus distant from the vertex crest 0.5× DAO. Vertex slightly convex with corner somewhat angled. VOL 0.85× HE. Head not flattened, its thickness 0.62× LH. Mesosoma (Fig. 1): Thorax slightly coriaceous. Pronotal disc 1.25× as long as mesoscutum, with transverse carinae very weak. Notauli very weak, occupying anterior third of the mesoscutum; parapsidal furrow absent; scutellar groove slender. Propodeal disc 1.12× as wide as long, weakly coriaceous, shinning; without median and posterior carinae, with lateral carinae, lateral margins straight; declivity without median carina; propodeal spiracle totally directed outward. Mesopleuron weakly coriaceous, with wide, shallow foveae occupying nearly all surface, with a small central pit. Fore wing (Fig. 3) with veins Sc+R, Rs+M, M+Cu and 1Cu–a, forming only one closed cell (median). Fore femur 2.1× as long as wide. Median tibia not spinose. Claws simple. Metasoma: posterior margin of sternites IV-VI biemarginated. Hypopygium with posterior margin narrow and concave. Genitalia (Fig. 4): Paramere completely divided in two arms, ventral arm wide, with apex somewhat truncate in ventral half, dorsal margin convex, ventral margin straight, dorsal arm shorter than ventral, slender, with apex rounded; volsella with cuspis laminar, very wide, slightly shorter than paramere, ventral margin excavate in apical half; aedeagus bottle-shaped, progressively slender apically, apex emarginated, basal margin rounded.

Female.—Body length 2.8 mm; LFW 1.9 mm. Similar to male except: Color: Head and thorax castaneous, except the pronotum light castaneous and propodeum yellowish anteriorly; metasoma dark castaneous; antennae and palpi light castaneous; mandibles and legs castaneous; wings hyaline, vein light castaneous. Head (Fig. 5): Mandible with 3 apical teeth, the higher very shorter than lowers (Fig. 6). Clypeus very short, concave median lobe, with median carina weakly high and concave in profile. First four antennal segments in a ration of 25:8:4:4; segment III as long as thick; segment XI 0.7× longer than thick; antennal sockets close to each other, separated by 0.6× their diameter. Front very weakly coriaceous, shinning. Head globoid, 0.58× as high as long, LH 1.15× WH; WF 0.37× WH; WF 1.30× HE; OOL 2.06× WOT; DAO 0.3× WOT; posterior ocelli distant from the vertex 1.4× DAO. Vertex slightly convex, with corner somewhat angled. Temples slightly converging anteriorly. VOL 1.20× HE. Mesosoma (Fig. 5): Thorax coriaceous. Pronotal disc 1.72× longer than mesoscutum; notauli very weak and inconspicuous; parapsidal furrow, incomplete anteriorly, occupying more than half of the mesoscutum. Propodeal disc as long as wide, coriaceous, lateral margins concave anteriorly. Mesopleuron slightly coriaceous, with large and shallow fovea occupying surface, with small central pit. Fore wing as for male (Fig. 7). Fore femur 1.94× as long as wide. Metasoma: 1.73× as long as the mesosoma. Posterior margin of sternites IV-VI biemarginated (Fig. 8).

Type material.—Holotype ♂, USA, **Florida**: Orange Co., Orlando, University Central Florida, Cypress Forest, 2.VI.1999, Malaise trap, P. Russell and S. Fullerton

col. (deposited in Entomological Collection, University of Central Florida, Orlando). Allotype ♀, USA, **Florida**: Orange Co., Orlando, University Central Florida, MacKay Tract, Sawgrass Marsh, Red Maple, 14.VI.1999, Malaise trap, P. Russell and S. Fullerton col. Paratypes, USA, **Florida**: Orange Co., Orlando, University Central Florida: 1♂, Sawgrass Marsh, Red Maple, 13.IX.1999, Malaise trap, P. Russell and S. Fullerton col.; 1♂ and 1♀, LLP-Sand Pine, Turkey Oak, 7.XI.1997 and 2.VII.1997, Malaise trap, P. Russell and S. Fullerton col.; 1♀, Pond, Pine Comm., Dahoon Holly, 11.V.1999, Malaise trap P. Russell and S. Fullerton col.; 1♀, Maidencane Marsh, 17.V.1999, Malaise trap, P. Russell and S. Fullerton col.

Etymology.—The name refers to the absence of the radial vein in the fore wings.

Discussion.—The description of the genus *Lepidosternopsis* was based on an apterous female of *L. kuscheliana* Olgloblin, 1953, from Masatierra Island (Chile). Evans (1964) described two species based on micropterous females from Australia. Azevedo (1999) described the first macropterous species of *Lepidosternopsis*, based on two females from Pará, Brazil. Now we described the male of this genus for the first time. *L. irradiata* differs from all the known species of the genus, because it is macropterous with fore wings having only the median cell closed and radial vein absent.

ACKNOWLEDGMENTS

We thank S. Fullerton for the loan of the material and the duplicates retained.

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A Revision of *Agathirsia* Westwood (Hymenoptera: Braconidae: Agathidinae) With Notes on Mouthpart Morphology

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Abstract.—A cladistic analysis of *Agathirsia* Westwood is performed and synapomorphies are proposed for the first time for members of *Agathirsia*, i.e., reduction of the ventral mandibular tooth, and apicomedial pegs of the hind tibia flattened, and for members of its sister-group *Crassomicrodus* Ashmead, i.e., apicomedial pegs of the hind tibia sharp and seta-like, and tarsal claws simple, without basal lobes. Members of *Agathirsia* are restricted to the arid regions of Mexico and the southwestern USA. Keys are provided to identify the genera of Agathidini and the species of *Agathirsia*. The mouthparts of *Agathirsia* are described and three main types of nectar extraction mechanisms are discussed, i.e., 1) sponge-like glossa that retracts within the galeae, 2) straw-like glossa that does not retract, and 3) labial palpi that form a drinking tube. The genus *Agathirsia* is revised to include 31 species, 23 of which are newly described, i.e., ***A. armandi, A. asterophila, A. bicolor, A. bifidilingua, A. campanisura, A. capillata, A. collini, A. davidi, A. foveiseries, A. heleni, A. kellyi, A. keni, A. jervisi, A. longigladia, A. longilingua, A. michelei, A. minuata, A. ninesevensi, A. papoui, A. parkeningi, A. reai, A. rostrata,*** **and** ***A. tiro. Agathirsia rufiventris*** **Westwood** is considered a **junior synonym** of *A. proxima* **Westwood.** The monotypic genus ***Cenostomus*** is synonomized with ***Agathrisia. Cenostomus trichiosomus*** **(Cameron)** is transferred to ***Agathirsia,*** and ***Crassomicrodus pumilus*** **(Szepligeti)** is transferred to ***Bassus*** **Fabricius.**

Agathirsia Westwood is a member of the Agathidinae, which is a well-established monophyletic group within the Braconidae (Sharkey 1992). Three autapomorphies for the subfamily are the presence of specialized male tergal glands on metasomal segments 7 and 8 (Buckingham and Sharkey 1988), a wing fold between the prestigma and the medial vein of the forewing, and a narrow marginal cell (Sharkey 1992). Agathidinae is a cosmopolitan subfamily composed of 52 genera (Sharkey 1997) and members are found in most terrestrial habitats.

Here we describe and key all known species of *Agathirsia*, members of which are restricted to the arid regions of Mexico and the southwestern USA. We also present a key to distinguish *Agathirsia* and *Crassomicrodus* from other agathidines with which they may be confused. A cladistic analysis is performed with the aims of testing the monophyly of *Crassomicrodus* and *Agathirsia*, revealing the relationships among species of *Agathirsia*, and uncovering the evolution of morphological characters such as those of the mouthparts. Previous to this study eight species of *Agathirsia* were described but the single revision of the genus (Muesebeck 1927) reviewed only species found north of Mexico. Neither Muesebeck's key to North American agathidine genera, nor Sharkey's (1997) key to the New World genera adequately distinguish between our concepts of *Crassomicrodus* and *Agathirsia* because they rely on the shape of the mouthparts—a variable character in both genera.

All known species of Agathidinae are solitary koinobiont endoparasitoids of larval Lepidoptera (Sharkey 1992) except for one gregarious species recently discovered by D. Janzen (unpublished). The few members of the Microdini and Agathidini with known biologies all attack the first instar larval stage of their lepidopteran hosts, and although *Agathirsia* is a putative member of the Agathidini we are not sure if its members share this characteristic. Many species of *Agathirsia* and *Crassomicrodus* have very short ovipositors. Within the Agathidinae this character state is found almost exclusively in the Disophrini, all members of which possess the state. There are few observations of members of Disophrini ovipositing but these few indicate that they attack late instars of their hosts. We suspect that the same is true for members of *Agathirsia* and *Crassomicrodus*, at least those with short ovipositors.

Little is known of the natural history of members of *Agathirsia*. We speculate that most or all species are diurnal based on their coloration and the absence of any label data to indicate otherwise. Members of *Agathirsia* appear to be restricted to the arid regions of Mexico and the southwestern USA and most species are collected from August through November, which is typically the end of a relatively wet period and the beginning of a dry period over most of the range. Many species have elongate mouthparts and since most desert flowers produce nectar in daylight hours, this is further evidence to suggest that they are diurnal.

Most members of *Agathirsia* appear to have mimetic coloration. E. G. Linsley noted the following behavior on a specimen tag of *A. nigricauda:* "while feeding [the] wasp spreads [its] wings and flashes abdominal and wing colors with each partial rotation". This behavior is similar to that of some stinging wasps and we speculate that it is likely a case of Batesian mimicry since members of *Agathirsia* have no obvious defense mechanisms. Many species of *Agathirsia* are partly or entirely orange, a common color for stinging Hymenoptera in the area. Other species of *Agathirsia* are entirely black with long, dense setae and may mimic bees.

The standard mandibular morphology for most species of Agathidinae is illustrated in figure 1a. These mandibles are rather gracile, flattened and designed to cut through silk, i.e., their own and/or that of their host Lepidoptera. In contrast, the mandibles of species of *Agathirsia* are cylindrical and much more robust (Figs. 1b,c). Due to their similarity to the mandibles of aculeate Hymenoptera that nest underground, we speculate that the shape may be a modification that facilitates digging. We suggest that species of *Agathirsia* are attacking larval Lepidoptera that are spending the daylight hours in the soil and/or that pupate in the soil. There is only one host record for *Agathirsia*; Bibby (1961) cites the larva of *Acontia cretata* (Noctuidae) as a host of *Agathirsia*, and the natural history of this host is consistent with our hypothesis. This same mandibular morphology, and perhaps the same biology, is present in members of *Crassomicrodus* as their mandibles are even more robust (Fig. 1d). Many species of *Agathirsia* have the apex of the hind tibia flared, much like bell-bottom pants. The flared region is highly sclerotized and we speculate that this may also be a modification for digging. Relative to most Agathidinae, which have rather large, cylindrical pegs on the hind tibia apico-laterally (Fig. 2a); those of members of *Agathirsia* are small and flat (Figs. 2b, c). The functional value of the flattened pegs is unknown but they may aid in soil excavation.

METHODS

Morphological terminology follows Sharkey and Wharton (1997). Glossa and galea lengths were measured from the bases of their respective palpomeres (see Fig. 4b).

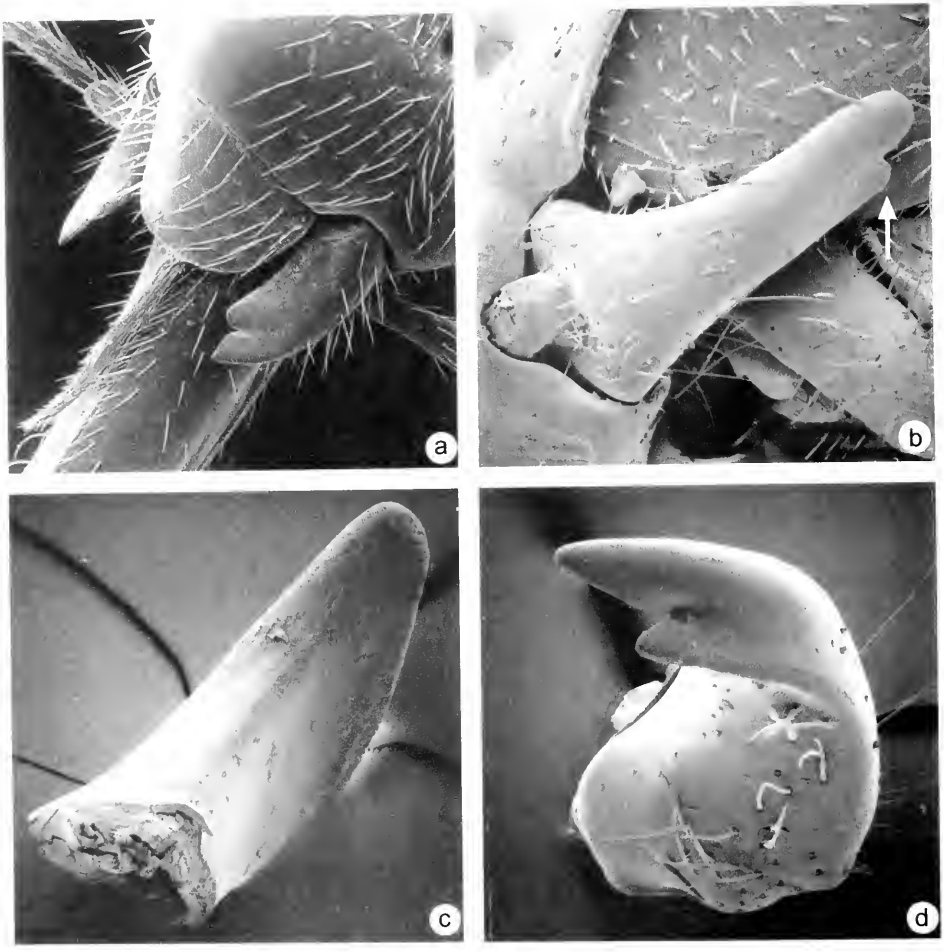
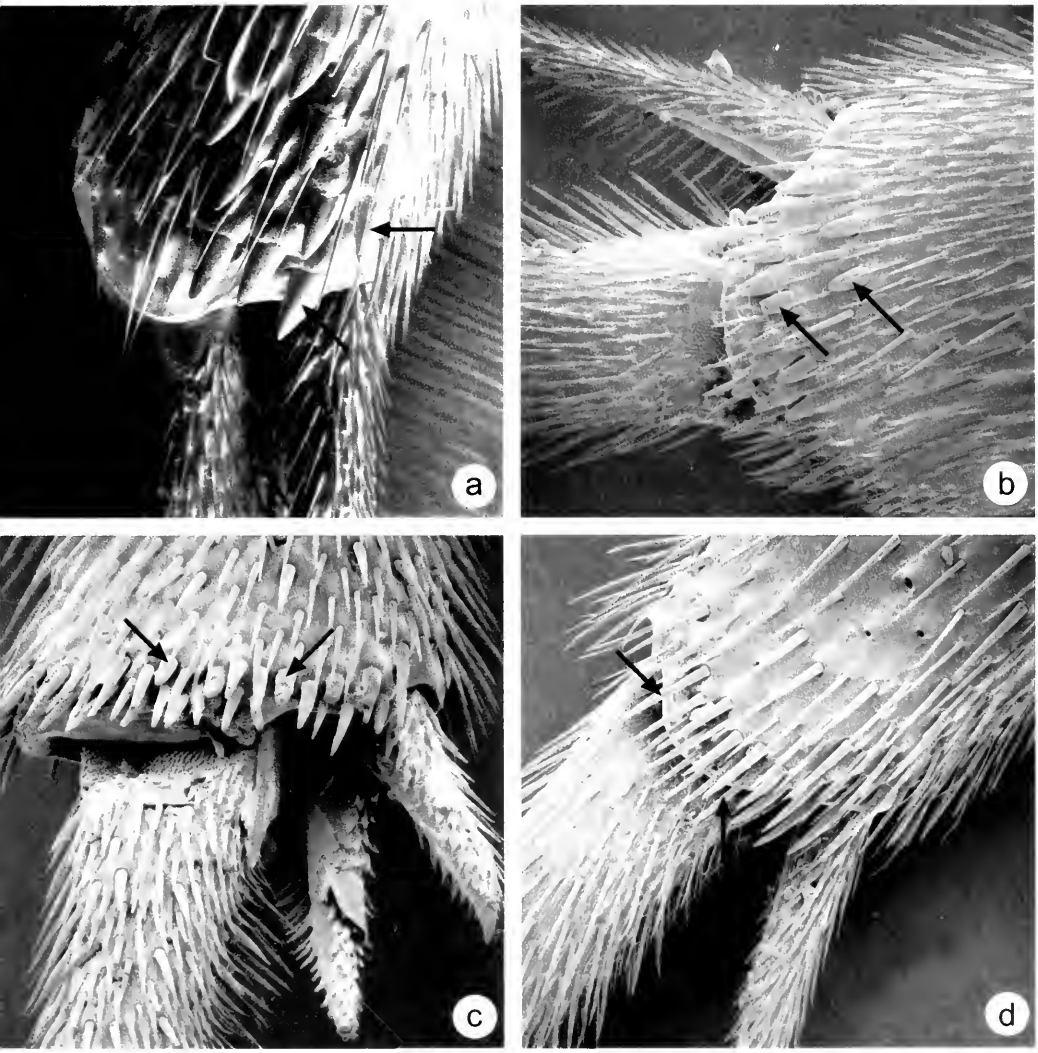


Fig. 1. Mandibles of Agathidini: a, *Agathis* sp., showing ground plan mandibles for the Agathidinae that are twisted and function like scissors to cut through silk. b, *Agathirsia testacea*, showing maximum size of ventral tooth in the genus. c, *Agathirsia nigricauda*, showing typical mandible for *Agathirsia*, robust, cylindrical, and lacking ventral tooth. d, *Crassomicrodus divisus*, showing typical shape of a mandible for *Crassomicrodus*.

The keys are designed for all known species. Although ovipositor characteristics are included, both males and females can be used. The percentages (%) indicated in the keys represent the frequency with which the user can expect to observe the character state given a specimen that should key to that side of the couplet. We weighted the common species to arrive at these figures.

The key to *Agathirsia* was produced by editing a key generated using DELTA (Dallwitz et al. 1993). The species descriptions of *Agathirsia* include total observed variation for both sexes. All measurements are in millimeters. Occasionally the glossae of short-tongued *Agathirsia* may be partly to completely folded lengthwise along the midline. The glossae of these specimens often measure 15 to 30% shorter than conspecifics because they are partly retracted. Measurements of these have not been included in the descriptions except where noted. The number of hind tibial pegs is a character that is often difficult to observe; high magnification with diffused lighting is essential.

The holotypes of all described species of



ig. 2. Hind tibial pegs: a, *Bassus ussuriensis*, showing typical cylindrical pegs of the Agathidinae. b, *Agathirsia igricauda*, showing flattened pegs. c, *Agathirsia collini*, showing flattened pegs. d, *Crassomicrodus divisus*, showng hair-like spines.

Agathirsia were examined. If a reliably determined species of *Crassomicrodus* was not present in the original assemblage of material the holotype was examined to ensure it was not a misplaced species of *Agathirsia*.

Depositories.—The following are the contributing museums. Acronyms are from Arnett et al. (1993) except for ATAM which is not included in their list: American Entomological Institute, Gainesville, Florida (AEIC); American Museum of Natural History, New York, New York (AMNH); Academy of Natural Sciences, Philadelphia, Pennsylvania (ANSP); Universidad Autonoma de Tamaulipas, Ciudad Victoria, Tamaulipas, Mexico (ATAM); British Museum of Natural History, London, England (BMNH); California Academy of Sciences, San Francisco, California (CASC); Canadian National Collection of Insects, Ottawa, Ontario

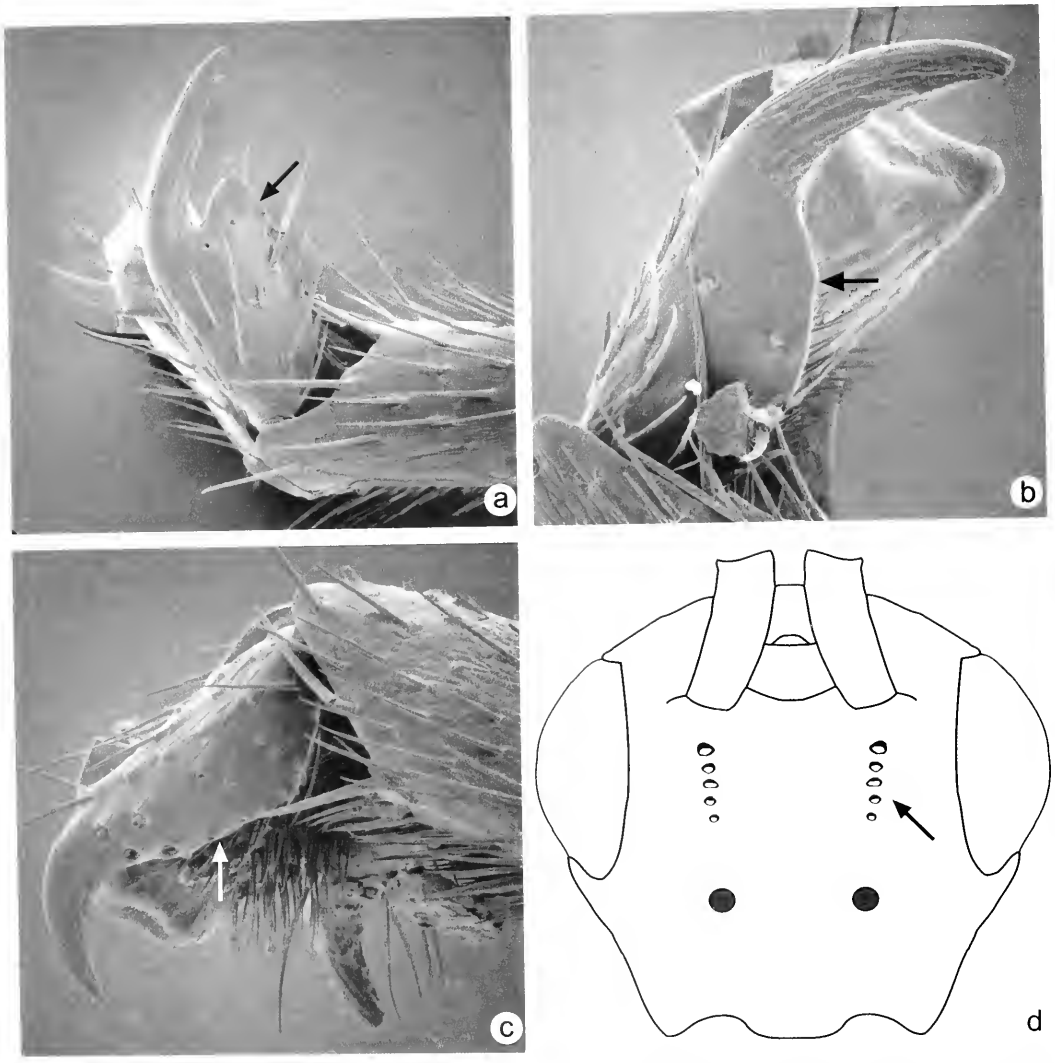


Fig. 3. Claws: a, *Agathirsia trichiosoma*, showing well developed basal lobe. b, *Agathirsia bicolor*, with basal lobe vestigial. c, *Crassomicrodus divisus*, with basal lobe absent. d, Head of *Agathirsia rostrata*, showing foveae below antennal insertions.

(CNCI); Deutshes Entomologisches Institut, Eberswalde, Germany (DEIC); Essig Museum of Entomology, University of California Berkley, California (EMEC); Los Angeles County Museum, Los Angeles, California (LACM); Michigan State University, Department of Entomology Collection, East Lansing, Michigan (MSUC); Oregon State University, Department of Entomology Collection, Corvallis, Oregon (OSUO); Oxford University Hope Entomological Collections, Oxford, England (OXUM); Snow Entomological Museum, University of Kansas, Lawrence, Kansas (SEMC); Texas A&M University, Department of Entomology Insect Collection, College Station, Texas (TAMU); University of Arkansas, Department of Entomology Collection, Fayetteville, Arkansas (UADE); Bohart Museum, University of California Davis, California (UCDC); University of Michigan, Division of Insects,

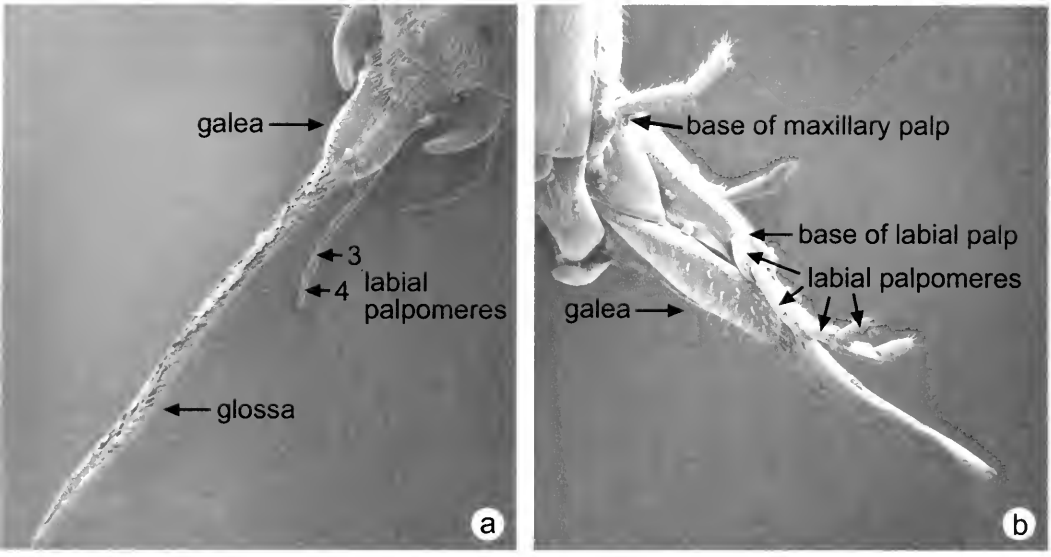


Fig. 4. Mouthparts: a, *Agathirsia proxima*, illustrating Type II mouthparts with the glossa adapted for straw-like sucking. b, *A. nigricauda*, illustrating Type I mouthparts in which the glossa is folded and enclosed by the galea in the drinking process.

Museum of Zoology, Ann Arbor, Michigan (UMMZ); United States National Museum of Natural History, Washington, D.C. (USNM).

MOUTHPART MORPHOLOGY

A recurring adaptation of parasitoid wasps is the presence of elongate mouthparts to facilitate nectar extraction from deep corollas (Jervis 1998). This is especially apparent in the Braconidae and Aculeata. In Braconidae, elongate mouthparts are present in members of five of the 29 subfamilies (Jervis 1998). Elongate glossae are common in *Agathirsia* but there is a great deal of interspecific variation. Jervis (1998) categorized the nectar feeding of parasitoid wasps into six types and placed species of *Agathirsia* into three of these. His Type I consists of "Elongated glossa and galea, glossa shallowly bilobed/forked and concealed by the galea for most of its length in dried specimens". *Agathirsia nigricauda* (Viereck) and *A. cressoni* Muesebeck & Walkley are cited as examples. Another category (Jervis' Type IV) is described as "Elongated glossa, galea and labial palps; glossa exposed for much of its length in dried specimens; labial palps closely aligned with glossa and assisting in nectar extraction/conduction". *Agathirsia* sp.1 (probably *A. longilingua* Pucci and Sharkey n.sp.) was given as an example of this category. Jervis also assigned a, then undescribed, species of *Agathirsia* (= *A. jervisi*) to his Type VI which consists of wasps with "Elongated glossa and labial palps; inner surfaces of labial palps concave" and covered with long and dense setae.

We recognize the same three types of nectar extraction mechanisms in *Agathirsia*. Species with Jervis' Type I mouthparts have glossae that vary in length from approximately 0.25 to 1.8 mm. The glossae are covered with dense setae that apparently are specialized for liquid uptake. The morphology of these setae is variable. Figure 8a shows the spoon-like setae of *A. testacea* (glossa length = 0.48 mm) and figure 8b shows the scale-like setae of *A. nigricauda* (glossa length = 1.4 mm). After

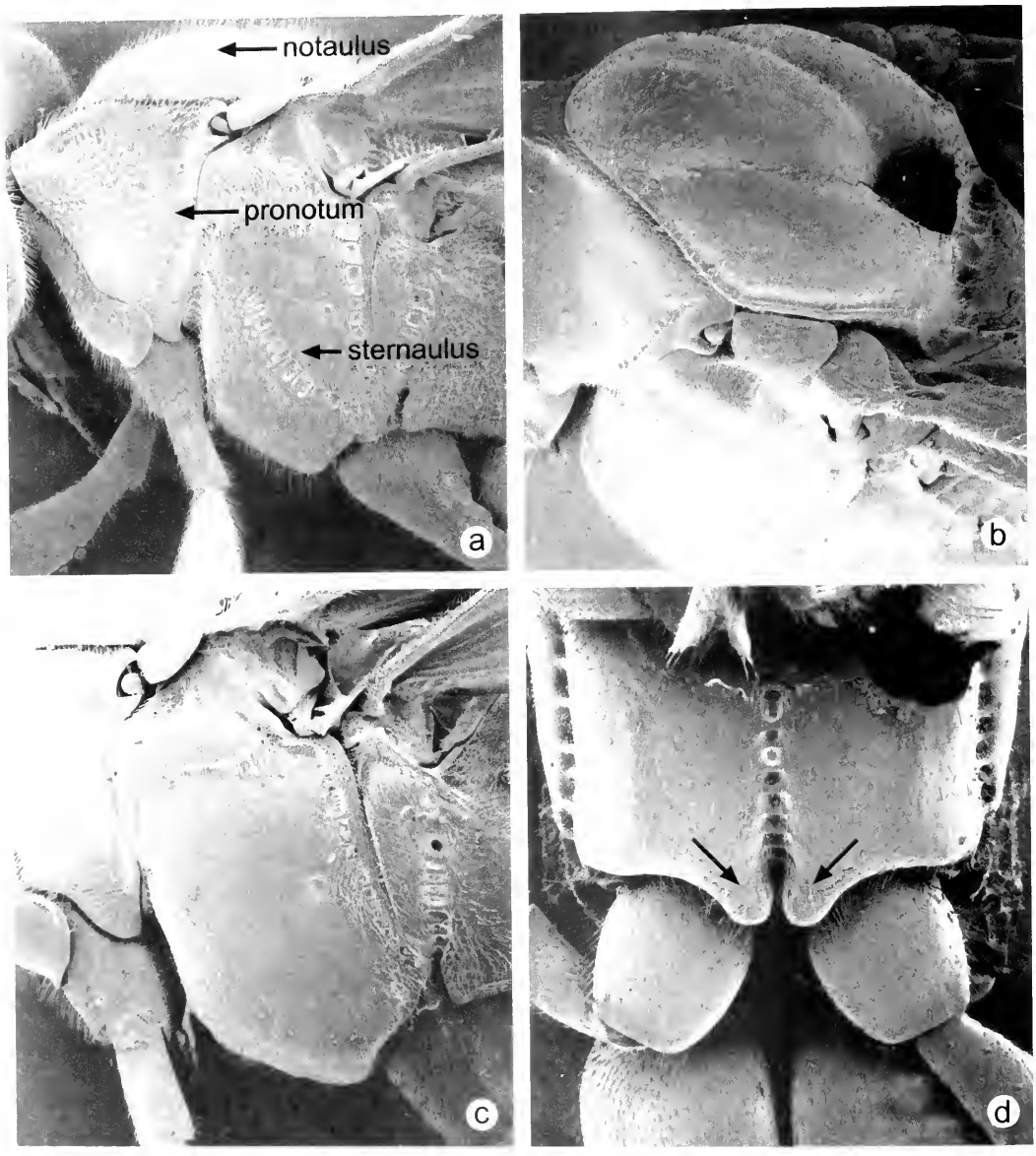


Fig. 5. *Agathirsia* spp., thoracic sculpture: a, *A. davidi*, showing foveate (crenulate) notaulus and sternaulus. b, c, *A. proxima*, showing smoothly impressed notauli and mostly absent sternaulus. d, *A. testacea*, showing posterior lobes of mesopleura.

the glossa is loaded with liquid we suppose it is retracted into the galea. Dried specimens, in which the glossa are partly retracted, show that the glossa folds posteriorly along its midlength as it is retracted. This results in the posterior surfaces of half of the glossa being pushed ner which would squeeze liquid towards the mouth opening. The galea likely acts as a template forcing the two halves of the glossa together as they are retracted. As with all other drinking types, the cibarial and pharyngeal pumps provide the negative pressure necessary to suck the liquid into the oral cavity.

Jervis' Type IV mouthparts are manifest

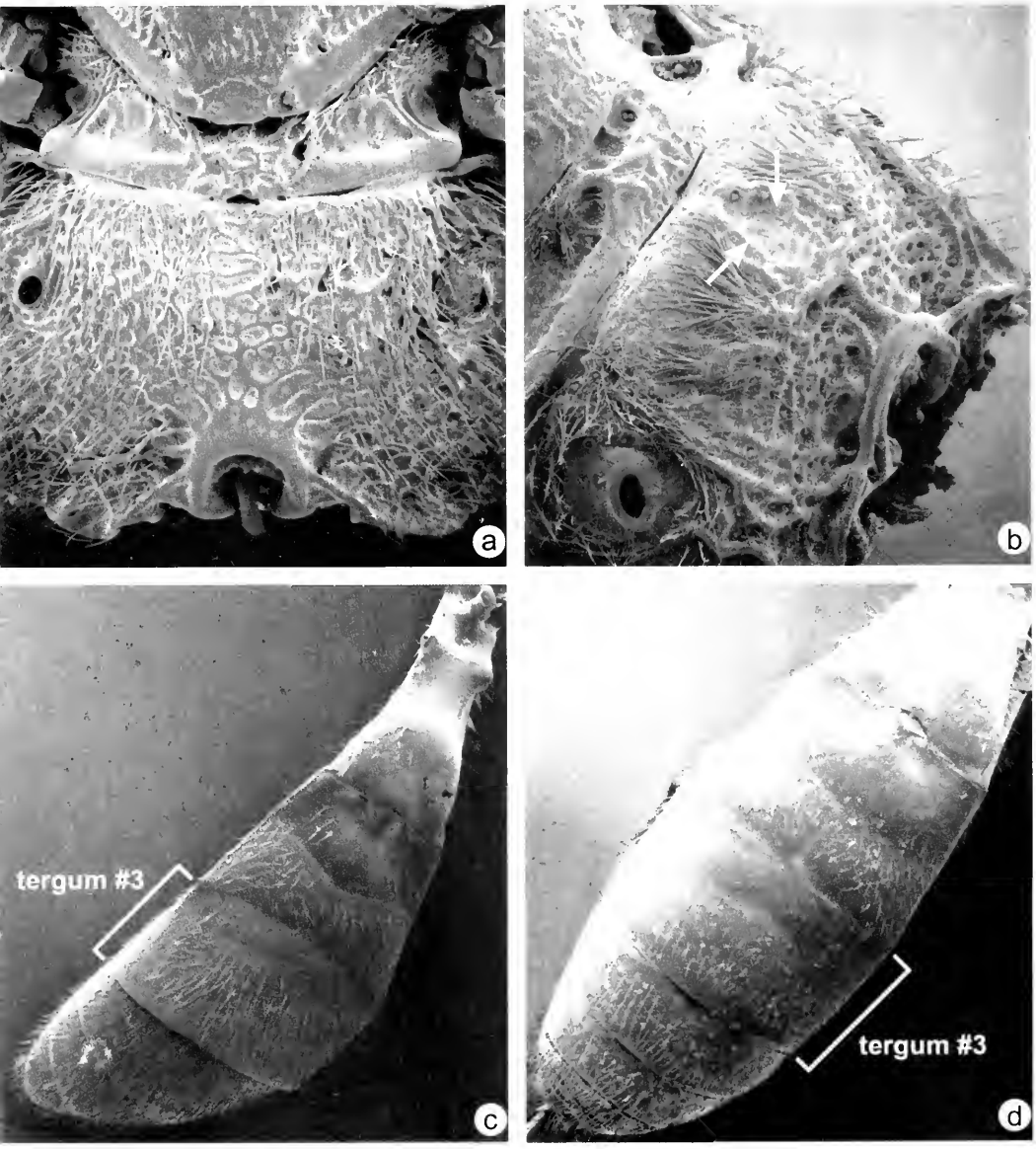


Fig. 6. *Agathirsia* spp. a, b, Propodea. a, *A. davidi*. b, *A. cressoni*. c, d, Abdominal terga. c, *A. trichosoma*. d, *A. davidi*

in specimens in which the galea is significantly shorter than the long, exposed glossa (Fig. 4a). All of these species possess glossae that are more than 2 mm in length. Because it seems apparent that the glossa cannot fold or otherwise be contained within the galeae, nectar must travel from the apex to the base of the glossa itself. The glossa is strongly curved posteriorly along most of its length, thereby forming a tube. The outer surface of the tubular glossa is covered by scale-like setae (Fig. 8d). The presence of setae on outer surface of the glossal tube has two possible explanations. Jervis (1998) posited that these setae are hydrophylic and that the glossa is retracted into the galeae where the nectar is extracted. He suggest-

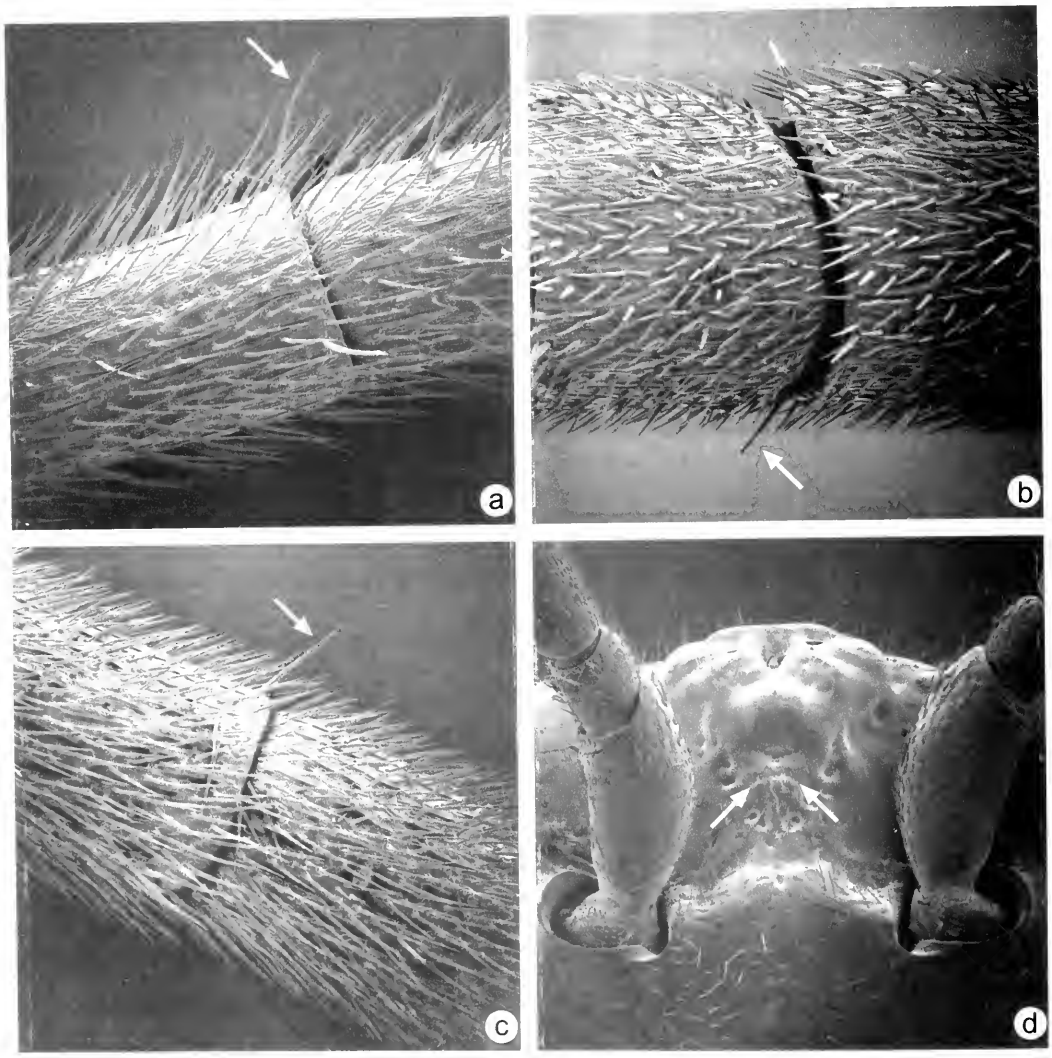


Fig. 7. *Agathirsia* spp., antennal setae. a, *A. asterophila*, showing long seta. b, *A. testacea*, showing short seta. c, *A. sericans*, showing seta of medium length. d, *A. testacea*, showing foveae around ocelli.

ed that the tube itself was used primarily to secrete salivary juices to dilute nectar in order both to pre-orally digest nectar and to optimize its viscosity. We cannot imagine how a glossa, that is frequently many times the length of the galeae, could be retracted to such a degree. There are no dried specimens that show partial retraction, and there are no apparent morphological structures, such as transverse s[illegible] ations on the glossa, that would allow [illegible] glossa to be folded into shorter sections. Therefore, contrary to Jervis (1998), we suggest that the scale-like, hydrophilic, setae on the outer surface of the glossa direct liquid toward the postero-medial longitudinal fissure where they are sucked into the lumen of the glossa and subsequently towards the oral cavity. This hypothesis requires that the glossa be able to open [illegible], at least part of its length, to allow [illegible] to enter. There are interesting

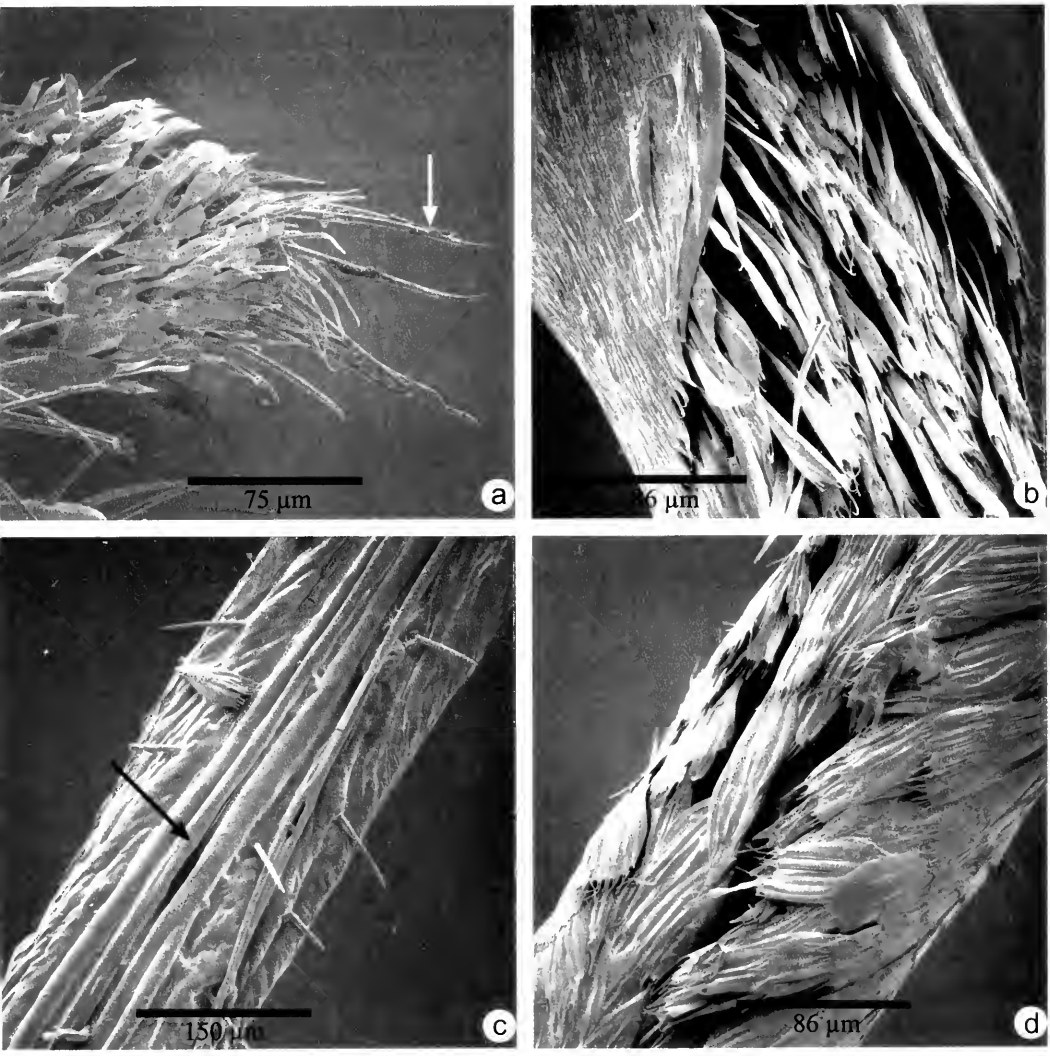


Fig. 8. *Agathirsia* spp., glossae. a, *A. testacea*, showing long terminal setae. b, *A. nigricauda*, close up of hydrophilic scales. c, *A. proxima*, showing longitudinal striations of inner surface. d, *A. proxima*, showing hydrophilic scales.

sensory setae along the length of the posterior fissure of the glossa (Fig. 9b) that may be responsible for signaling the presence or absence of liquid. While liquid is present the fissure should remain open, and when it is not present the fissure should collapse. The interior of the glossal tube is glabrous with longitudinal striations (Fig. 8c). These striations may allow the circumference of the tube to expand and contract to accommodate a greater or smaller flow of liquid. They may also function to strengthen the walls of the glossal tube so that they do not collapse when experiencing the negative pressure associated with sucking. This hypothesis does not negate the idea that the glossal tube may also be used to secrete salivary juices into nectaries.

A. jervisi Pucci and Sharkey is the only species with Jervis' type VI mouthparts. There is only one known specimen of this

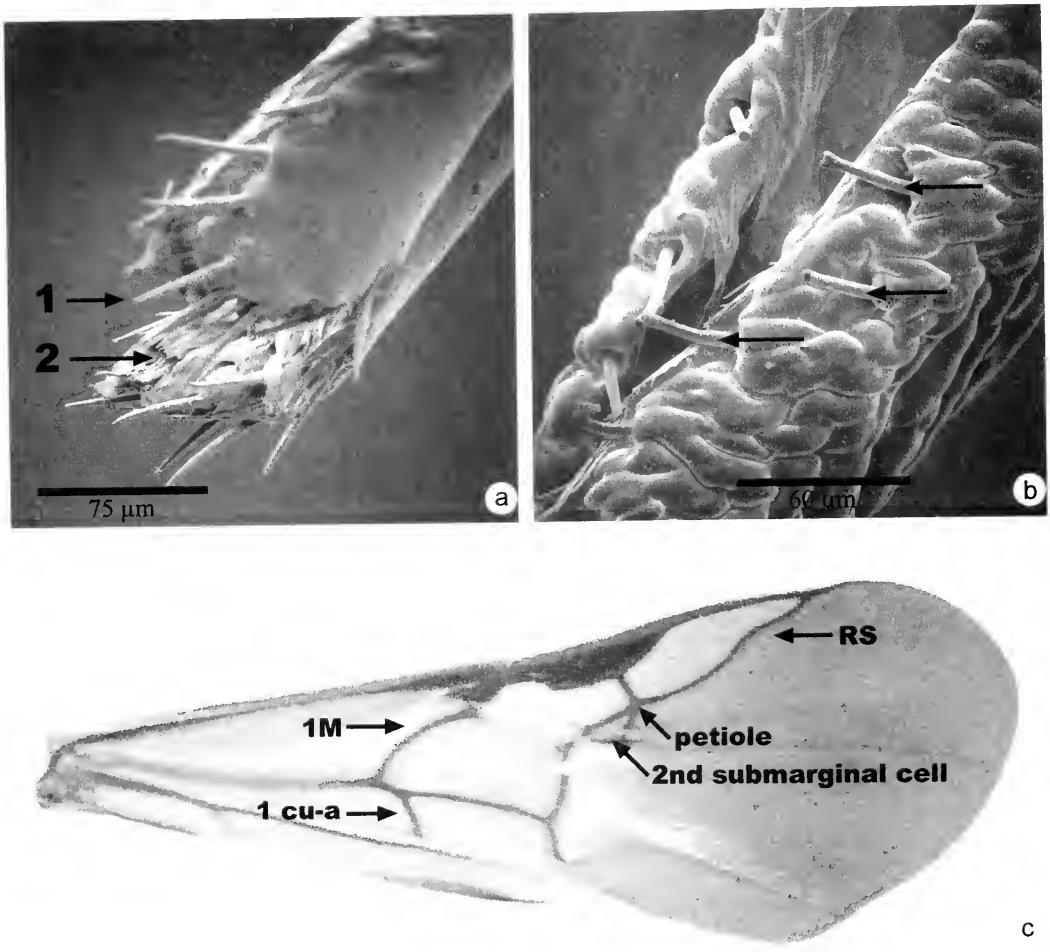


Fig. 9. *Agathirsia* spp., glossae. a, *A. nigricauda*, showing 1) long terminal setae, and 2) glossal scales. b, *A. proxima*, showing tube-like morphology and specialized setae. c, Forewing of *A. davidi*

species. One of its maxillary palps has only 4 palpomeres instead of the usual 5; the 4th and 5th are fused. The other palp has 5 palpomeres, the last being extremely small. Incredibly, the labial palpi are very long, 1.7 mm, and 5 segmented, instead of 4, which is ground-plan for the Hymenoptera. The last palpomere is very small and globose. Palpomeres 2–4 (and possibly 1) have the inner sides concave and hirsute. The glossa is hirsute, 1.2 mm, and sits between the labial palpi. The galea is much smaller than the glossa and we suspect that the setae on the glossa and inner surface of the labial palpi are hydrophilic and transport liquid along the length of the proboscis aided by negative pressure applied by the pharyngeal and cibarial pumps.

CLADISTIC SECTION

Methods.—The data matrix for the cladistic analysis is presented in Table 1. Characters 1 and 13–18 are treated as ordered. Character 13 is meristic and characters 14–18 are continuous. Median values were used when there was variation in these characters. A heuristic search was performed using PAUP* version 4.0b10 (Swofford 2002). Five hundred random

Table 1. Character matrix for species of *Agathirsia* and outgroups, including multiple species of *Crassomicrodus*.

	Discrete									Continuous and Meristic								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Pselaphanus trogoides	1	?	1	1	1	1	1	1	1	1	1	1	—	6	0	0	1	0
Earinus limitaris	1	2	1	1	1	1	1	1	1	1	1	1	—	6	0	5	2	1
Agathis arida	1	2	1	$	1	1	2	2	1	1	2	2	—	4	0	6	7	1
Agathis semiaciculata	1	2	1	2	1	1	2	2	1	1	2	2	—	6	0	6	9	2
Agathis malvacearum	1	2	1	$	1	1	2	2	1	1	2	2	—	5	0	9	4	1
Bassus sp.	1	1	1	1	1	2	1	1	1	1	2	2	—	8	1	2	4	1
Bassus brooksi	1	2	1	1	1	2	1	1	1	1	2	2	—	9	0	4	4	1
Crassomicrodus sp.	+	3	2	2	1	?	1	1	2	1	2	2	—	?	0	1	4	2
Crassomicrodus apicipennis	1	3	2	2	1	1	1	1	2	1	2	2	—	9	0	0	4	2
Crassomicrodus divisus	1	3	2	2	1	1	1	1	2	1	2	2	—	7	0	0	8	1
Crassomicrodus fenestratus	1	3	2	2	1	?	1	1	2	1	2	2	—	4	0	0	5	1
Crassomicrodus fulvescens	1	3	2	2	1	1	1	1	2	1	2	2	—	7	0	0	5	0
Crassomicrodus medius	1	3	2	2	1	1	1	1	2	1	2	2	—	8	0	0	4	2
Crassomicrodus muesebecki	+	3	?	2	1	1	1	1	2	1	2	2	—	8	0	1	3	1
Crassomicrodus nigriceps	1	3	2	2	1	1	1	1	2	1	2	2	—	6	0	0	4	2
Crassomicrodus nigrithorax	1	3	?	2	1	1	1	1	2	1	2	2	—	9	0	0	4	5
Crassomicrodus pallens	1	3	2	2	1	1	1	1	2	1	2	2	—	6	0	0	8	1
Agathirsia armandi	3	1	1	2	1	1	1	1	2	1	2	2	0	5	1	?	2	4
Agathirsia asterophila	2	1	1	2	1	1	1	1	2	2	2	2	2	0	0	0	0	5
Agathirsia bicolor	*	1	?	2	1	1	1	1	2	1	2	2	7	5	1	1	2	3
Agathirsia bifidilingua	3	1	?	2	1	1	1	1	2	1	2	2	5	5	2	3	4	5
Agathirsia campanisura	*	1	1	2	1	1	1	1	2	1	2	2	3	5	2	3	3	5
Agathirsia capillata	*	1	1	2	1	1	1	1	2	2	2	2	5	3	0	0	1	4
Agathirsia collini	*	1	1	2	1	1	1	1	2	?	2	2	1	5	1	2	2	2
Agathirsia cressoni	*	1	1	2	1	1	1	1	2	1	2	2	9	6	1	0	2	7
Agathirsia davidi	3	1	1	2	1	1	1	1	2	2	2	2	3	2	1	1	0	5
Agathirsia foveiseries	2	1	?	2	1	1	1	1	2	2	2	2	3	0	1	1	4	8
Agathirsia fulvocastanea	2	1	1	2	1	1	1	1	2	1	2	2	2	5	2	3	4	5
Agathirsia heleni	2	1	1	2	1	1	1	1	2	1	2	2	1	4	0	1	2	4
Agathirsia kellyi	2	1	1	2	1	1	1	1	2	1	2	2	0	3	1	?	1	3
Agathirsia kent	*	1	1	2	1	1	1	1	2	2	2	2	3	6	1	1	1	3
Agathirsia jervisi	2	1	1	?	2	1	2	1	2	1	2	2	1	5	3	0	1	8
Agathirsia longigladia	3	1	?	2	2	1	1	1	2	1	2	2	0	2	8	7	0	5
Agathirsia longilingua	*	1	1	2	2	1	1	1	2	1	2	2	6	6	9	4	4	3
Agathirsia michelei	3	1	1	2	1	1	1	1	2	?	2	2	3	4	2	4	3	9
Agathirsia minuata	*	1	?	2	1	1	1	1	2	1	2	2	0	4	0	0	4	2
Agathirsia nigricauda	3	1	1	2	1	1	1	1	2	1	2	2	8	4	2	1	2	7
Agathirsia ninesevensi	3	1	?	2	1	?	1	1	2	1	2	2	1	2	1	2	4	5
Agathirsia papoui	*	1	1	2	1	1	1	1	2	$	2	2	6	3	0	0	0	5
Agathirsia parkeningi	3	1	?	2	1	?	1	1	2	?	2	2	1	2	2	4	2	4
Agathirsia proxima	3	1	1	2	2	1	1	1	2	1	2	2	2	4	8	5	2	3
Agathirsia reai	3	1	1	2	1	1	1	1	2	1	2	2	0	5	2	5	3	5
Agathirsia rostrata	*	1	1	2	1	1	1	2	2	2	2	2	1	2	0	3	4	2
Agathirsia rufula	3	1	1	2	2	1	1	1	2	1	2	2	2	4	5	4	4	4
Agathirsia sericans	3	1	1	2	1	1	1	1	2	2	2	2	6	0	2	0	1	7
Agathirsia testacea	*	1	1	2	1	2	1	1	2	1	2	2	5	8	0	3	5	1
Agathirsia tiro	2	1	?	2	1	1	1	1	2	1	2	2	1	5	0	1	3	4
Agathirsia trichiosoma	*	1	1	2	1	1	1	1	2	2	2	2	3	0	0	0	0	6

? = unknown, e.g. could not be viewed on the specimen
+ = uncertainty between states 1 and 2, the state falls somewhere between the two states and is treated as polymorphic in the nexus file used for analysis
$ = polymorphic between states 1 and 2
* = polymorphic between states 2 and 3
– = not applicable

additions were carried out, each followed by TBR and unlimited maxtrees. The continuous characters were all scaled between 10 states (0–9) and could have a minimum of 9 steps. We down-weighted the continuous characters so that the total weight of each continuous character (99) was approximately equivalent to the total weight of a discrete binary character (100). This was accomplished by giving all continuous characters a weight of 11 and all binary characters a weight of 100. Trees were rooted with *Pselaphanus trogoides* Szépligeti due to its purported and supported sister-group relationship with Agathidinae (van Achterberg 1990). Before starting this revision we were uncertain of the monophyly of both *Crassomicrodus* and *Agathirsia* because testable synapomorphies had never been proposed for either genus. To test for the monophyly of *Agathirsia* and *Crassomicrodus* and to strengthen our outgroup analysis we included 10 species of *Crassomicrodus* as well as members of the genera *Agathis* and *Bassus*. The undescribed species of *Bassus (Bassus sp.)* was included because it has flattened pegs as do all species of *Agathirsia* and we were not sure to which genus it belonged. It was included to test the question of its placement in either *Bassus* or *Agathirsia*.

Character List.—

1. Mandible: 1- with well-developed second tooth (Figs. 1a, d); 2- with vestigial second tooth (Fig. 1b); 3- without second tooth (Fig. 1c). Twelve species of *Agathirsia* are polymorphic for states 2 and 3. Further observations of rare species will no doubt yield more taxa that possess both states. The second author suspects that the second mandibular tooth may be present in specimens of most species but that it is worn off in the process of digging through soil.

2. Apical pegs of the hind tibia: 1- flattened distally (Figs. 2b, c); 2- rounded distally (peg-like) (Fig. 2a); 3- hair-like (Fig. 2d). Although we have described state 3 as pegs "hair-like" we really do not know if the pegs are hair-like or if they are lost. Some of the "hairs" are thicker than others and this lead us to suggest that they are modified pegs but this is not a well corroborated conclusion. It may be more appropriate to describe the character state in *Crassomicrodus* as "without thickened peg-like setae" but the terminology makes no practical difference in the results of the analysis.

3. Foreclaw: 1- with basal lobe (Fig. 3a), 2- without basal lobe (Fig. 3c). Very tiny (vestigial) basal lobes (Fig. 3b) are coded as uncertain.

4. Two longitudinal carinae on first tergum extending past spiracles: 1- present; 2- absent. This character is variable within *Agathis* and the phylogeny of members of *Agathis* will have to be resolved before there can be confidence in our scoring of this taxon.

5. Quotient of galea divided by glossa: 1- more than 0.55 (Fig. 4b); 2- less than 0.40 (Fig. 4a). See the Mouthpart Morphology section for a more complete discussion. State 2 represents Jervis' Type IV mouthpart morphology described earlier.

6. Hind coxal cavity: 1- open; 2- closed.

7. Relative position of lateral ocelli and hind margin of eyes: 1- tangent with posterior margin of eyes; 2- anterad posterior margin of eyes. State 2 appears to be synapomorphy for members of *Agathis*. This state is associated with the forward migration of the ocelli due to invagination of the back of the head. The invagination allows the head to rotate anterodorsally into a prognathous position without the occiput hitting the pronotum. The prognathous position facilitates probing into deep floral nectaries.

8. Shape of the labrum: 1- oval; 2- circular. The elongation of the face in members of *Agathis* includes the elongation of the labrum which is therefore rather more circular than those of typical agathidines, which are significantly wider than long. This character state is also found in (the appropriately named) *Agathirsia rostrata*,

as well as most members of the Cremnoptini. The state is also scattered throughout the Microdini and Disophryini.

9. Mandible: 1- dorsoventrally flattened (Fig. 1a); 2- thick and relatively cylindrical (Figs. 1b-d). See Biology section for more information on mandible morphology.

10. Medial setae on tergum 3: 1- at most a fringe distally; 2- present distally as a wide, complete band (Figs. 6c, d). As mentioned previously, the extensive setosity may be effective in mimicking bees.

11. Second submarginal cell: 1- quadrate; 2- triangular (Fig. 9c). A quadrate cell is found in the outgroups *Pselaphanus* and *Earinus*. The character was included to add some resolution to the outgroup analysis.

12. Rs + M vein: 1- complete; 2- not complete (Fig. 9c). A complete Rs + M vein is found in the outgroups *Pselaphanus* and *Earinus*. The character was included to add some resolution to the outgroup analysis.

The following six characters are meristic or continuous and the absolute values are scaled between 0 and 9.

13. Number of distally flattened pegs on hind tibia. The number of pegs varies between 0–21.

14. Quotient of basal width of tergum 1 divided by length of tergum 1. Quotients are between 0.40–1.13.

15. Quotient of glossa length divided by foretibia length. Quotients are between 0.20–3.10. Because there are only a few species with exceptionally long tongues, most species clump between states 0 and 2.

16. Quotient of ovipositor length divided by foretibia length. Quotients are between 0.54–6.30.

17. Quotient of malar space length divided by eye height. Quotients are between 0.22–0.59.

18. Quotient of length of labial palpomere 2 divided by length of labial palpomere 4. Quotients are between 0.9–2.5.

Results.—Figure 10a shows the strict consensus tree of 32 minimum length trees (branches with a minimum length of zero collapsed), each with a weighted length of 4266 steps. The minimum length trees have the following values: consistency index 0.47, retention index 0.82, and rescaled consistency index 0.38. The characters mapped onto the consensus tree are those that are unequivocal over all primary trees, with two exceptions that are discussed below. In the following discussion the numbers in square brackets [ ] refer to character states.

The monophyly of *Agathirsia* is supported by one unequivocal autapomorphy, i.e., the reduction of the second mandibular tooth (Figs. 1 b, c) (character 1[2]). Most species lack a second mandibular tooth (Fig. 1c), although some still have a slight indication of the inner (ventral) tooth (Fig. 1b). The presence of a small ventral tooth appears as a reoccurrence of the tooth from an ancestral species of *Agathirsia* in which the tooth was absent. The presence of flattened pegs on the apicomedial surface of the hind tibia (Figs. 2b, c) (character 2[1]) is an autapomorphy implied by DELTRAN optimization only. The flattened pegs of the hind tibia are found convergently in the undescribed species of *Bassus* included in the analysis (*Bassus sp.*).

The sister-group relationship of *Crassomicrodus* + *Agathirsia* is supported by the robust cylindrical shape of the mandibles (character 9[2]), which appears to be a modification for digging in the soil.

The results of the cladistic analysis suggest two synapomorphies for members of *Crassomicrodus*. The first, which is implied exclusively by DELTRAN optimization, is that the apical pegs of the hind tibia are hair-like (Fig. 2d) (character 2[3]), unlike the standard agathidine pegs illustrated in figure 2a and unlike the flattened pegs of members of *Agathirsia* (Figs. 2b, c). A weakness with this proposed autapomorphy is that it rests on the assumption that the flattened pegs of *Agathirsia* and the

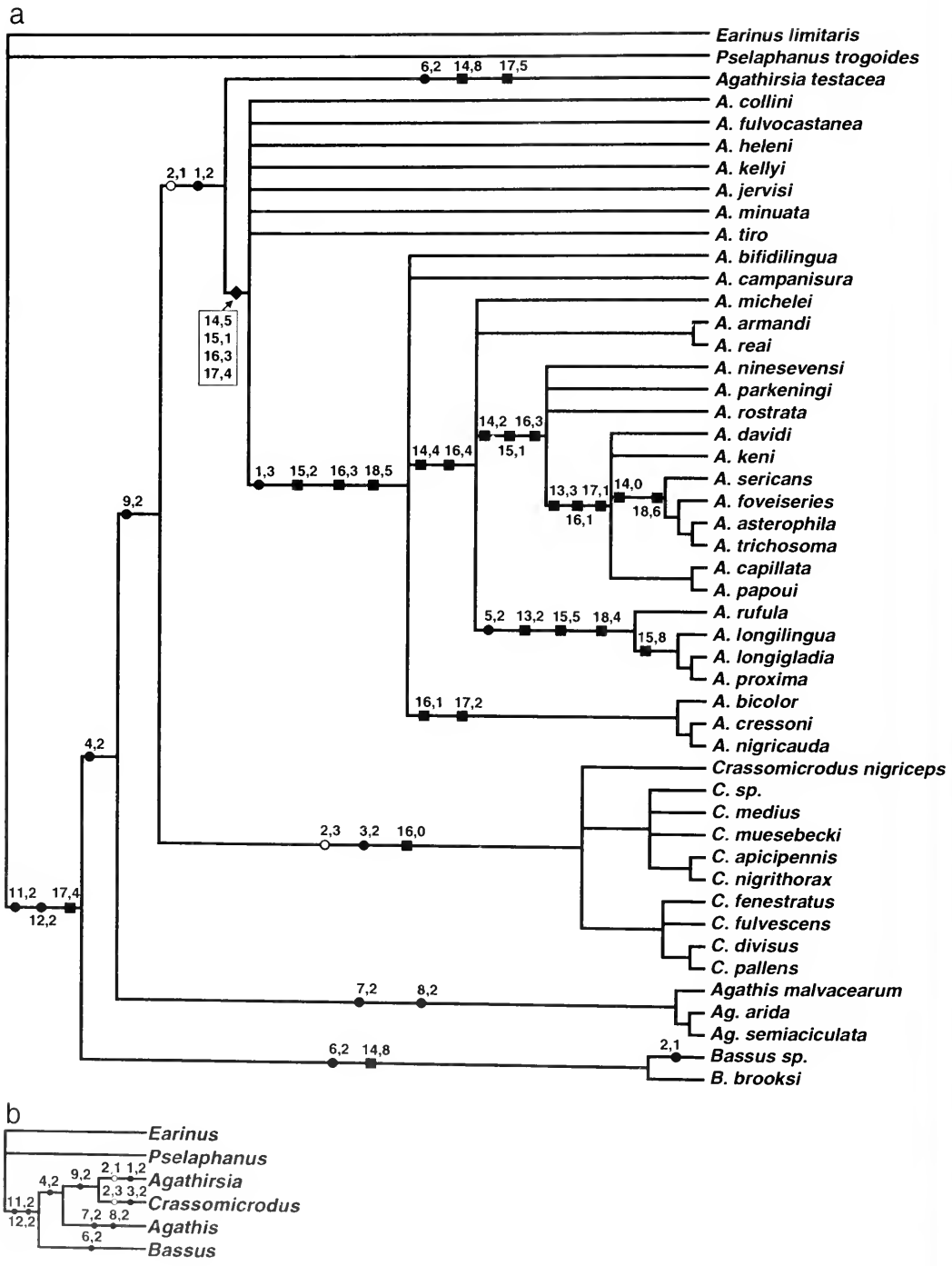


Fig. 10. *Agathirsia* spp. a, Strict consensus tree of species and outgroups employing all characters. b, Strict consensus tree using only discrete, non-meristic, characters.

hair-like spines of *Crassomicrodus* evolved independently from a peg-like ancestor. It is equally parsimonious to suggest that the flat pegs were derived from the hair-like spines or vice versa. The second proposed autapomorphy for *Crassomicrodus* is the loss of lobes at the base of the tarsal claws (character 3[2]) (Fig. 3c). The plesiomorphic condition, with a well-defined basal lobe, is shown in figure 3a. The loss of this lobe is also found in some members of the Earinini, and sporadically in other agathidines including some species of *Agathirsia*.

Autapomorphies for *Agathis* are the anterior placement of ocelli (character 7[2]) and shape of the labrum (character 8[2]). The closed hind coxal cavities appear as an autapomorphy for *Bassus* (character 6[2]). This result is a product of the abbreviated nature of this analysis. The closed coxal cavities are far more widespread in the Agathidinae, occurring in most Microdini, Cremnoptini and Disophryini. At present there is no evidence for the monophyly of *Bassus* though the two included species are part of a much larger monophyletic group.

Figure 10b illustrates the strict consensus tree generated when the meristic and continuous characters (characters 13–18) are excluded. In this simplified tree all polytomies have been collapsed. The discrete characters resolve the genera but do nothing to resolve the relationships within *Agathirsia*. All of the resolution within *Agathirsia* illustrated in figure 10a is the result of the addition of the meristic and continuous characters. Due to the limited number of discrete characters, and to the nature of ordered multistate characters, characters 13–18 would add much resolution even if they were totally random. To test whether or not the meristic and continuous characters have information content we randomized the meristic and continuous characters while holding the character state frequencies constant. If characters 13 to 18 have information content then the randomized characters that replace them should add significantly to the length of the tree. Characters 13–18 were randomized with "true random numbers" a program found at www.random.org. Rather than being replaced with completely random numbers, the states were rearranged to maintain the character state frequency, for example, if there were 3 cells with a score of 7 in the original matrix the random matrix would also contain 3 cells scored as 7. One hundred randomized datasets were generated and analyzed in Paup using TBR, unlimited Maxtrees, 50 random addition-sequence replicates with a time limit of 120 seconds on each replicate on a Pentium 4 1.8GHz processor. Taken as a whole, the characters are 43% longer when randomized than they are in the non-randomized results and they make the resulting minimum length trees an average of 21% longer.

Within *Agathirsia* several major clades supported by the continuous characters are worth discussing. *A. testacea* is the sister-taxon of the remainder of the species of *Agathirsia*. *A. testacea* is particularly interesting because it is the sole species with a large sclerite between the foramina of the metasoma and the hind coxa (character 6[2]). This putatively derived state is found convergently in the vast majority of *Bassus*, as well as most Microdini, Disophryini, and Cremnoptini. The monophyly of the remainder of the species is supported by four continuous characters. Moving up the tree there is a large polytomy of seven species and one large monophyletic group united by the complete loss of the second mandibular tooth and three continuous characters. Further up the tree there is a polytomy composed of four lineages. One of these clades contains all of the species with long glossae (Jervis Type IV). Because the independence of some of the characters is suspect, the monophyly of the group and the unique derivation of the elongate glossa

that this topology suggests are not considered well supported, though the observation that other characters do not imply other groupings indicates some support. What is interesting, and better supported, is the distant placement of *A. jervisi* relative to this clade, giving some confidence to the conclusion that the Jervis Type IV and Jervis Type VI mouth-parts are independently derived from type I mouth-parts.

DESCRIPTIONS AND KEYS

Agathidini Sharkey 1992

Diagnosis.—Members of the Agathidini may be distinguished from all other Agathidinae by the following combination of characters: Labio-maxillary complex usually (95%) elongate (galea longer than mandible) (Figs. 1a, 4a, b); labial palpomere 3 not reduced, more than 0.5 length of palpomere 4 (Figs. 4a, b); tarsal claws not cleft, i.e., without two sharp teeth; 1-Rs+M vein of forewing incomplete (Fig 9c); posterior transverse carina of propodeum absent; hind coxal cavity usually (80%) not separated from metasomal foramen, sometimes (20%) separated by narrow sclerite.

WORLD KEY TO THE GENERA OF AGATHIDINI + *BASSUS*

Notes: The limits of the Agathidini are based on Sharkey (1992). The genus *Bassus* belongs to the tribe Microdini (Sharkey 1992) but the genus is not well defined and can sometimes be confused with members of the Agathidini; it is therefore included in this key. If no characters in any particular side of a couplet are definitive then the reader should choose that alternative with the most applicable characters.

1. Wide transverse carina, i.e. more that $\frac{1}{5}$ as wide as long, between hind coxae **usually** (90%) present; hind coxa and metasoma **usually** separated by wide sclerite, rarely with a very narrow sclerite or none at all; galea **usually** (90%) shorter than mandible; third labial palpomere **usually** (90%) less than half the length of the fourth; propodeum **often** (70%) areolated ..... ***Bassus* Fabricius**

– Wide transverse carina between hind coxae **rarely** (1%) present, sclerite usually absent (90%) or very narrow, i.e. less that $\frac{1}{8}$ as wide as long, (9%); galea **usually** (99%) longer than mandible; third labial palpomere more than half the length of fourth (95%); propodeum not areolated ..... 2 (Agathidini)

2 (1) Mandible dorso-ventrally flattened (Fig. 1a); hind tibial spines peg-like (Fig. 2a); RS of forewing **usually** (90%) straight; second submarginal cell **usually** (90%) not petiolate; head excavated posteromedially and ocelli shifted anterad such that line drawn over lateral ocelli meeting the compound eyes; labrum **usually** (90%) almost as high as wide. ..... ***Agathis* Latreille**

– Mandible not flattened as above (Figs. 1b-d); hind tibial spines either somewhat flattened or hair-like (Figs. 2b-d); RS of forewing **usually** (90%) sinuate (Fig. 9c); second submarginal cell **usually** (90%) petiolate (Fig. 9c); head not excavated posteromedially and ocelli not shifted anterad such that a line drawn over lateral ocelli is approximately tangent with posterior margin of compound eyes; labrum **usually** (97%) distinctly wider than high 3

3 (2) Glossa **usually** (90%) at least as long as mandible; hind tibial pegs somewhat flattened (Figs. 2b,c); claws with distinct to vestigial basal lobe (Figs. 3a, b) ..... ***Agathirsia* Westwood**

– Glossa shorter than mandible; hind tibial pegs hair-like (Fig. 2d); claws with basal lobe absent (Fig. 3c) or **sometimes** (20%) vestigial ..... ***Crassomicrodus* Ashmead**

Agathirsia Westwood

Agathirsia Westwood 1882: 20. Type species *Agathirsia rufula* Westwood, designated by Viereck, 1914: 6. [Examined].

Agathona Westwood 1882: 22. Type species *Agathona sericans* Westwood, monobasic. Syn. by Szepligeti 1904: 128. [Examined].

Paragathis Ashmead 1889(1888): 638. Type species *Microdus thoracicus* [= *cressoni*] Cresson, monobasic. Syn. by Ashmead 1900: 128. [Examined].

Cenostomus Cameron 1905: 387. Type species, *Cenostomus trichiosomus* Cameron, by monotypy. **Syn. n.** [Examined].

Description.—Head: Gena lacking flange posteroventrally, posterolateral corner rounded to acute; mandible robust and cylindrical in cross-section (Figs. 1b,c); second tooth of mandible much reduced or absent (Figs. 1b,c); third (penultimate) labial palpomere more than half as long as last (distal) palpomere (Fig. 4a,b); frons not bordered with carinae; face not elongated into rostrum except for *A. rostrata*. *Mesosoma:* Notauli always impressed, foveolate to smooth (Figs. 5a,b); propodeum not evenly areolated, usually rugose to varying degrees (Figs. 6a,b); tarsal claws usually with basal lobe but sometimes lobe vestigial (Figs. 3a,b); hind tibia with small flattened pegs distally (Figs. 2b,c); second cubital cell of the forewing triangular and usually petiolate (Fig. 9c); wings transparent to infumate (Fig. 9c); hind coxal cavities open, sharing common opening with the metasoma except for *A. testacea*. *Metasoma:* First median tergite smooth, lacking sculpture, or pair of well-developed longitudinal carinae (Figs. 6c,d); ovipositor (when fully exerted) from 0.1 to 1.3× as long as the body.

TRANSFER OF *CRASSOMICRODUS PUMILUS* TO *BASSUS PUMILUS*

One of the species of *Crassomicrodus* that we investigated is clearly misplaced and is here transferred to *Bassus*. The fact that it is from South Africa was the first clue suggesting that it was misassigned to *Crassomicrodus*. Originally placed in the genus *Epimicrodus* by Szepligeti (1913), it was transferred to *Crassomicrodus* when Brues (1924) synonymized *Epimicrodus* under *Crassomicrodus*. The name *Bassus pumilus* is available. The specific name is occupied in *Agathis*, i.e., *Agathis pumila* (Ratzeburg), and rationale for its placement in *Agathis* (as opposed to *Bassus*) are discussed by Sharkey (1985, 1992).

Bassus pumilus (Szepligeti), n. comb.

Epimicrodus pumilus Szepligeti 1913: 385; (DEIC). [Examined].

Crassomicrodus pumilus Brues 1924: 144.

The following description is not meant to be exhaustive but rather to support the placement of the species in *Bassus*.

Penultimate labial palpomere (number 3) half the length of number 2; mandible narrow and scissor-like; occiput not dorsally excavated as in *Agathis*; propodeum sharply declivous, with strong posterior transverse carinae; hind coxal cavity closed; tergum 1 striate; metasomal terga wide; hind tibial pegs peg-like; claws with basal lobes present and sharply angled; forewing 3Rs decurved as in *Bassus conspicuus* (Wesmael); hind wing 2Cub tubular; ovipositor approximately 0.8× body length.

KEY TO FEMALES AND MALES OF *AGATHIRSIA*

Note: An interactive version of this key with color illustrations is available at www.uky.edu/~mjshar0, it is much simpler to use primarily due to its use of color characters, nonetheless the following key is effective in distinguishing species.

1 Labial palpi elongate, concave, and encasing glossa ..... *A. jervisi*

– Labial palpi not as above, not encasing glossa (as in Fig. 4b) 2

2 (1) Glossa more than 2× longer than galea (as in Fig. 4a) 3
– Glossa less than 2× longer than galea (as in Fig. 4b) 6
3 (2) Hind femur black; metasomal terga entirely black; propodeum entirely black; notauli foveate (as in Fig. 5a) 4
– Hind femur orange; metasomal terga not entirely black; propodeum partially or entirely orange; notauli lacking foveae (as in Fig. 5b) 5
4 (3) Number of thick, apically flattened pegs on apex of hind tibia (as in Figs. 2b,c) six or less; tarsal claws with vestigial basal lobes (as in Fig. 3b); ovipositor length more than 6× hind basitarsus length ..... *A. longigladia*
– Number of thick, apically flattened pegs on apex of hind tibia (as in Figs. 2b,c) more than six; tarsal claws with distinct basal lobes (as in Fig. 3a); ovipositor length less than 6× hind basitarsus length ..... *A. longilingua*
5 (3) Foveae of sternaulus present for at least one third length of mesopleuron (as in Fig. 5a); glossa length less than 3mm ..... *A. rufula*
– Foveae of sternaulus restricted to extreme posterior of mesopleuron (Fig. 5c); glossa length at least 3mm ..... *A. proxima*
6 (2) Pair of lobes between midcoxae (Fig. 5d) ..... *A. testacea*
– Without pair of lobes between midcoxae 7
7 (6) With the following combination of characters: first tergum lacking black color basally; hind tibia lacking black color; at least 9 thick, apically flattened hind tibial pegs (as in Fig. 2b) 8
– Not exactly as above 9
8 (7) Dorsal metasoma usually orange basally and completely black for distal one third; hind femur orange; glossa length 0.68–0.95× foretibia length ..... *A. nigricauda*
– Tergum 1 black distally; remaining dorsal metasoma usually orange with transverse black bars; hind femur usually (~90%) black; glossa length 0.60–0.69× foretibia length ..... *A. cressoni*
9 (7) Hind femur entirely to mostly black 10
– Hind femur entirely to mostly orange 20
10 (9) Metasomal terga entirely black 11
– Metasomal terga with at least some orange or yellow 15
11 (10) Foveae present between tentorial pit and antennal insertion (Fig. 3d) ..... *A. rostrata*
– Foveae absent between tentorial pit and antennal insertion 12
12 (11) Setae on propodeum present along midline; ovipositor length greater than 3× hind basitarsus length ..... *A. parkeningi*
– Setae on propodeum absent along midline (as in Figs. 6a,b); ovipositor length less than 3× hind basitarsus length 13
13 (12) Setae on tergum 3 dense distally (as in Fig. 6c); ovipositor shorter than length of hind basitarsus ..... *A. capillata*
– Setae on tergum 3 not dense distally (as in Fig. 6d); ovipositor longer than hind basitarsus length 14
14 (13) Propodeum with pronounced rugosity near midline (as in Fig. 6b); distal half of hind tibia entirely black ..... *A. keni*
– Propodeum without pronounced rugosity near midline (Fig. 6a); distal half of hind tibia not entirely black ..... *A. davidi*
15 (10) Mesoscutum entirely black 16
– Mesoscutum partially to entirely orange 19
16 (15) Setae on propodeum present along midline 17
– Setae on propodeum absent along midline (as in Figs. 6a,b) 18
17 (16) Glossa length greater than 0.75× foretibia length; basal lobe of claw not large (smaller than Fig. 3a) ..... *A. sericans*
– Glossa length less than 0.75× foretibia length; basal lobe of claw large (Fig. 3a) ..... *A. trichiosoma*

18 (16) Setae on tergum 3 dense (as in Fig. 6c) and present on at least distal 0.75 . . . *A. sericans*
– Setae on tergum 3 not dense and present on less than distal 0.75 (as in Fig. 6) . . . . . *A. asterophila*
19 (15) Foveae of sternaulus present for at least one third length of mesopleuron (as in Fig. 5a); ovipositor length equal or shorter than length of hind basitarsus; setae on tergum 3 dense (as in Fig. 6c) and present on at least distal 0.75 . . . . . *A. sericans*
– Foveae of sternaulus restricted to extreme posterior of mesopleuron (as in Fig. 5c); ovipositor more than 2× length of hind basitarsus; setae on tergum 3 not dense and present on less than distal 0.75 (as in Fig. 6d) . . . . . *A. bifidilingua*
20 (9) Mesoscutum entirely black 21
– Mesoscutum partially to entirely orange or brownish orange 28
21 (20) Metasomal terga entirely black 22
– Metasomal terga partially to entirely orange or brownish orange 25
22 (21) Labial palpomere 2 at least equal to combined length of palpomeres 3 + 4 (as in Fig. 4b) 23
– Labial palpomere 2 shorter than combined length of palpomeres 3 + 4 24
23 (22) Glossal length more than 0.75× foretibia length; ovipositor length more than 3x hind basitarsus length . . . . . *A. michelei*
– Glossal length less than 0.75× foretibia length; ovipositor length less than 2x hind basitarsus length . . . . . *A. papoui*
24 (22) Notauli lacking foveae (as in Fig. 5b); longest setae at midlength of antenna approximately equal to antennal width (as in Fig. 7a) . . . . . *A. kellyi*
– Notauli foveate (as in Fig. 5a); longest setae at midlength of antenna less than 0.5× antennal width (as in Fig. 7b) . . . . . *A. collini*
25 (21) Labial palpomere 2 shorter than combined length of palpomeres 3 + 4 26
– Labial palpomere 2 approximately equal to combined length of palpomeres 3 + 4 (as in Fig. 4b) . . . . . *A. michelei*
26 (25) Claws with basal lobe distinct (as in Fig. 3a); propodeum largely sculptured and setae present except along midline (as in Figs. 6a,b); ovipositor distinctly longer than mesosoma . . . . . *A. campanisura*
– Claws with basal lobe vestigial (as in Fig. 3b); propodeum largely smooth and glabrous medially; ovipositor shorter than mesosoma 27
27 (26) Sternaulus with foveae restricted to extreme posterior of mesopleuron (as in Fig. 5c); glossal length more than 0.5× foretibia length; longest setae at midlength of antenna less than 0.5× antenna width (as in Fig. 7b) . . . . . *A. ninesevensi*
– Sternaulus completely foveate for entire length of mesosoma; glossal length less than 0.5× foretibia length; longest setae at midlength of antenna approximately equal to antenna width or longer (as in Fig. 7a) . . . . . *A. tiro*
28 (20) Area between tentorial pit and antennal insertion with line of foveae (as in Fig. 3d) . . . . . *A. foveiseries*
– Area between tentorial pit and antennal insertion without line of foveae 29
29 (28) Propodeum entirely black 30
– Propodeum partially or entirely orange 32
30 (29) Propodeum smooth along midline; tarsal claws with basal lobes distinct (as in Fig. 3a) . . . . . *A. heleni*
– Propodeum sculptured along midline (as in Fig. 6a); claw with basal lobe variable . . . 30
31 (30) Labial palpomere 2 approximately equal to combined length of palpomeres 3 + 4 (as in Fig. 4b) . . . . . *A. armandi*
– Labial palpomere 2 shorter than combined length of palpomeres 3 + 4 . . . . . *A. bicolor*
32 (28) Head entirely orange; glossal length shorter than 0.5× foretibia length; ovipositor less than 1.5x hind basitarsus length . . . . . *A. minuata*
– Face and frons at least partially black; glossal length more than 0.5× foretibia length; ovipositor longer than 1.5× hind basitarsus length 33

33 (32) Forecoxa and midcoxa orange; first tergum orange ..... *A. reai*
– Forecoxa and midcoxa black; first tergum black basally ..... *A. fulvocastanea*

Agathirsia armandi Pucci and Sharkey, sp. n.

Distribution (Fig. 11j).—Known only from the type locality in Puebla, Mexico.

Males.—Color: Orange and black, orange except as follows: antenna black; maxillary and labial palpomeres partly black; head except clypeus black; pronotum black ventrally; propleuron black; mesoscutum sometimes slightly black anteriorly; mesopleuron mostly black except slightly orange anteriorly; metanotum sometimes with black laterally; metapleuron black; propodeum black; hind tarsus sometimes dark orange; first tergum black; remaining terga dark orange with black mottling; wings slightly infumate. *Body length:* excluding ovipositor 6.6–7.0. *Head:* Longest seta at midlength of antenna approximately half or slightly less than half antenna width (as in Figs. 7b,c); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.33–0.40; glossa length less than 2× galea length; glossa length 0.83–0.90; glossa length 0.64–0.83× shorter than foretibia length; malar space 0.41–0.42× shorter than eye height; face above clypeus with distinct or vestigial longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose, setae present except along midline and posterior central area (as in Fig. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws small (cf. Figs. 3a,b); number of thick, apically flattened apical pegs on hind tibia 0–4; hind basitarsus straight; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.76–0.82× length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove distinct or vestigial.

Female.—Unknown.

Specimens examined.—Holotype: ♂, Mexico, Puebla, 3 mi. N Petalcingo, viii.21.1963 (Parker & Stange) (USNM). Paratype: 1 ♂, same data as holotype (USNM).

Remarks.—Similar to *A. heleni* and *A. bicolor*—see characters in the key and remarks under those species.

Etymology.—In honor of the senior author's father.

Agathirsia asterophila Pucci and Sharkey, sp. n.

Distribution (Fig. 11b).—Southwestern Mexico.

Females and males.—Color: Mostly black except as follows: maxillary and labial palpomeres partly pale; fore and midfemur with small orange area distally; foretibia sometimes entirely or partly pale yellow/orange; foretarsus sometimes entirely or partly pale yellow; midtibia partly pale yellow; midtarsus sometimes pale; hind tibia pale basally, pale color extending further laterally; hind tarsus sometimes partly or entirely pale yellow; first and second terga both yellow basally; wings slightly infumate. *Body length:* excluding ovipositor 8.2–10.3. *Head:* Longest seta at midlength of antenna subequal to antenna width (as in Fig. 7c); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible with or without indication of second tooth (as in Fig. 1b,c); glossa fork length 0.13–0.17; glossa length less than 2× galea length; glossa length 0.57–0.61; glossa length 0.38–0.42× shorter than

oretibia length; malar space 0.23–0.29× horter than eye height; face above clypeus with or without median longitudinal arinae; area anterior to ocellus with pits orming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion vithout line of foveae. *Mesosoma:* Notauli oveate and complete (as in Fig. 5a); propodeum rugose posteriorly, foveate anteriorly, setae present except along midline nd posterior central area (as in Fig. 9a,b); ternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; asal lobe of claws distinct (as in Fig. 3a); umber of thick, apically flattened apical egs on hind tibia 3–8; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing eparated by a distance greater than 2 vein vidths (as in Fig. 9c). *Metasoma:* Posterior vidth of first tergum 0.40–0.50× shorter han length of first tergum; setae on tergum 3 not dense (as in Fig. 6d), present n distal one third; tergum 3 with transerse groove distinct or vestigial; ovipositor length 1.0–1.2; ovipositor length 0.67–.92× shorter than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexco, Morelos, 3.8 mi. W Yautapec, 3800′, iii.17.1962 (Ordway) (SEMC). Paratypes: **Mexico:** Guerrero: 1♂, 10.3 mi. S. Iguala, ii.23.1981 (Bogar, Schaffner, & Friedlander) (TAMU); Jalisco: 1♂, 16 km N Autlan, ii.31.1978 (Plitt & Schaffner) (TAMU); ♂, 16 km N Autlan, vii.31-viii.2.1978 Plitt & Schaffner) (TAMU); 1♀, 28 mi. E Guadalajara, viii.15.1962 (CNCI); Morelos: ♂, Cuernovaca [Cuernavaca], viii.15.1954 Dreisbach) (MSUC); 1♂, as previous AEIC); 1♂, 12 mi. E Cuernavaca, elev. 200′, viii.12.1954 (Dreisbach) (AEIC); 1♀, 2 mi. E Cuernavaca, elev. 4300′, iii.14.1954 (Univ. Kans. Mex. Expedition) SEMC); 1♀, 11 mi. S Tlaltizapan, iii.16.1962 (Roberts & Marston) (SEMC); ♀, 1♂, same data as holotype (SEMC); ♀, 2mi. W. Zacatepec, vii.28.1967 (R.H. & E.M. Painter) (AEIC); Puebla: 1♀, Chietla, iii.13.1991 (Pena) (ATAM).

Remarks.—Similar to *A. sericans* and *A. trichiosoma*—see characters in the key.

Etymology.—Lover of aster—referring to the Asteraceae pollen commonly attached to specimens. Pollen identified by Gretchen Jones USDA, ARS, APMRU, College Station, TX.

Agathirsia bicolor Pucci and Sharkey, sp. n.

Distribution (Fig. 11h).—Known from two localities in Chihuahua, Mexico.

Females and males.—Color: Black and orange; variable, black except as follows: maxillary and labial palpomeres mostly orange; clypeus sometimes orange ventrally; pronotum entirely orange to slightly black ventrally; propleuron sometimes black and orange; mesoscutum and scutellum orange; mesopleuron black and orange; metanotum partly to entirely orange; propodeum black or black and orange; metapleuron black or black and orange; legs orange except tarsi orange to pale yellow; forewing clear in basal half, infumate in distal half; first tergum orange distally; remaining terga orange, sometimes with dark orange mottling; hind wing clear to slightly infumate in basal half and distinctly infumate in distal half. *Body length:* excluding ovipositor 7.7–8.5. *Head:* Longest seta at midlength of antenna approximately half or < half antenna width (as in Figs. 11b,c); labial palpomere 2 shorter than combined length of 3 + 4; mandible with indication of second tooth vestigial (as in Fig. 1b) or absent (as in Fig. 1c); glossa fork length 0.32; glossa length less than 2× galea length; glossa length 0.74; glossa length 0.53× shorter than foretibia length; malar space 0.40–0.43× shorter than eye height; face above clypeus without or with vestigial longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose, setae present ex-

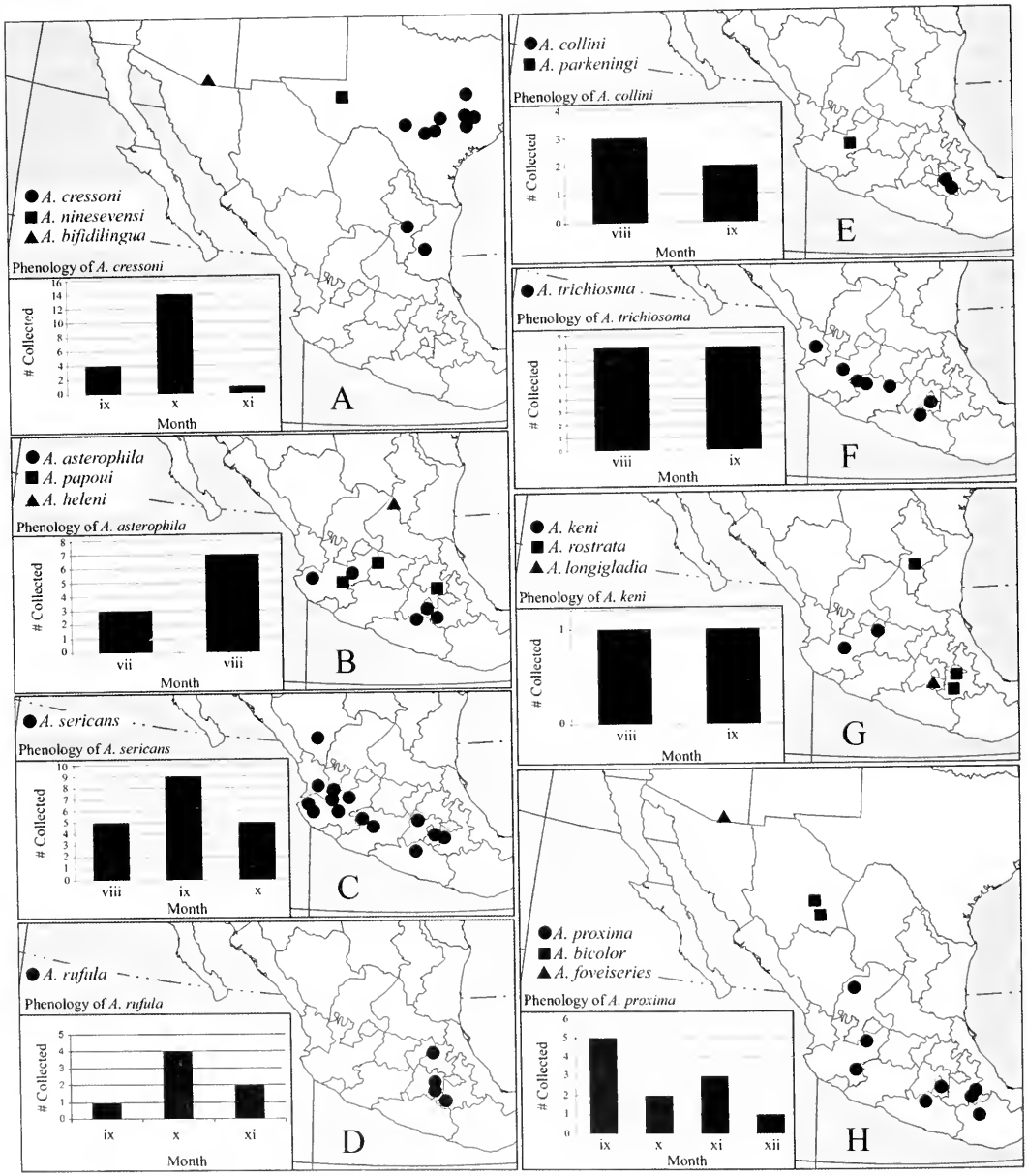


Fig. 11. *Agathirsia* spp., distributions and phenologies of selected species.

cept along midline and posterior central area (as in Fig. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 11–15; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.75–0.91× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove absent or vestigial; ovipositor length 2.1–2.3; ovipositor length 1.8–1.9× longer than hind basitarsus length.

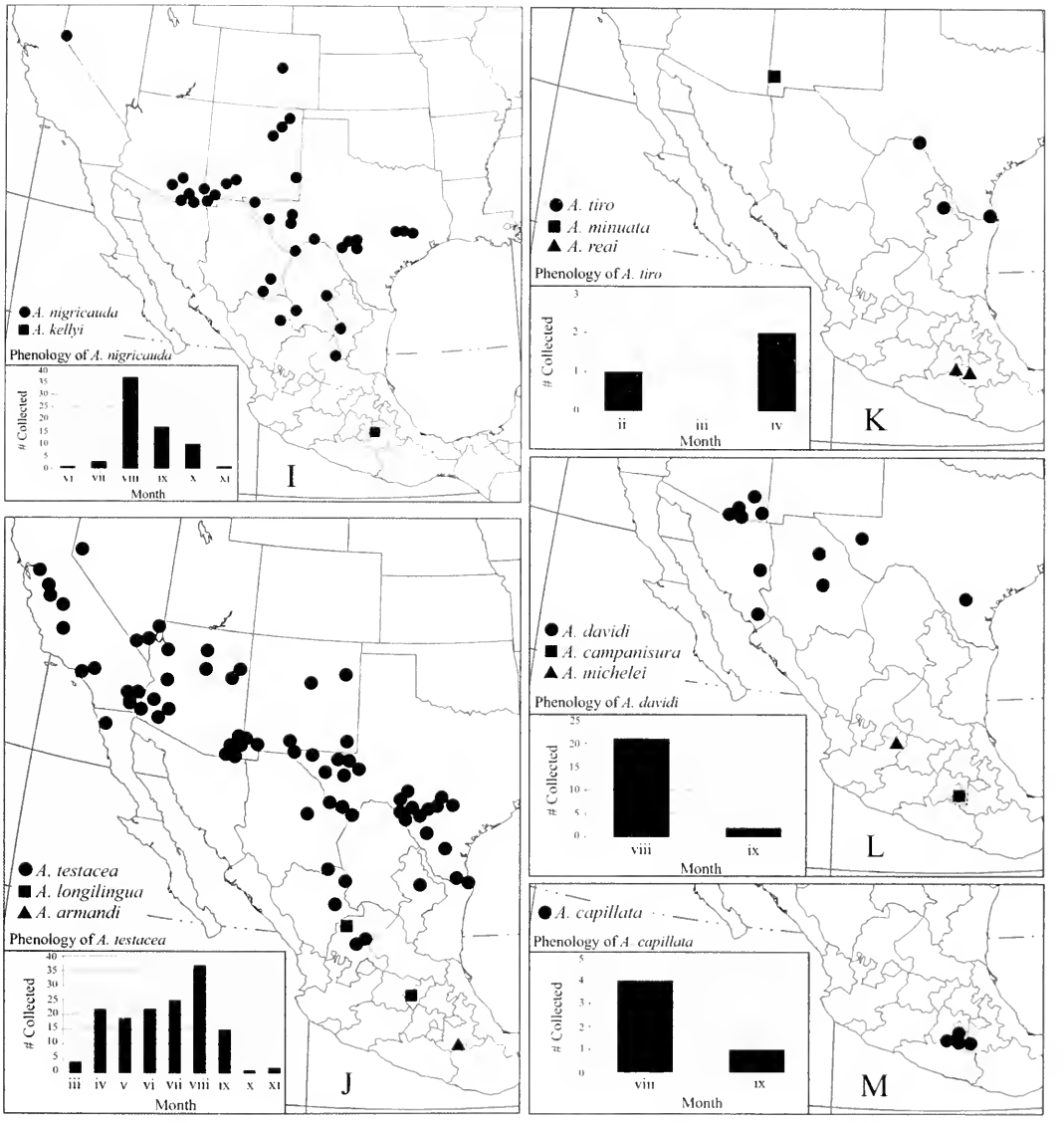


Fig. 11. Continued.

Specimens examined.—Holotype: ♀, Mexico, Chihuahua, 16 km N Cd. Jimenez, viii.26.1991 (Griswold) (CNCI). Paratypes: 1♀, 1♂, same data as holotype (CNCI); 1♀, same data as holotype except viii.27.1991 (CNCI).

Remarks.—Similar to *A. heleni* and *A. armandi*—see characters in the key and remarks under those species. *A. bicolor* is longer than *A. heleni* and *A. armandi* but overlap is possible considering the limited number of specimens measured. The basal lobe of the claw is vestigial (Fig. 3b) unlike the other two species.

Etymology.—Two colors—referring to the orange and black coloration.

Agathirsia bifidilingua Pucci and Sharkey, sp. n.

Distribution (Fig. 11a).—Known only from type locality in Arizona.

Holotype female.—Color: Mostly black

with some orange; orange as follows: pronotum dorsally; mesoscutum; scutellum partly orange; mesopleuron with orange area under sternaulus; fore and midlegs with some orange; forewing slightly infumate in basal half, infumate in distal half; hind wing clear in basal half, infumate in distal half. *Body length:* excluding ovipositor 9.4. *Head:* Longest seta at midlength of antenna approximately half antenna width (as in Fig. 7c); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.50; glossa length less than 2× galea length; glossa length 1.0; glossa length 0.77× shorter than foretibia length; malar space 0.54× shorter than eye height; face above clypeus with vestigial median longitudinal carinae; area anterior to ocellus without pits forming V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli very weak and absent anteriorly; propodeum mildly rugose, midline mostly smooth, setae present except along midline (similar to Fig. 6a); sternaulus slightly impressed with only a few foveae posteriorly (as in Fig. 5c); mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 7–12; hind basitarsus tapered distally; 1-cu-a and 1-M in forewing partially or nearly overlapping. *Metasoma:* Posterior width of first tergum 0.80× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 without transverse groove; ovipositor length 4.3; ovipositor length 3.9× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype: ♀, USA, Arizona, Pima Co., 12 mi. E Tucson, iv.13.1957 (USNM).

Remarks.—The combination of an orange mesoscutum and black legs is enough to distinguish this species from all other known *Agathirsia.* The collection date in April is much earlier than most species of *Agathirsia.*

Etymology.—Forked tongue—referring to glossa shape.

Agathirsia campanisura Pucci and Sharkey, sp. n.

Distribution. (Fig. 11l).—Known only from type locality in Morelos, Mexico.

Holotype female.—Color: Black and orange. Black except orange as follows: maxillary and labial palpomeres mostly orange; clypeus partially orange ventrally; forecoxa and foretrochanter partially orange; remainder of foreleg orange; midleg orange; hind leg orange except hind tarsus black and orange; terga orange except black mottling; wings slightly infumate. *Body length:* excluding ovipositor 7.3. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 shorter than combined length of 3 + 4; mandible with indication of second tooth (as in Fig. 1b); glossa fork length 0.30; glossa length less than 2× galea length; glossa length 1.0; glossa length 0.77× shorter than foretibia length; malar space 0.46× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus without pits forming V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate anteriorly, barely impressed as smooth groove posteriorly; propodeum foveate, rugose posteriorly to spiracles, shallow medial longitudinal furrow partially smooth, setae present except along midline and posterior central area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 5–8; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.78× shorter than length of first ter-

gum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove vestigial; ovipositor length 4.3; ovipositor length 4.6× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype: ♀, Mexico, Morelos, Yautepec, vii.31.1963 (Parker & Stange) (USNM).

Remarks.—Similar to *A. nineseevensi*—see characters in the key. These two species also differ in the distance 1-cu-a and 1-M are from each other, however, intraspecific variation, when it is better understood, may make this character of limited value.

Etymology.—Bell calf—referring to the dilated hind tibia and narrow basitarsus.

Agathirsia capillata Pucci and Sharkey, sp. n.

Distribution (Fig. 11m).—South-central Mexico.

Females and males.—*Color:* Mostly black with some orange to yellow markings. Black except as follows: forefemur, tarsus, and tibia with some orange or pale yellow; midfemur mostly black, slightly orange distally; midtibia black and pale yellow to orange; midtarsus black and pale yellow; hind femur black or with some orange distally; hind tibia pale yellow basally and medially, hind tarsus black and orange to pale yellow; wings clear to slightly infumate. *Body length:* excluding ovipositor 7.2–8.0. *Head:* Longest seta at midlength of antenna approximately half antenna width (as in Fig. 7c); labial palpomere 2 subequal or shorter than combined length of 3 + 4; mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.17–0.18; glossa length less than 2× galea length; glossa length 0.49–0.64; glossa length 0.36–0.47× shorter than foretibia length; malar space 0.34–0.38× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a) or absent posteriorly; propodeum mildly rugose posteriorly mildly foveate anteriorly, shallow furrow along midline mildly sculptured, setae present except along midline and posterior central area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 7–11; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.61–0.74× shorter than length of first tergum; setae on tergum 3 long and dense on distal half (as in Fig. 6c); tergum 3 with transverse groove; ovipositor length 0.90–0.98; ovipositor length 0.68–0.89× shorter than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, Morelos, 12 mi. E Cuernavaca, 4300', viii.14.1954 (Chillcott) (AEIC). Paratypes: **Mexico:** Guerrero: 1♀, 33 mi. N Taxco, elev. 5700', viii.29.1963 (Scullen & Bolinger) (OSUO); Morelos: 1♀, 3 mi. NW Tequesquitango, viii.16.1962 (Roberts & Martson); 1♀, same data as holotype (AEIC); 1♂ [metasoma missing] same data as holotype except collector (Univ. Kans. Expedition) (SEMC); 1♀, 45 mi. S Cuernavaca, elev. 4300' ix.12.1957 (Scullen) (CNCI); Puebla: 1♂, 5 mi. S Izucar de Matamoros, viii.1.1963 (USNM).

Remarks.—Similar to *A. davidi, A. keni* and *A. parkeningi*—see characters in the key and remarks under *A. parkeningi.* In addition, *A. capillata* has longer setae throughout the body and reduced sculpture on the propodeum and pronotum compared to *A. davidi* (Fig. 5a) and *A. keni.*

Etymology.—Hairy—referring to the long and extensive setae.

Agathirsia collini Pucci and Sharkey, sp. n.

Distribution (Fig. 11e).—South-central Mexico.

Females and males.—*Color:* Mostly black with some orange or light brown as follows: maxillary and labial palpomeres mostly orange; foretrochantellus orange or brown; forefemur orange or orange and brown; foretibia and foretarsus orange; midtrochanter, midtrochantellus, and midfemur orange or orange and brown; midtibia entirely orange or with small black area basally; midtarsus orange; hind trochanter and hind trochantellus orange; hind femur usually orange; hind tibia entirely orange or slightly black basally; hind tarsus black and orange; wings clear or slightly infumate. *Body length:* excluding ovipositor 5.9–7.4. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 shorter than combined length of 3 + 4; mandible with or without indication of second tooth (as in Fig. 1b,c); glossa fork length 0.20–0.30; glossa length less than 2× galea length; glossa length 0.48–0.59; glossa length 0.44–0.53× shorter than foretibia length; malar space 0.31–0.46× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d) or wide and vestigial V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose, inverted V-shape anteriorly, setae present except along midline and posterior central area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 2–6; hind basitarsus either straight distally or very slightly tapered; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.71–0.92× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 without transverse groove; ovipositor length 2.2–2.3; ovipositor length 2.1–2.3× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, Puebla, Matamoros, ix.8–9.1948 (Wagner) (AEIC). Paratypes: **Mexico:** Puebla: 7♀, 1♂, same data as holotype or ix.10.1948 (AEIC); 2♂, Petalcingo, viii.3.1963 (Parker & Stange) (USNM); 1♀, 1♂, 3 mi. N Petalcingo (Parker & Stange) (USNM), 3♂, 5 mi. S Izucar de Matamoros, viii.1.1963 (Parker & Stange) (USNM).

Remarks.—Similar to *A. kellyi*, *A. michelei* and *A. papoui*—see characters in the key.

Etymology.—In honor of the senior author's cousin.

Agathirsia cressoni (Muesebeck and Walkley)

Microdus thoracicus Cresson 1872: 181 (preoccupied by Nees von Esenbeck 1834: 143—currently *Earinus thoracicus*). [Examined].
Agathirsia thoracicus Szepligeti 1904: 129.
Agathirsia cressoni Muesebeck and Walkley 1951: 116.

Distribution (Fig. 11a).—Southeastern Texas to northeastern Mexico.

Females and males.—*Color:* Orange and black; black except as follows: antenna orange basally; maxillary and labial palpomeres mostly orange; pronotum orange dorsally; mesoscutum orange except sometimes black medially or entirely black; scutellum black and/or orange; metanotum black or black and orange; propodeum black or with some orange; foretrochanter and foretrochantellus black, or black and orange; forefemur black and orange; foretibia and foretarsus orange to pale yellow; midtrochantellus black or black and orange; midfemur mostly black to mostly orange; midtibia and midtarsus orange to pale yellow; hind trochanter and hind trochantellus black to orange; hind femur mostly black except slightly orange distally, sometimes mostly orange; hind tibia pale yellow, usually somewhat orange in distal quarter; hind tarsus orange to pale yellow; first tergum orange basally, black distally; remaining terga orange with 0 to

6 transverse black bands especially on terga 2 and 3, bands sometimes broken medially, dark mottling also occurs on some specimens; forewing shaded yellow to infumate in basal half, infumate in distal half; hind wing infumate or slightly infumate. *Body length:* excluding ovipositor 9.7–11.2. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible with or without indication of second tooth (as in Figs. 1b,c); glossa fork length 0.21–0.32; glossa length less than 2× galea length; glossa length 1.2–1.3; glossa length 0.60–0.69× shorter than foretibia length; malar space 0.38–0.45× shorter than eye height; face above clypeus with median longitudinal carinae; area anterior to ocellus with pits forming vestigial or distinct V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum rugose posteriorly, foveate anteriorly, inverted V-shape anteriorly, setae present except along midline and posterior central area (Fig. 6b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 14–21; hind basitarsus tapered distally; 1-cu-a and 1-M in forewing separated by approximately the width of 1-M, sometimes slightly more. *Metasoma:* Posterior width of first tergum 0.75–0.94× shorter than length of first tergum; setae on tergum 3 not dense (as in Fig. 6d), present on distal one third or less; tergum 3 with transverse groove; ovipositor length 1.8–2.2; ovipositor length 1.0–1.2× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, USA, Texas, type No. 1728.1 (ANSP). Homotypes: (44♀♂) ATAM, AEIC, ANSP, CNCI, TAMU, USNM.

Remarks.—Similar to *A. nigricauda*—see characters in the key and remarks under *A. nigricauda.*

Agathirsia davidi Pucci and Sharkey, sp. n.

Distribution (Fig. 11l).—Southern Arizona and Texas to northern Mexico.

Females and males.—Color: Mostly black except as follows: fore and midfemora with small orange area distally; fore and midtibiae black and pale yellow/orange; all tarsi pale yellow to black; hind tibia pale yellow basally laterally; forewing clear to slightly infumate in basal half, infumate in distal half; hind wing clear to slightly infumate. *Body length:* excluding ovipositor 6.8–9.6. *Head:* Longest seta at midlength of antenna approximately half antenna width (as in Fig. 7c); labial palpomere 2 subequal (as in Fig. 4b) or less to palpomeres 3 + 4; mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.20–0.30; glossa length less than 2× galea length; glossa length 0.54–0.71; glossa length 0.44–0.58× shorter than foretibia length; malar space 0.24–0.30× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose, setae present except along midline and posterior central area (Fig. 6a); sternaulus foveate (Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws small to distinct; number of thick, apically flattened apical pegs on hind tibia 5–9; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (Fig. 9c). *Metasoma:* Posterior width of first tergum 0.56–0.68× shorter than length of first tergum; setae on tergum 3 not dense (as in Fig. 6d) present for approximately distal 0.4; tergum 3 with transverse groove distinct or vestigial; ovipositor length 1.5–2.1; ovipositor

length 1.4–1.8× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, USA, Arizona, Parker Canyon Lk., viii.20.1974 (H. & M. Townes) (AEIC). Paratypes: **Mexico:** Chihuahua: 1♀, 1♂, 118 km N Chihuahua, viii.29.1991 (Griswold) (CNCI); 1♂, General Trias, viii.20.1991 (Griswold) (CNCI); Sonora: 1♀, Alamos, elev. 1200′, ix.22.1963 (Scullen & Bolinger) (OSUO); 1♀, 14 mi. W Alamos, elev. 800′, ix.22.1963 (Scullen & Bolinger) (OSUO); 1♀, 17 mi. E Navajoa, elev. 700′, ix.22.1963 (Scullen & Bolinger) (OSUO); 1♂, road 35 km SE Cancoba, viii.23.1971 (Rozen & Favreau) (AMNH); 1♂, road 35 km SE Cancoba, viii.29.1984 (Pulawski) (CASC); **USA:** Arizona: 2♀, 2♂, Cochise Co., Chiri. Mts. Pinery Cyn., 10 mi. NW Onion Saddle, viii.16.1965 (Ballmer) (USNM); 1♂, Cochise Co., Apache, viii.18.1964 (Rozen) (AMNH); 1♀, Cochise Co., Apache, viii.20.1971 (Rozen & Favreau) (AMNH); 1♂, Cochise Co., Willcox, viii.18.1958 (Hurd) (USNM); 1♀, Canelo, viii.22.1974 (H. & M. Townes) (AEIC); 2♀, Nogales, viii.24.1939 (Crandall) (USNM); 3♂, Nogales, viii.22.1974 (H. & M. Townes) (AEIC); 1♀, 3♂, Santa Cruz Co., 5 mi. N Lochiel, ix.6.1971 (Grissell & Denno) (UCDC); 1♀, 1♂, Santa Cruz Co., 17 mi. NE Patagonia, elev. 4950′, viii.27.1955 (Scullen) (USNM); 1♂, Santa Cruz Co., Pena Blanca, viii.30.1963. (Parker & Stange) (USNM); 3♀ same data as holotype (AEIC); 1♂, Sonoita, viii.21.1974 (H. & M. Townes) (AEIC); 1♀, 1♂, Pima Co., Sycamore, elev. 4000′, viii.15–16.1993 (Sharkey) (CNCI); Texas: 1♀, Jeff Davis Co., Madera Co., W Ft. Davis, viii.23.1969 (Board & Hafernik) (TAMU); 1♀, Jeff Davis Co., 20 mi. S Toyahvale on SR 17, viii.23.1974 (Greenbaum) (TAMU); 1♂, Jeff Davis Co., 11.3 mi. W SR 17 on SR 166, viii.21.1974 (Greenbaum) (TAMU); 4♂, Jeff Davis Co., Limpia Cyn., 2.3–4.1 mi. W Davis Mts., State Park on SR 118, viii.18–[illegible]1974 (Greenbaum) (TAMU); 2♂, 1 mi. N Rockpile, W of Ft. Davis, viii.23.1969 (Board & Hafernik) (TAMU).

Remarks.—Similar to *A. capillata*, *A. keni* and *A. parkeningi*—see characters in the key and remarks under *A. capillata* and *A. parkeningi*.

Etymology.—In honor of the senior author's brother.

Agathirsia foveiseries Pucci and Sharkey, sp. n.

Distribution (Fig. 11h).—Known only from type locality in Arizona.

Holotype female.—Color: Mostly orange and black; orange except as follows: antenna black distally; maxillary and labial palpomeres black and orange; propleuron black; mesoscutum and scutellum orange; mesopleuron orange, black ventrally; metanotum orange; propodeum black and orange; metapleuron black and orange; forecoxa black; foretrochanter black and orange; foretarsus orange to testaceous; mid and hind trochanter black and orange; hind coxa with a little black; hind trochantellus black and orange; first tergum yellowish basally; remaining terga orange except dark mottling present; wings slightly infumate in basal half, infumate in distal half. *Body length:* excluding ovipositor 6.8. *Head:* Longest seta at midlength of antenna subequal to antenna width (as in Fig. 7c); labial palpomere 2× longer than combined length of 3 + 4 (similar to Fig. 4b); mandible with indication of second tooth (as in Fig. 1b); glossa fork length 0.41; glossa length less than 2× galea length; glossa length 0.78; glossa length 0.62× shorter than foretibia length; malar space 0.53× shorter than eye height; face above clypeus with median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion with line of foveae (as in Fig. 3d). *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum rugose. longitudinal oval shape medially, setae present except posterior central area and somewhat along midline;

sternalus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 6–8; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.46× shorter than length of first tergum; setae on tergum 3 present distal half; tergum 3 with transverse groove vestigial; ovipositor length 1.7; ovipositor length 1.4× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype: ♀, USA, Arizona, Douglas, viii.27.1979 (Bohart) (UCDC).

Remarks.—The combination of facial sculpture and coloration is distinctive for this species. Due to the variation of propodeal sculpture found in *Agathirsia* and the fact that only one specimen has been examined, the oval-shaped areola of the propodeum, noted above, may not be a reliable character.

Etymology.—Line of foveae—referring to the lines of foveae on the face.

Agathirsia fulvocastanea Westwood

Agathirsia fulvo-castanea Westwood 1882: 22. [Examined].

Distribution.—Only known from the type locality which is an unknown site in Mexico.

Holotype female.—Color: Mostly orange to brownish orange; parts with other coloration are as follows: Antenna black distally; head with black areas medially on face and frons; pronotum slightly black ventrally; propleuron black; mesopleuron black ventrally; propodeum with small black area posteriorly; metapleuron black posteriorly; forecoxa black; midcoxa black; hind coxa with small black area ventrally; first tergum black basally; forewing slightly infumate in basal half, infumate in distal half; hind wing slightly infumate. *Body length:* excluding ovipositor 8.4. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 subequal to (as in Fig. 4b) or shorter than combined length of 3 + 4; mandible with indication of second tooth (as in Fig. 1b); glossa fork length 0.51; glossa length less than 2× galea length; glossa length 1.1; glossa length 0.79× shorter than foretibia length; malar space 0.53× shorter than eye height; face above clypeus with median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose to foveate, setae present except along midline (similar to Figs. 9a,b); sternaulus foveate (as in Fig. 5a) for posterior half to three quarters, absent anteriorly; mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 3–6; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.81× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove; ovipositor length 4.0; ovipositor length 2.7× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, 75 (Coffin) (OXUM).

Remarks.—Similar to *A. proxima, A. reai* and *A. rufula*—see characters in the key. In addition, *A. fulvocastanea* has foveate notauli and an indication of a second tooth unlike *A. proxima* and *A. rufula*. The presence of brownish-orange should not be used to decisively identify this species considering the similarity to what is called orange elsewhere.

Agathirsia heleni Pucci and Sharkey, sp. n.

Distribution (Fig. 11b).—Known only from type locality in San Luis Potosi, Mexico.

Holotype female and paratype male.—*Color:* Mostly orange except as follows: antenna black; head entirely black except clypeus sometimes dark orange; pronotum black ventrally; propleuron black; propodeum and metapleuron black; forecoxa black; foretrochanter and fore-trochantellus black or black and orange; midcoxa black or orange; midtrochanter black or black and orange; midtrochantellus, midfemur, midtibia, and midtarsus black; hind coxa black or black and orange; hind trochanter black or orange; hind trochantellus black or dark orange; hind femur black; hind tibia black distally, dark orange to black basally; hind tarsus black and orange; first tergum black; tergum 2 black basally, remaining terga dark orange or orange with black mottling; wings slightly infumate. *Body length:* excluding ovipositor 5.4–6.7. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 subequal to (as in Fig. 4b) or shorter than combined length of 3 + 4; mandible with very weak indication of second tooth; glossa fork length ~0.10 (?, difficult to measure on specimen); glossa length less than 2× galea length; glossa length 0.48? (glossa folded); glossa length 0.33–0.49× shorter than foretibia length; malar space 0.43× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus with pits partially forming V-shape (similar to Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose and setae present except smooth and glabrous along midline and posterior central area (setae as in Fig. 6a); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 3–5; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.74–0.77× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove; ovipositor length 1.4; ovipositor length 1.75× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, [San Luis Potosi], Metehuala, x.25.62 N.L. (Townes) (AEIC). Paratype: 1♂, same data as holotype (AEIC).

Remarks.—Similar to *A. armandi* and *A. bicolor*—see characters in the key and remarks under those species. The glossa in *A. armandi* and *A. bicolor* seems to be about twice the length of *A. heleni* but proper measurement of *A. heleni* has not been attained due to the condition of the specimens.

Etymology.—In honor of the senior author's mother.

Agathirsia jervisi Pucci and Sharkey, sp. n.

Distribution.—Known only from the type locality in Guerrero, Mexico.

Holotype female.—*Color:* Mostly black except as follows: antenna fuscous distally, pedicel orange distally; maxillary palp brown, lighter distally; labial palp fuscous basally and gradually turning yellow distally; ventral margin of clypeus brownish-orange; tibiae with small orange area basally and distally; fore- and mid tarsi mostly orange; hind tarsus partly orange; forewing clear in basal half, infumate in distal half; hind wing clear in basal half, slightly infumate in distal half. *Body length:* excluding ovipositor 5.8. *Head:* Longest seta at midlength of antenna approximately half antenna width (as in Fig. 7c); labial palpomere 2 subequal to combined length of 3 + 4; mandible with indication of second tooth (as in Fig. 1b); glossa fork length unknown; glossa length more than 2× galea length; glossa length 1.2; glossa length 1.0× longer than foretibia length; malar space .25× shorter than eye height; face above clypeus without longitudinal carinae; area anterior to ocellus with pits

forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum rugose, setae present except posterior central area; sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 3; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum .85× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 without transverse groove; ovipositor length 1.0; ovipositor length .98× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype: ♀, Mexico, Amula, Guerrero, 6000 ft. Aug. (H.H. Smith) Godman-Salvin Coll. (BMNH).

Remarks.—This is the only species with elongated labial palpi that are convex medially and form a drinking tube.

Etymology.—The specific name is in honor of Mark Jervis for his interesting research on hymenopteran mouthpart morphology.

Agathirsia kellyi Pucci and Sharkey, sp. n.

Distribution (Fig. 11i).—Known only from type locality in Puebla, Mexico.

Holotype male.—Color: Mostly Black except as follows: all femora and tibiae orange; all tarsi mostly orange; wings slightly infumate. *Body length:* excluding ovipositor 7.1. *Head:* Longest seta at midlength of antenna subequal to antenna width (as in Fig. 7c); labial palpomere 2 shorter than combined length of 3 + 4; mandible with indication of second tooth (as in Fig. 1b); glossa fork length 0.13; glossa length less than 2× galea length; glossa length 0.62; glossa length 0.52× shorter than foretibia length; malar space 0.36× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus without pits forming V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli complete, non foveate (as in Fig. 5b); propodeum foveate, inverted V-shape anteriorly, setae present except along midline and posterior central area (as in Fig. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 1–2; hind basitarsus straight distally; 1-cu-a and 1-M in forewing separated by a distance subequal to width of 1-M (see Fig. 9c). *Metasoma:* Posterior width of first tergum 0.68× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove vestigial; ovipositor length unknown.

Females.—Unknown.

Specimens examined.—Holotype: ♂, Mexico, Puebla, Huegotzingo, elev. 5–6000', viii.17.1962 (Milliron) (CNCI).

Remarks.—Similar to *A. collini*, *A. michelei* and *A. papoui*—see characters in the key.

Etymology.—In honor of the senior author's aunt.

Agathirsia keni Pucci and Sharkey, sp. n.

Distribution (Fig. 11g).—Known from 2 localities in Jalisco, Mexico.

Holotype female and paratype male.—Color: Mostly black except as follows: foretibia black or orange to brown; foretarsus sometimes with some orange distally; midtibia black or orange to brown; midtarsus orange to mostly black; hind tibia mostly pale yellow basally; forewing clear or slightly infumate in basal half, slightly infumate to infumate in distal half; hind wing clear to slightly infumate. *Body length:* excluding ovipositor 7.8–8.3. *Head:* Longest seta at midlength of antenna ap-

proximately half antenna width (as in Fig. 7c); labial palpomere 2 shorter than combined length of 3 + 4; presence of 2nd mandibular tooth not seen due to specimen position; glossa fork length 0.43; glossa length less than 2× galea length; glossa length 0.70–0.83; glossa length 0.51–0.61× shorter than foretibia length; malar space 0.33–0.37× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d) or vestigial V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum rugose, setae present except along midline (similar to Fig. 6a); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 5–8; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.79–0.92× shorter than length of first; setae on tergum 3 not dense (as in Fig. 6d), present on distal half; tergum 3 with transverse groove; ovipositor length 2.1; ovipositor length 1.6× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, Jalisco, 18 mi. SW Guadalajara, ix.6.1971 (Villegas & Kane) (UCDC). Paratype: **Mexico:** Jalisco: 1♂, Lagos de Moreno, elev. 6300', viii.12.1954 (Dreisbach) (USNM).

Remarks.—Similar to *A. capillata, A. davidi* and *A. parkeningi*—see characters in the key and remarks under *A. capillata.*

Etymology.—In honor of the senior author's uncle.

Agathirsia longigladia Pucci and Sharkey, sp. n.

Distribution (Fig. 11g).—Known only from type locality in Morelos, Mexico.

Holotype male and paratype male.—Color: Black except as follows: maxillary and labial palpomeres with some pale color femora and tibiae of fore and midlegs with small orange area distally; hind tibia with small orange area basally; forewing infumate or slightly infumate; hind wing clear to infumate in basal half, slightly infumate to infumate in distal half. *Body length:* excluding ovipositor 7.3–7.4. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 shorter than combined length of 3 + 4; mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.37–0.45; glossa length more than 2× galea length; glossa length 3.4–3.5; glossa length 2.6–2.7× longer than foretibia length; malar space 0.29–0.33× shorter than eye height; face above clypeus without or with vestigial longitudinal carinae; area anterior to ocellus without pits forming V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose posteriorly, foveate and longitudinal medial furrow anteriorly, setae present except along midline and posterior central area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 2–3; hind basitarsus straight distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.80× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove vestigial; ovipositor length 8.2; ovipositor length 8.2× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, Morelos, Cuernavaca, 3i.19–21.1987 (Parker) (CNCI). Paratype: 1♂, same data as holotype (CNCI).

Remarks.—The combination glossa

length and coloration make this species distinctive.

Etymology.—Long sword—referring to the elongate ovipositor.

Agathirsia longilingua Pucci and Sharkey, sp. n.

Distribution (Fig. 11j).—Central Mexico.

Females and males.—*Color:* Mostly black except as follows: maxillary and labial palpomeres mostly orange; clypeus sometimes partially orange; fore and midfemora orange or orange and black; all tibiae and tarsi orange; hind femur black and orange, orange may be restricted to extreme distal portion; forewing slightly infumate or infumate in basal half, infumate in distal half; hind wing slightly infumate. *Body length:* excluding ovipositor 8.0–9.3. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 shorter than combined length of 3 + 4; mandible with or without indication of second tooth (as in Fig. 1b,c); glossa fork length 0.63–0.72; glossa length more than 2× galea length; glossa length 4.5–5.5; glossa length 2.8–3.1× longer than foretibia length; malar space 0.50–0.59× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum foveate except smooth or mostly smooth central area and rugosity surrounding and below spiracles, setae present except narrowly along midline (similar to Fig. 6a); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 10–12; hind basitarsus tapered distally; distance between 1-cu-a and 1-M in forewing subequal to the width of 1-M (see Fig. 9c). *Metasoma:* Posterior width of first tergum 0.80–0.93× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove distinct to absent; ovipositor length 5.3–6.9; ovipositor length 4.4–4.7× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, Jalisco, San Fandia [San Fandila?], ix.24.1963 (Michelbacher) (EMEC). Paratypes: **Mexico:** Jalisco: 1♂, same data as holotype (EMEC); Queretaro: 3♀, 9 mi. N Queretaro, ix.21.1977 (Chemsak & A.&M. Michelbacher) (EMEC); Zacatecas: 1♀, 8 mi. NW Rio Grande ix.27.1975 (Villegas) (UCDC).

Remarks.—The combination of glossa length and coloration distinguishes this species from all others in the genus.

Etymology.—Long tongued—referring to the elongate glossa.

Agathirsia michelei Pucci and Sharkey, sp. n.

Distribution (Fig. 11l).—Known only from type locality in Jalisco, Mexico.

Holotype female.—*Color:* Mostly black and orange; black except as follows: maxillary and labial palpomeres mostly orange; all trochanters black and orange; all trochantelli femora and tibiae orange; terga with 3 dark reddish-brown transverse bands on terga 2 and 3; wings slightly infumate. *Body length:* excluding ovipositor 8.2; *Head:* Longest seta at midlength of antenna approximately half antenna width (as in Fig. 7c); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.49; glossa length less than 2× galea length; glossa length 1.4; glossa length equal to foretibia length; malar space 0.49× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus with pits forming vestigial V-shape (similar to Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum foveate, setae present except

along midline and central posterior area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 7–8; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.74× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove; ovipositor length 5.4; ovipositor length 4.9× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype: ♀, Mexico, Jalisco, 12 mi. S Encarnacion de Diaz (C. & P. Vaurie) (AMNH).

Remarks.—Similar to *A. collini, A. kellyi* and *A. papoui*—see characters in the key.

Etymology.—In honor of the senior author's sister-in-law.

Agathirsia minuata Pucci and Sharkey, sp. n.

Distribution (Fig. 11k).—Known only from type locality.

Holotype female.—Color: Mostly orange except as follows: antenna black distally; mesosoma orange except propodeum somewhat darkened; midleg somewhat darkened, hind tibia darkened distally; hind tarsus black; large brown area on terga 2 and 3 (likely the result of stains caused by internal fluids); wings very slightly infumate. *Body length:* excluding ovipositor 5.7. *Head:* Longest seta at midlength of antenna approximately half antenna width (as in Fig. 7c); labial palpomere 2 shorter than combined length of 3 + 4; mandible with weak indication of second tooth; glossa fork length unknown; glossa length less than 2× galea length; glossa length approximately 0.20; glossa length 0.20× shorter than foretibia length; malar space 0.55× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum foveate, sparse setae present laterally; sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 1–2; hind basitarsus straight distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.71× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 without transverse groove; ovipositor length 0.54; ovipositor length 0.73× shorter than hind basitarsus length.

Male.—Unknown.

Specimens examined.—Holotype: ♀, [USA, New Mexico] Hidalgo Co., Rodeo, viii.21.1958 (Bohart) (UCDC).

Remarks.—The combination of glossa length and coloration distinguishes this species from all others in the genus.

Etymology.—Small—referring to the relatively small glossa, ovipositor and overall length.

Agathirsia nigricauda (Viereck)

Crassomicrodus nigricaudus Viereck 1905: 288. [Examined].
Microdus nigricaudus Withington 1909: 329.
Agathirsia nigricauda Muesebeck 1927: 14.

Distribution (Fig. 11i).—Common in northern Mexico and southern Arizona, New Mexico, and Texas; occasionally found in states somewhat north of these.

Females and male.—Color: Quite variable, black and orange: black except as follows: Antenna orange basally; maxillary and labial palpomeres mostly orange; rarely orange behind ocelli and lateral area of face; clypeus sometimes orange; pronotum orange dorsally; mesoscutum orange, some-

times with black area anteriorly; scutellum black and/or orange; mesopleuron usually black, rarely mostly orange to orange; metanotum sometimes black and orange; propodeum black or black and orange, rarely entirely orange; metapleuron rarely with some orange; legs orange except: coxae of fore and midlegs black and/or orange, hind coxa orange or black and orange, fore and midtibiae orange to pale yellow, hind tibia pale yellow except usually at least somewhat orange in distal quarter, tarsi orange to testaceous; terga orange basally, black distally, rarely with black area basally and orange distally; forewing shaded yellow in basal half, slightly infumate to infumate in distal half; hind wing slightly infumate to infumate. *Body length:* excluding ovipositor 9.1–10.4. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 subequal to palpomeres 3 + 4 (Fig. 4b); mandible without indication of second tooth (as in Fig. 1c) or very weak; glossa fork length 0.19–0.34; glossa length less than 2× galea length; glossa length 1.2–1.5; glossa length 0.68–0.95× shorter than foretibia length; malar space 0.35–0.47× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d) or vestigial; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate, usually incomplete anteriorly (~75%) otherwise weakly or totally complete; propodeum foveate to rugose, less sculpture anteriorly, often with inverted V-shape anteriorly, central area usually depressed with sculpture differentiated from surrounding areas, setae present except along midline and central posterior area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 11–18; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.65–0.85× shorter than length of first tergum; setae on tergum 3 not dense (as in Fig. 6d), present on distal one third or less; tergum 3 with transverse groove distinct or vestigial; ovipositor length 2.2–3.2; ovipositor length 1.3–2.1× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Colorado, Colorado Springs, 5015 ft., 643, viii (Tucker) (SEMC). Homotypes: (200♀♂) AEIC, AMNH, CASC, CNCI, EMEC, LACM, MSUC, OSUO, SEMC, TAMU, UCDC, USNM.

Remarks.—Similar to *A. cressoni*—see characters in the key. The characters we used to separate these either have rare exceptions, e.g., terga coloration, hind femur color, notauli sculpture, and relative glossa length, or can be very similar, e.g., relative length of ovipositor. Although these species overlap in time and space, *A. nigricauda* has a greater geographic range and an earlier flight period. Specimens of both species have been collected within a few days from each other, late September to early October, in Pearsall, Texas. These specimens are housed in TAMU.

Agathirsia ninesevensi Pucci and Sharkey, sp. n.

Distribution (Fig. 11a).—Known only from type locality in Texas.

Holotype female.—Color: Mostly black except as follows: antenna fuscous basally; maxillary and labial palpomeres black and orange; foretrochantellus, forefemur, foretibia, and foretarsus orange; midtrochantellus, midfemur, midtibia, and midtarsus orange; hind leg orange except hind coxa black; terga orange except tergum 1 and distal tip of metasoma black; wings infumate. *Body length:* excluding ovipositor 8.2. *Head:* Longest seta at midlength of antenna > half antenna width (as in Fig. 7a); labial palpomere 2 shorter than combined length of 3 + 4; mandible without indi-

cation of second tooth (as in Fig. 1c); glossa fork length 0.23; glossa length less than 2× galea length; glossa length 0.94; glossa length 0.67× shorter than foretibia length; malar space 0.54× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus without pits forming V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate anteriorly, present as smooth groove medially and posteriorly; propodeum with large smooth and glabrous area medially, weak rugosity and sparse setae elsewhere; sternaulus foveate (as in Fig. 5a) posteriorly, smooth groove anteriorly; mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 3–4; hind basitarsus tapered distally; 1-cu-a and 1-M in forewing partially or nearly overlapping. *Metasoma:* Posterior width of first tergum 0.61× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 without transverse groove; ovipositor length 3.4; ovipositor length 2.8× longer than hind basitarsus length.

Male.—Unknown.

Specimens examined.—Holotype: ♀, USA, Texas, Pecos Co., x.17.1973 (Bohart) (UCDC).

Remarks.—Similar to *A. campanisura*—see characters in the key and remarks under *A. campanisura.*

Etymology.—In honor of the musical group Old 97's.

Agathirsia papoui Pucci and Sharkey, sp. n.

Distribution (Fig. 11b).—Central Mexico.

Females and males.—*Color:* Most black except as follows: maxillary and labial palpomeres sometimes with pale color; femora orange; tibiae orange except hind tibia may be darkened distally; tarsi orange or mostly orange except hind tarsus may be dark orange; wings clear to slightly infumate. *Body length:* excluding ovipositor 7.8–8.6. *Head:* Longest seta at midlength of antenna subequal to half or less antenna width (as in Figs. 11b,c); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible with or without indication of second tooth (as in Figs. 1b,c); glossa fork length 0.11–0.24; glossa length less than 2× galea length; glossa length 0.49–0.60; glossa length 0.36–0.46× shorter than foretibia length; malar space 0.28–0.33× shorter than eye height; face above clypeus with median longitudinal carinae; area anterior to ocellus with or without pits forming V-shape; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose, central area depressed, setae present except narrowly along midline (similar to Fig. 6a); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 9–15; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.67–0.73× shorter than length of first tergum; setae on tergum 3 not dense (as in Fig. 6d), present on distal third to half; tergum 3 with transverse groove; ovipositor length 0.83–0.88; ovipositor length 0.69–0.73× shorter than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, Hidalgo, 13.5 mi. NE Tizayuca, elev. 7700', viii.28.1962 (SEMC). Paratypes: **Mexico:** Guanajuato: 1♂, 10 mi. NW Leon, viii.19.1954 (Chillcott) (CNCI); Hidalgo: 1♀, 3♂, same data as holotype (SEMC); 1♂, same data as holotype except 3.5 mi. NE Tizayuca (SEMC); Jalisco: 1♂ [metasoma missing], 1♂, Guadalajara, [♂ date], (McClendon) (ANSP).

Remarks.—Similar to *A. collini, A. kellyi* and *A. michelei*—see characters in the key. We have viewed a damaged specimen re-

sembling *A. papoui* except that the length of the glossa appears to be subequal to the foretibia. It was collected in Mexico, Jalisco, Largos de Moreno, elev. 6400', August 21, 1954 and is housed in SEMC.

Etymology.—In honor of the senior author's grandfather.

Agathirsia parkeningi Pucci and Sharkey, sp. n.

Distribution (Fig. 11e).—Known only from type locality in Jalisco, Mexico.

Holotype female.—Color: Mostly black except as follows: maxillary and labial palpomeres with some pale color; all femora with small orange area distally; all tibiae with some orange basally; foretarsus with some pale color; midtarsus mostly black; hind tarsus pale yellow basally, black distally; wings infumate. *Body length:* excluding ovipositor 7.1. *Head:* Longest seta at midlength of antenna approximately half or < half antenna width (as in Fig. 11b-c); labial palpomere 2 shorter than combined length of 3 + 4; mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.49; glossa length less than 2× galea length; glossa length 1.2; glossa length 0.86× shorter than foretibia length; malar space 0.43× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum foveate, setae present throughout; sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 3–4; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.60× shorter than length of first tergum; setae on tergum 3 not dense (as in Fig. 6d), present on distal one third; tergum 3 with wide shallow area; ovipositor length 5.6; ovipositor length 5.1× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype: ♀, Mexico, Jalisco, Zapotlanejo, x.3.[19]66 (G.E. & A.S. Bohart) (CNCI).

Remarks.—Similar to *A. capillata*, *A. davidi* and *A. keni*—see characters in the key. In addition, glossa length and malar space are distinctly longer in *A. parkeningi* than in the others.

Etymology.—In honor of the musician Christopher Parkening.

Agathirsia proxima Westwood

Agathirsia proxima Westwood 1882: 22. [Examined].

Agathirsia rufiventris Westwood 1882: 21. [Examined]. **Syn. n.**

Distribution (Fig. 11h).—Central to southern Mexico.

Females and males.—Color: Orange and black, color quite variable; antenna orange basally black distally; maxillary and labial palpomeres mostly orange; head orange except at least central area of face black, often frons and face black, rarely entirely black; pronotum varies from orange, to black with small orange area dorsally; propleuron black or orange and black; mesoscutum orange; scutellum orange or black and orange; mesopleuron mostly orange to black; metanotum black or black and orange; propodeum black to orange; metapleuron black to mostly orange with some black; (rarely mesosoma entirely black); legs orange except sometimes black on basal portion of coxae, tarsi orange to pale yellow; terga orange except often with black or dark orange mottling; forewing slightly infumate in basal half, infumate or slightly infumate in distal half; hind wing slightly infumate. *Body length:* excluding ovipositor 7.3–9.0. *Head:* Longest seta at midlength of antenna approximately half or < half antenna width (as in Figs. 11b,c); labial palpomere 2

shorter than combined length of 3 + 4; mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.56–0.69; glossa length more than 2× galea length; glossa length 3.1–3.9; glossa length 2.2–2.8× longer than foretibia length; malar space 0.38–0.49× shorter than eye height; face above clypeus without or with vestigial longitudinal carinae; area anterior to ocellus with pits forming vestigial V-shape (similar to Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli complete, non foveate (Fig. 5b); propodeum weakly sculptured, usually with small depression along anterior midline, smooth below, setae present except along midline and central posterior area (as in Figs. 9a,b); sternaulus with few foveae at extreme base (Fig. 5c); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 3–6; hind basitarsus straight distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.59–0.82× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove distinct to absent; ovipositor length 6.0–7.1; ovipositor length 5.0–5.6× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, 74 (Coffin) (OXUM). Coffin #25 "Also at Los Barros. Hovering in the neighbourhood of plants inhabited by larvae." Homotypes: (33♀♂) AMNH, CNCI, EMEC, OXUM, UCDC.

Remarks.—Very similar to *A. rufula*—the characters in the key are the only ones found to distinguish these species. Also similar to *A. fulvocastanea* and *A. reai*—see characters in the key and remarks under *A. fulvocastanea*. We have viewed three specimens that we consider to be melanic forms, one of these being the holotype of *A. rufiventris*. The head and mesosoma are completely black.

Agathirsia reai Pucci and Sharkey, sp. n.

Distribution (Fig. 11k).—South-central Mexico.

Females.—Color: Mostly orange except as follows: antenna black or with some orange basally; maxillary and labial palpomeres mostly orange; head black except orange clypeus and behind ocellus; propodeum and metapleuron with some black; wings clear in basal half, infumate in distal half or slightly infumate throughout. *Body length:* excluding ovipositor 6.5–7.4. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible with indication of second tooth (as in Fig. 1b); glossa fork length 0.31; glossa length less than 2× galea length; glossa length 0.89–1.0; glossa length 0.71–0.86× shorter than foretibia length; malar space 0.45–0.53× shorter than eye height; face above clypeus with distinct or vestigial longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum foveate, with or without inverted V-shape anteriorly, setae present except along midline and central posterior area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 1–2; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.73–0.82× shorter than length of first tergum; setae on tergum 3 absent; tergum 3 with shallow indentation; ovipositor length 5.4–6.3; ovipositor length 5.4–5.7× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype: ♀, Mexico, Morelos, Lk. Tequesquitengo, approx. 5000′, ix.13.1957 (Scullen) (CNCI). Paratype: **Mexico:** Puebla: 1♀, Chietla, Atencingo, elev. 1098 m, ix.25.1989 (Pena) (ATAM).

Remarks.—Similar to *A. fulvocastanea*, *A. proxima* and *A. rufula*—see characters in the key and remarks under *A. fulvocastanea*.

Etymology.—In honor of the senior author's grandmother.

Agathirsia rostrata Pucci and Sharkey, sp. n.

Distribution (Fig. 11g).—Northeastern to south-central Mexico.

Females and males.—*Color:* Mostly black except as follows: antenna sometimes dark orange basally; fore and midfemora sometimes with small orange area distally; foretibia completely fuscous or orange basally; foretarsus orange or fuscous basally; midtibia orange or fuscous basally; midtarsus orange basally; hind tibia orange basally; hind tarsus black and orange; wings infumate. *Body length:* excluding ovipositor 5.8–6.8. *Head:* Longest seta at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 shorter than combined length of 3 + 4; mandible with indication of second tooth (as in Fig. 1b) or vestigial; glossa fork length 0.10–0.14; glossa length less than 2× galea length; glossa length 0.48–0.53; glossa length 0.45× shorter than foretibia length; malar space 0.50–0.59× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus with or without pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion with line of foveae, rarely vestigial (Fig. 3d). *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum mildly rugose, sometimes with medial furrow anteriorly, long, dense setae throughout; sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a) or vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 1–5; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.63–0.65× shorter than length of first tergum; setae on tergum 3 not dense (as in Fig. 6d), present on distal half; tergum 3 without transverse groove; ovipositor length 2.8–3.1; ovipositor length 2.5–2.8× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, Puebla, 30 mi. SW Tehuacan, elev. 6800′, x.13.1968 (R.H. & E.M. Painter) (AEIC). Paratypes: **Mexico:** Nuevo Leon: 1♀, San Pedro Iturbide, 32 km W Linares, x.6.1962 (H. & M. Townes) (AEIC); Puebla: 1♀, same data as holotype (AEIC); 1♂, nr. Puebla, x.15.1962 (Townes) (AEIC).

Remarks.—The combination of facial sculpture and coloration is diagnostic for this species. In addition, the head in frontal view appears somewhat like a rostrum (Fig. 3d), similar to that of *Agathis* species.

Etymology.—Beaked, with a muzzle—referring to the head shape.

Agathirsia rufula Westwood

Agathirsia rufula Westwood 1882: 21. [Examined].

Distribution (Fig. 11d).—South-central Mexico.

Females and males.—*Color:* Mostly orange except as follows: antenna black distally; maxillary and labial palpomeres with some orange; frons and face black medially; pronotum black ventrally; propleuron black or black and orange; mesopleuron mostly black to mostly orange; metanotum orange or black and orange; propodeum black and orange; metapleuron black or black and orange; tarsi sometimes pale yellow; terga usually orange to dark orange except black mottling often present; wings infumate to slightly infumate.

Body length: excluding ovipositor 6.8–8.2. *Head:* Longest seta at midlength of antenna approximately half or < half antenna width (as in Fig. 11b-c); labial palpomere 2 shorter than palpomeres 3 + 4; mandible without indication of second tooth (as in Fig. 1c); glossa fork length 0.45–0.51; glossa length more than 2× galea length; glossa length 2.1–2.6; glossa length 1.6–2.0× longer than foretibia length; malar space 0.48–0.51× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming wide V-shape or vestigial wide V-shape (similar to Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli not foveate (as in Fig. 5b), complete or not complete; propodeum weakly sculptured, depression along anterior midline, setae present except along midline and central posterior area (as in Figs. 9a,b); sternaulus foveate (as in Fig. 5a) posteriorly, absent anteriorly; mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 2–6; hind basitarsus straight distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.69–0.84× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 with transverse groove; ovipositor length 4.4–5.8; ovipositor length 4.0–6.1× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, 72 (Coffin) (OXUM). Coffin # 405 Sept. 1840, nr. Chapultepec. Homotypes: (8♀♂) AEIC, ATAM, CNCI, OSUO, OXUM.

Remarks.—Very similar to *A. proxima*—the characters in the key are the only ones found to distinguish the two species. Also similar to *A. fulvocastanea* and *A. reai*—see characters in the key and remarks under *A. fulvocastanea*.

Agathirsia sericans (Westwood)

Agathona sericans Westwood 1882: 23. [Lectotype. Examined].
Agathirsia sericans Szepligeti 1904: 129.

Distribution (Fig. 11c).—Southwestern to south-central Mexico.

Females and males.—*Color:* Mostly black except as follows: antenna sometimes orange basally; maxillary and labial palpomeres with some pale color; mesoscutum sometimes partly orange; fore and mid legs from entirely orange to black; hind femur sometimes with small orange area distally; hind tibia with some orange; hind tarsus with varying degrees of orange; first tergum with yellow or orange area basally; tergum 2 yellow basally; forewing infumate but usually darker in distal half; hind wing slightly infumate. *Body length:* excluding ovipositor 10.0–11.6. *Head:* Longest seta at midlength of antenna approximately half antenna width or shorter (as in Fig. 11b,c); labial palpomere 2 subequal to combined length of 3 + 4 (as in Fig. 4b); mandible with or without indication of second tooth (as in Figs. 1b,c); glossa fork length 0.38–0.47; glossa length less than 2× galea length; glossa length 1.5–1.8; glossa length 0.85–1.2× as long as foretibia length; malar space 0.31–0.39× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus with pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum foveate to rugose, often with inverted V-shape anteriorly and carina extending from medial posterior end to center of propodeum, setae present throughout or glabrous along midline and/or posteriorly; sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws small to vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 8–13; hind basitarsus tapered distally; 1-cu-

a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.43–0.53× shorter than length of first tergum; setae on tergum 3 dense on distal 0.75 to throughout and colored yellow except rarely white; tergum 3 with transverse groove distinct to absent; ovipositor length 1.0–1.6; ovipositor length .63-.87× shorter than hind basitarsus length.

Specimens examined.—Lectotype: ♀, Mexico, 76 ½ (Coffin) (OXUM): designated by van Achterberg, 1980. Homotypes: (19♀♂) AEIC, ATAM, EMEC, CASC, CNCI, LACM, MSUC, OSUO, OXUM, SEMC.

Remarks.—Similar to *A. trichiosoma* and *A. asterophila*—see characters in the key.

Agathirsia testacea Muesebeck

Agathirsia testacea Muesebeck 1927: 13. [Examined].

Distribution (Fig. 11j).—Central California to southeast Texas south to central Mexico.

Females and males.—Color: Mostly orange except as follows: antenna black distally; maxillary and labial palpomeres partly black; mesosoma may contain black areas; hind tibia usually black distally and hind tarsus usually somewhat darkened; black mottling usually present on terga; fore and hind wings from completely infumate to clear in basal half and infumate in distal half. *Body length:* excluding ovipositor 6.7–8.4 (one exceptional specimen 5.5). *Head:* Longest setae at midlength of antenna < half antenna width (as in Fig. 7b); labial palpomere 2 shorter than combined length of palpomeres 3 + 4; mandible with indication of second tooth (Fig. 1b), rarely distinct or weak indication; glossa fork length 0.12–0.20; glossa length less than 2× galea length; glossa length 0.43–0.53; glossa length 0.35–0.42× shorter than foretibia length; malar space 0.48–0.65× shorter than eye height; face without median longitudinal carinae; area anterior to ocellus with pits forming distinct V-shape (Fig. 7d) or vestigial; area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli complete, varying from smoothly impressed to foveate; propodeum rugose, setae present laterally; sternaulus foveate (as in Fig. 5a); mesepisternum with pair of lobes between midcoxae (Fig. 5d); basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 6–14; hind basitarsus tapered distally; 1cu-a and 1-M of forewing almost contiguous, separated by the width of a vein or less (Fig. 9c). *Metasoma:* Posterior width of first tergum 0.85–1.13× as long as length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 without transverse groove; ovipositor length 3.2–3.6; ovipositor length 2.4–3.0× longer than hind basitarsus length.

Specimens examined.—Holotype: ♀, USA, Mesilla [New Mexico], xi.6 (USNM). Homotypes: (285♀♂) AEIC, AMNH, CASC, CNCI, EMEC, LACM, MSUC, OSUO, SEMC, TAMU, UADE, UCDC, USNM.

Remarks.—The lobes between the midcoxae are distinctive for this species (Fig. 5d).

A. testacea is the most commonly collected species of *Agathirsia* and has one of the largest geographic ranges. The range of collection dates extends well into spring, which is unusual for *Agathirsia.*

Bibby (1961) cites the larva of *Acontia cretata* (Noctuidae) as a host of *A. testacea* from Yuma Arizona, viii.19.1953.

Agathirsia tiro Pucci and Sharkey, sp. n.

Distribution (Fig. 11k).—Southern Texas and northeast Mexico.

Females.—Color: Black and orange, orange except as follows: antenna black; maxillary and labial palpomeres partly black; head black; mesosoma black; fore and midcoxa partly black; hind tibia black to dark orange basally; hind tarsus black

to orange; first tergum black or orange; remaining terga with some black mottling; forewing slightly infumate to infumate in basal half, clear to slightly infumate in distal half but lighter than basal portion; hind wing slightly infumate in basal half, clear to slightly infumate in distal half. *Body length:* excluding ovipositor 5.7–5.9. *Head:* Longest seta at midlength of antenna > half antenna width (as in Fig. 7a); labial palpomere 2 shorter than combined length of 3 + 4; mandible with indication of second tooth (as in Fig. 1b); glossa fork length unknown; glossa length less than 2× galea length; glossa length approximately 0.25; glossa length approximately 0.22–0.32× shorter than foretibia length; malar space 0.46–0.52× shorter than eye height; face above clypeus without median longitudinal carinae; area anterior to ocellus with or without pits forming V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion without line of foveae. *Mesosoma:* Notauli weakly foveate basally, barely impressed as smooth groove elsewhere; propodeum largely smooth medially, foveate elsewhere, setae present except along midline; sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws vestigial (as in Fig. 3b); number of thick, apically flattened apical pegs on hind tibia 2–4; hind basitarsus straight distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.73–0.87× shorter than length of first tergum; setae on tergum 3 sparse distally (as in Fig. 6d); tergum 3 without transverse groove; ovipositor length 1.2–1.3; ovipositor length 1.5–1.6× longer than hind basitarsus length.

Males.—Unknown.

Specimens examined.—Holotype. ♀, Mexico, Nuevo Leon, 50 mi. S Nuevo Laredo, ii.22.1972 (Parker & Miller) (AEIC). Paratypes: 2♀, same data as holotype (AEIC); USA: Texas: 1♀, Del Rio, iv.18.1984 (Bo- [illegible] (UCRC); 1♀, Southmost [Ranch, School or Cemetery?], Carneton Co. [Cameron Co.?], iv.13.1956 (Beamers, Stephen, Michener & Rozen) (SEMC).

Remarks.—The combination of glossa length and coloration makes this species distinctive.

Etymology.—Recruit, beginner—referring to the relatively early (spring) collection dates.

Agathirsia trichiosoma (Cameron), n. comb.

Cenostomus trichiosomus Cameron 1905: 387. [Examined].

Agathis trichiosoma Shenefelt 1970: 362.

Distribution (Fig. 11f).—Southwestern to south-central Mexico.

Females and males.—*Color:* Mostly black except as follows: maxillary and labial palpomeres partly pale; head black; mesosoma black; foretibia partly pale; foretarsus pale yellow to orange to fuscous; midtibia partly pale yellow; midtarsus sometimes orange to pale yellow; hind tibia pale yellow/orange basally extending distally on lateral side; hind tarsus sometimes with orange or pale yellow; first tergum sometimes with small yellow/orange area basally; tergum 2 with some yellow or orange basally; forewing slightly infumate in basal half, infumate in distal half; hind wing slightly infumate. *Body length:* excluding ovipositor 8.5–12.0. *Head:* Longest seta at midlength of antenna subequal to 0.5–0.75 antenna width (as in Figs. 11a,c); labial palpomere 2 subequal to palpomeres 3 + 4 (as in Fig. 4b); mandible without indication of second tooth (as in Fig. 1c) or weak; glossa fork length 0.17–0.23; glossa length less than 2× galea length; glossa length 0.60–0.76; glossa length 0.40–0.51× shorter than foretibia length; malar space 0.22–0.27× shorter than eye height; face above clypeus with or without median longitudinal carinae; area anterior to ocellus without pits forming distinct or vestigial V-shape (as in Fig. 7d); area between tentorial pit and antennal insertion

without line of foveae. *Mesosoma:* Notauli foveate and complete (as in Fig. 5a); propodeum rugose, longitudinal furrow anteriorly, long, dense setae throughout; sternaulus foveate (as in Fig. 5a); mesepisternum without lobes between midcoxae; basal lobe of claws distinct (as in Fig. 3a); number of thick, apically flattened apical pegs on hind tibia 6–10; hind basitarsus tapered distally; 1-cu-a and 1-M of forewing separated by a distance greater than 2 vein widths (as in Fig. 9c). *Metasoma:* Posterior width of first tergum 0.43–0.59× shorter than length of first tergum; setae on tergum 3 dense on distal 0.66–0.75; tergum 3 with transverse groove; ovipositor length 0.87–0.97; ovipositor length 0.54–0.78× shorter than hind basitarsus length.

Specimens examined.—Holotype: ♀, Mexico, B.M. HYM. 3.c.974 (BMNH). Homotypes: (23♀♂) AEIC, ATAM, BMNH, CASC, CNCI, MSUC, SEMC, UADE, UCDC, USNM.

Remarks.—Similar to *A. sericans*—see characters in the key.

We recognize two forms that may be separate species. None of the following characters used to distinguish them are without exceptions and the putative forms overlap in time and space. Type I (holotype form): tergum 2 completely yellow or orange behind gently sloping groove, black hind basitarsus, median body length 10.8. Type II: tergum 2 partially yellow or orange behind V-shaped groove, pale yellow hind basitarsus, median body length 9.2.

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Two New Species of *Quadrastichus* Girault (Hymenoptera: Eulophidae): Parasitoids of the Leafminers *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) and *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)

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Abstract.—The parasitoids ***Quadrastichus citrella*** **Reina and La Salle** and ***Q. plaquoi*** **Reina and La Salle** (Hymenoptera: Eulophidae) are described. *Quadrastichus citrella*, native of South-East Asia, has been used as a biological control agent of the citrus leafminer *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) in several countries that the pest has recently invaded. *Quadrastichus plaquoi*, from India, is a parasitoid of *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae). Characters of these new species are discussed, as well as their relationship to other members of the "*anysis* group" of species. Distributional and biological details of these wasps are given.

Leafmining insects can be severe pests that reduce plant metabolic activities and can lead to desiccation, and premature fall of the leaves. If leaves are seriously attacked, crops can be reduced or seedling plants even totally destroyed (Spencer 1990). The leafmining habit is found in several species of Lepidoptera and Diptera and also in some Coleoptera and Hymenoptera. The main antagonists of leafminers are parasitic Hymenoptera, especially those belonging to Chalcidoidea, which penetrate the mines with their ovipositors to lay eggs in or on the body of the mining larvae or to feed on the host's body fluids (Askew and Shaw 1974).

Among Lepidoptera, the citrus leafminer (CLM) *Phyllocnistis citrella* Stainton (Gracillariidae) is an important pest which has recently spread throughout all citrus areas around the world. This species, native of South-East Asia, entered Africa and Australia in the early 1900's and has spread throughout the Mediterranean Basin and in the New World from SE and SW USA to South America in the last decade (Hoy and Nguyen 1997, Gates et al. 2002).

In newly infested citrus-growing regions, the CLM indigenous antagonists (mainly parasitoids) have never been able to reduce damage below economic threshold, as reported from Florida (Hoy and Nguyen 1997), Israel (Argov and Rössler 1996), Italy (Siscaro et al. 2003), Spain (Garrido Vivas 1995) and Turkey (Uygun et al. 1996). However in the native range, pest population can be controlled below the economic threshold by natural enemies, which represent its main biological mortality factor (Morakote and Nanta 1996, Tan and Huang 1996, Wang et al. 1999). Therefore, in order to achieve natural control of this pest, several parasitoids have been introduced to the newly infested countries from the native range of *P. citrella*. Among these, *Quadrastichus citrella* sp.n. (Hymenoptera: Eulophidae) has been used in Cyprus, Israel, Italy, Morocco and Spain (as Q. sp. "A" in Schauff

et al. 1998; as *Q.* sp. in Smaili et al. 1999, Argov 2000, Barbagallo et al. 2000). However, the only evidence of establishment for this species is in Spain, where the species overwintered in the Valencia area (García Marí et al. 2000).

Among Diptera, agromyzid leafminers, and particularly the species belonging to the genus *Liriomyza* Mik, are considered damaging pests of numerous vegetable and floricultural crops throught the world. Several of these species can cause extensive economic damage to a large range of host plants under both field and greenhouse conditions (Spencer 1989). Knowledge about agromyzid natural enemies has become increasingly important as a key element to biological control strategies of these pests. A large number of parasitoids have been recorded in the New and Old World, especially species from the families Eulophidae and Pteromalidae (Chalcidoidea) and, less commonly, species of the families Braconidae (Ichneumonoidea) and Eucoilidae (Cynipoidea) (Konishi 1998, Murphy and La Salle 1999). Nevertheless, the majority of these species are generalists and care must be taken when deciding to introduce exotic natural enemies. Biological control strategies appropriate for agromyzid leafminers in field vegetables often include the introduction of appropriate exotic natural enemies or conservation and enhancement of local natural enemies. However, these strategies are not mutually exclusive, as it is clear that any introductions should take into account the existing local natural enemy community (La Salle 1993, La Salle and Gauld 1993). Recently, Murphy and La Salle (1999) recommended that, due to the prevalence and often general nature of leafminer parasitoids, effort should be put into understanding and conserving indigenous leafminer parasitoids rather than relying solely on the introduction of exotic parasitoids. *Quadrastichus plaquoi* sp.n. found parasitising *L. trifolii* (Burgess) in India is an example of a species which might be used in future sustainable control programs.

Species of *Quadrastichus* are often endoparasites of Cecidomyiidae (Diptera); less commonly, they parasitize Cynipidae (Hymenoptera), Buprestidae and Curculionidae (Coleoptera), Agromyzidae and Tephritidae (Diptera). Also, *Q. sajoi* (Szelényi) larvae are predatory of eriophid mites within galls (Graham 1991, La Salle 1994, Hansson and La Salle 1996).

Within the Tetrastichinae, *Quadrastichus* is characterized by having the following characters: a single seta on submarginal vein; mesoscutum usually with a single adnotaular seta; propodeum without Y-shaped paraspicular carina; cercal setae unequal in length, with one being distinctly longer and sinuate; antenna with all funicular segments longer than wide; scutellum with submedian and sublateral lines; propodeal spiracles close or fairly close to metanotum, with their rim exposed; ovipositor sheaths not or only slightly projecting beyond last tergite of gaster (Graham 1991).

This genus was treated under the name *Cecidotetrastichus* Kostjukov (Kostjukov 1977, Graham 1987), but Boucek (1988: 677) remarked on the similarity between *Quadrastichus* and *Cecidotetrastichus* and Graham and La Salle (1991) placed *Cecidotetrastichus* in synonymy with *Quadrastichus*. Discussions on differentiating *Quadrastichus* from related genera, such as *Aprostocetus* Westwood, *Citrostichus* Boucek, *Oomyzus* Rondani and *Tetrastichus* Haliday in particular, are available in literature (Graham 1987, 1991, La Salle 1994, Schauff et al. 1998, Reina and La Salle 2003). At the moment, keys to *Quadrastichus* species are available only for Europe (Graham 1991).

ABBREVIATIONS

ANIC, Australian National Insect Collection, CSIRO Entomology, Canberra, Australia; **BMNH,** The Natural History Museum, London, UK; **DISTEF,** Diparti-

mento di Scienze e Tecnologie Fitosanitarie, University of Catania, Italy; **EMBT,** Department of Agriculture, Bangkok, Thailand; **INPC,** National Pusa Collections, Indian Agriculture Research Institute, New Delhi, Haryana, India; **IZCAS,** Institute of Zoology, Chinese Academy of Sciences, Beijing, China; **USNM,** National Museum of Natural History, Washington D.C., USA.

Quadrastichus citrella Reina and La Salle, sp. nov.

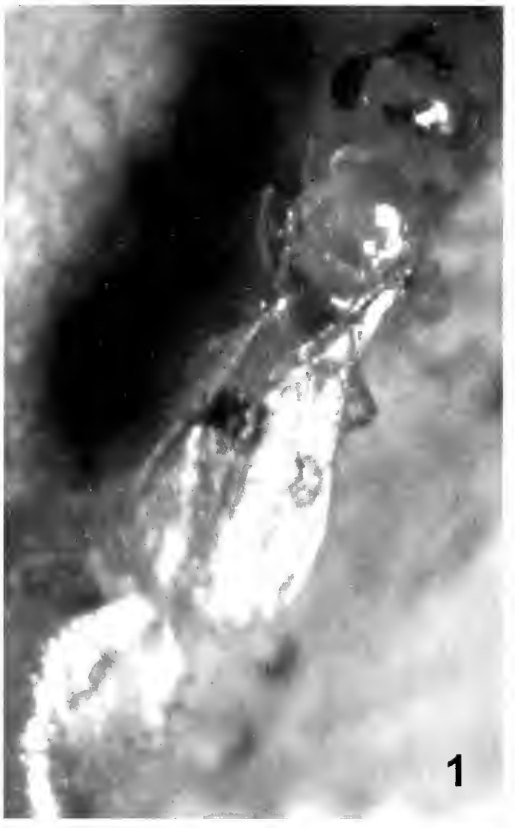
(Figs. 1, 2, 4–11, 14, 15)

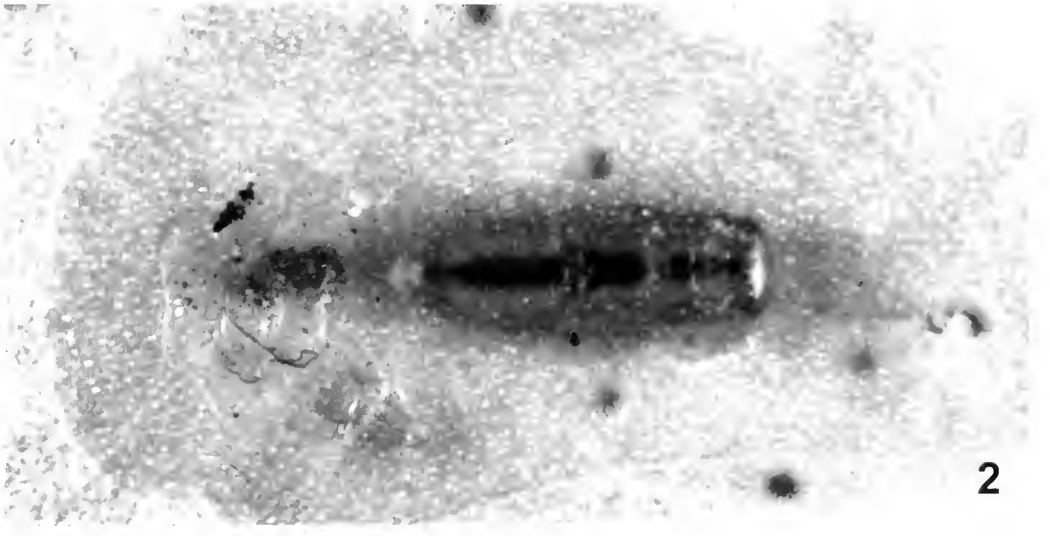
Diagnosis.—Body mainly yellowish with metanotum brown, transverse dark band on 3–4th gastral segments. Frons with broad median area rather than distinct median line. Malar sulcus curved, without fovea beneath eye. Antennal scape not reaching above top of vertex. First funicular segment slightly shorter than other two which are subequal in length. Midlobe of mesoscutum with single adnotaular seta placed in posterior half. Anterior seta on scutellum longer than posterior one. Dorsellum very short (0.2–0.3× as long as broad). Propodeum well sculptured, with distinct median carina and anterior margin not covered by dorsellum. Forewing with distinct speculum and bare area behind marginal vein.

Female.—Length 0.9–1.3mm. Body mainly yellowish (Fig. 1); following parts brown to black: ocellar triangle, basal portion of pedicel (about half pedicel length), flagellar segments, mesosternum, metanotum, transverse band on 3–4th gastral segments. *Head* (Fig. 4): Frons with broad median area rather than distinct median line. Malar space about 0.5× eye height. Malar sulcus (Fig. 5) without fovea, distinctly curved especially beneath eye. Anterior margin of clypeus slightly bilobate, without distinct teeth. Mandible 3-dentate. *Antenna* (Fig. 14): Torulus placed slightly above lowest margin of eye. Scape 5.0–5.5× as long as wide, slightly longer than eye height, and reaching the top of vertex. One anellus. First funicular segment slightly shorter than other two which are subequal in length (F1 about 0.7–0.8× as long as F2 or F3 length). Club 3-segmented, 5.0–5.5× as long as wide, slightly longer than F2 and F3 combined; distinct terminal spine and oblique suture between apical 2 segments. *Mesosoma* (Figs. 6–7): Slightly sculptured. Pronotum medially about 0.3× as long as mesoscutum. Midlobe of mesoscutum 1.5–1.6× longer than scutellum, with very weak to indistinct median line and single adnotaular seta placed in posterior half. Scutellum about 0.6× as long as broad. Dorsellum very short (0.2–0.3× as long as broad), not extending posteriorly over propodeum, 0.2–0.3× as long as scutellum. Propodeum more strongly sculptured than thorax and with distinct median carina and distinct paraspicular carina which encloses a concave area surrounding spiracle. *Fore wing* (Fig. 10): 2–2.2× as long as broad. Submarginal vein with a single dorsal seta. Marginal vein 6.2× longer than stigmal vein. Postmarginal vein present, about 0.9× as long as stigmal vein. Fringe on marginal vein 0.1–0.2× width of wing. Speculum present and extending below marginal vein for 0.2–0.3× its length; bare area extending behind full length of marginal vein. *Metasoma:* Ovate and slightly shorter than head and mesosoma combined. Cercus (Fig. 8) with one seta distinctly longer than the remaining setae and sinuate.

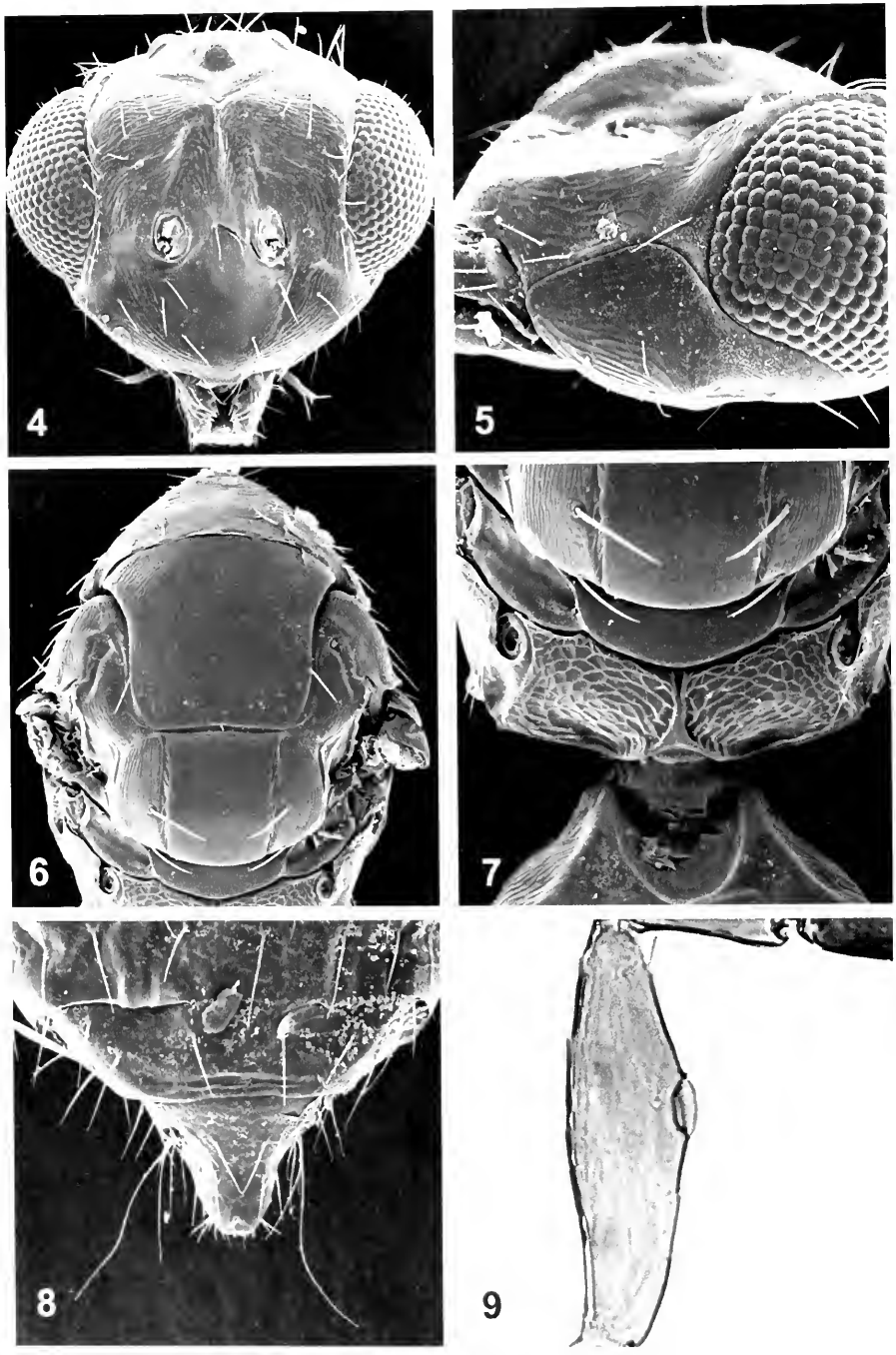
Pupa.—Yellow-orange with dark longitudinal stripe for entire length (Fig. 2). Meconium usually can be found outside the pupa near the caudal region.

Male.—Length 0.7–1.1mm. Similar to female except darker markings: pronotum, axilla partially and costula, mesosternum, mesopleura, mesoscutum especially in anterior half, propodeum, dorsellum and finally gaster in posterior half. *Fore wing:* Fringe distinct, setae on marginal vein about 0.3× width of wing (Fig. 11). *Antenna* (Fig.15): Basal whorls of setae present





Figs. 1–3. 1–2, *Quadrastichus citrella*, female. 1, Ovipositing on *Phyllocnistis citrella* larva. 2, Pupa. 3, *Quadrastichus plaquoi*, female.



Figs. 4–9. 4–8, *Quadrastichus citrella*, female. 4, Head, frontal view. 5, Malar space. 6, Thorax. 7, Propodeum. 8, Cercal setae. 9, *Quadrastichus citrella*, male, scape.

on all funicular segments and at least 0.5× as long as flagellum length. Funicle segments ratio F1/F2/F3/F4: 5/12/15/16. Club slightly longer than F1 and F2 combined. Ventral plaque (Fig. 9) on scape ovate, very small (about 0.1–0.2× as long as scape), and placed about slightly above the middle.

Etymology.—This species is named for the specific name of its host, *Phyllocnistis citrella* Stainton.

Distribution.—*Quadrastichus citrella* is recorded as a native of China, Japan, Taiwan and Thailand (as *Q.* sp. "A" in Schauff et al. 1998).

Biology.—*Quadrastichus citrella* is an idiobiont ectoparasitoid of second and third *Phyllocnistis citrella* instar larvae, the only host recognized by now. Its developmental cycle takes about 20 days at 20°C and R.H.>80%; at the same temperature, the adults survive up to 40 days (as *Q.* sp. in Argov and Rössler 1998, Llácer et al. 1998).

Type material.—Holotype ♀: Thailand, 1996, Y. Rössler, ex *Phyllocnistis citrella* Stainton (BMNH). Paratypes 22♂, 31♀, deposited as follows: same data as holotype (1♂, 5♀ ANIC; 1♂, 3♀ BMNH; 1♂, 5♀ DISTEF; 1♂, 3♀ EMBT; 1♂, 1♀ INPC; 1♀ IZCAS; 1♂, 2♀ USNM); Israel, Bet Dagan, Jaffa Corp., first delivery from Israel to Catania (Italy), 18.iv.1996, coll. by E. Swirski, ex *P. citrella* (2♂, 1♀ ANIC; 2♂, 1♀ DISTEF); Italy, University of Catania, mass rearing on *P. citrella*, 26.vi.1996, coll. by G. Siscaro (2♂, 2♀ ANIC; 2♂, 1♀ BMNH; 4♂,3♀ DISTEF; 2♂, 1♀ EMBT; 1♂, 1♀ IZCAS; 1♂, 1♀ USNM).

Comments.—Several specimens (with the same data as the type material) have been examined and the only variation we could recognize is with the coloration on mesoscutum and gaster. The anterior half of midlobe of mesoscutum can sometimes have some brownish markings, while the transverse band on 3–4th gastral segments may rarely be either larger or indistinct.

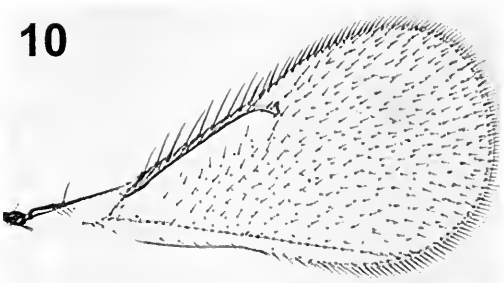
Quadrastichus citrella may be distinguished from both *Quadrastichus liriomyzae* Hansson and La Salle and *Q. plaquoi* by having dorsellum very short (0.2–0.3× as long as broad), fore wing with a distinct speculum (extending below marginal vein for 0.2–0.3× its length) and the area behind marginal vein asetose for its entire length; males can also be recognized by having a distinctly smaller plaque on scape: it is oval in shape, about 0.1–0.2× as long as scape length, and placed slightly above the middle. *Quadrastichus liriomyzae* and *Q. plaquoi* have a longer dorsellum (at least 0.4× as long as broad), fore wings have speculum almost indistinct, the area behind marginal vein setose for its entire length, and males have also a longer ventral plaque on the scape: about 0.6 (*liriomyzae*) or 0.7 (*plaquoi*) × as long as scape length.

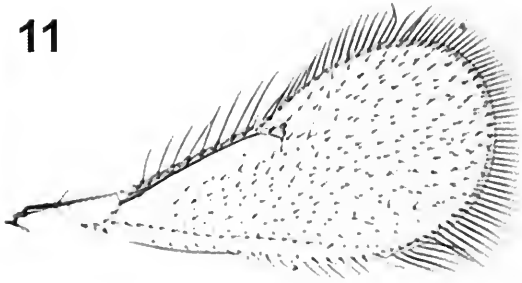
Quadrastichus plaquoi Reina and La Salle, sp. nov.

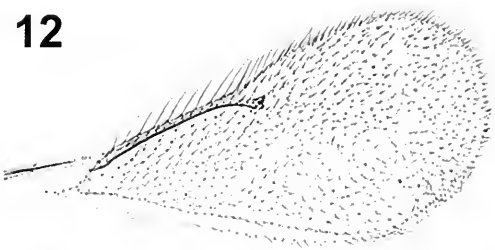
(Figs. 3, 12, 13, 16–22)

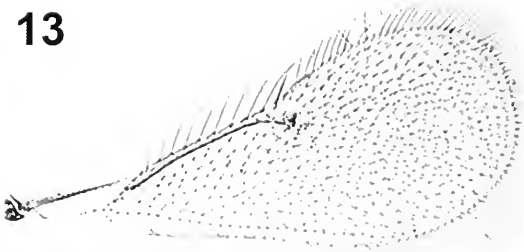
Diagnosis.—Body yellowish with dark spot in middle of pronotum and with transverse dark band on 4th gastral segment. Frons with broad median area rather than distinct median line. Malar sulcus curved and without fovea beneath eye. Antennal scape reaching slightly higher than top of vertex. First and second funicular segments equal in length. Midlobe of mesoscutum with single adnotaular seta placed in posterior half. Anterior seta on scutellum longer than posterior one. Propodeum quite shiny, without a distinct median carina. Dorsellum rounded posteriorly, at least 4.0× as long as broad. Forewing with speculum very small, area just distal to basal vein almost completely covered with setae, and area behind marginal vein setose.

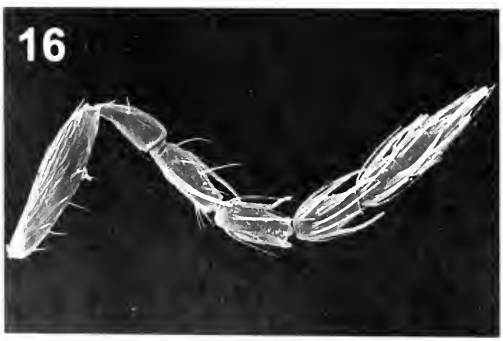
Female.—Length 0.9–1.4mm. Body mainly yellowish (Fig. 3) with following parts brown to black: basal portion of pedicel (about 0.5 its length), ocellar triangle, flagellar segments, medial 0.3–0.4 of pronotum, mesoscutum anteriorly, median











Figs. 10–17. 10, 11, 14, 15, *Quadrastichus citrella*. 10, Female fore wing. 11, Male fore wing. 14, Female antenna. 15, Male antenna. 12, 13, 16, 17, *Quadrastichus plaquoi*. 12, Female fore wing. 13, Male fore wing. 16, Female antenna. 17, Male antenna.

area on the propodeum, and transversal band on 4th gastral segment. *Head* (Fig. 18): Frons without a distinct median line and with only broad median area. Malar space about 0.6× as long as eye height. Malar sulcus (Fig. 19) distinctly curved and without fovea. Clypeus truncate anteriorly, without distinct teeth. Mandible 3-dentate. *Antenna* (Fig. 16): Torulus placed slightly above lowest eye margin. Scape 5× as long as wide, reaching slightly above top of vertex. One anellus present. First and second funicular segments equal in length, third one about 0.8× as long as other two. Club 3-segmented, 4.0–4.5× as long as wide, longer than F1 and F2 combined, with distinct terminal spine and suture between apical 2 segments slightly oblique. *Mesosoma* (Figs. 20, 21): Pronotum uniformly lineolate, medially 0.2–0.3× as long as mesoscutum. Midlobe of mesoscutum slightly sculptured, 1.6–1.7× longer than scutellum, and with a very weak to indistinct median line; single adnotaular seta present in posterior half. Scutellum about 0.7× as long as broad. Dorsellum at least 0.4× as long as broad, evenly rounded posteriorly, 0.3–0.4× as long as scutellum and slightly extending posteriorly over propodeum. Propodeum shiny and without distinct median carina; distinct paraspicular carina present which encloses a concave area associated with spiracle. *Fore wing* (Fig. 12): 2.2–2.4× as long as broad. Submarginal vein with single dorsal seta. Marginal vein about 4× as long as stigmal vein. Postmarginal vein slightly shorter than stigmal vein: about 0.9× as long as stigmal vein. Fringe on marginal vein 0.2–0.3× as long as wing width. Speculum very small, area just distal to basal vein almost completely covered with setae, and area behind marginal vein setose. *Metasoma:* Oval in shape in dorsal view and slightly shorter than head and mesosoma together. Cercus with one seta distinctly longer than remaining setae and sinuate. Tip of ovipositor slightly exserted.

Male.—Length 0.7–0.9mm. Similar to female but with darker markings as follows: anterior half of mesoscutum, metanotum, dorsellum, propodeum and almost entire basal half of gaster. *Fore wing* with fringe distinct, and setae on marginal vein about 0.3× width of wing (Fig. 13). *Antenna* (Fig. 17): Basal whorls of setae present on all the funicular segments and about 0.4–0.5× as long as flagellum length. Funicular segments ratio F1/F2/F3/F4: 6/10/11/9. Club longer than F2 and F3 combined, which are longest funicular segments. Ventral plaque (Fig. 22) on scape placed medially and large: about 0.7× long as scape length.

Etymology.—Males of this species have a large ventral plaque on the scape in comparison with the much smaller one present in *Q. citrella*; therefore, the name *plaquoi* refers to this character.

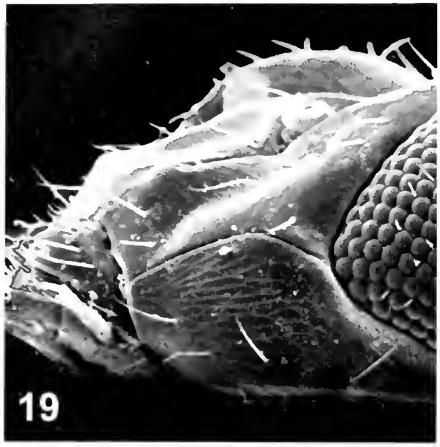
Distribution.—Known only from Himachal Pradesh, India.

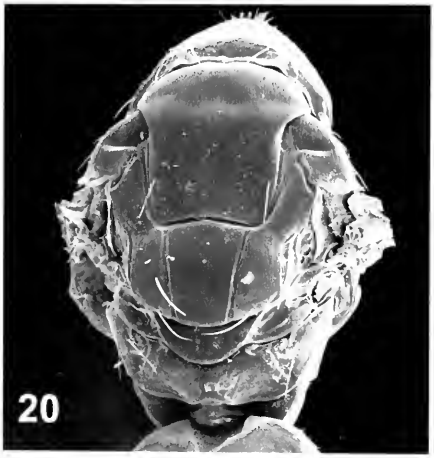
Biology.—*Quadrastichus plaquoi* has been recorded only on *Liriomyza trifolii* (Burgess).

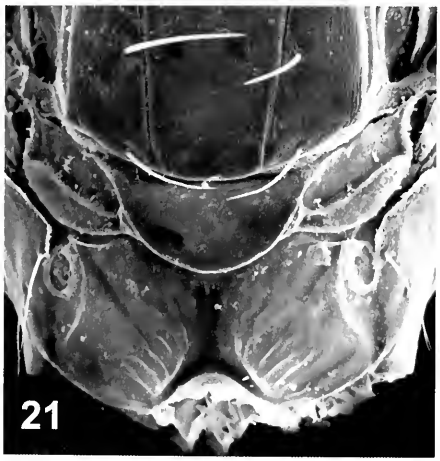
Type material.—Holotype ♀: India, Sulam, Himachal Pradesh, 2000, ex *Liriomyza trifolii* (Burgess) (BMNH). Paratypes 5♂, 9♀, deposited as follows: data as holotype (1♂, 3♀ ANIC; 1♂, 1♀ BMNH, 2♀ DISTEF; 1♂, 1♀ INPC; 1♂, 1♀ IZCAS; 1♂, 1♀ USNM).

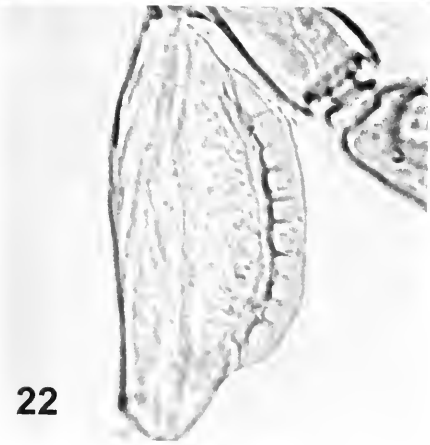
Comments.—No distinguishable variation has been recognized from the examined material.

It may be difficult to distinguish *Q. plaquoi* from *Q. liriomyzae*. The *Q. plaquoi* female has F1 and F2 equal in length and scape reaching slightly above the apex of vertex; moreover, both sexes have pronotum mainly yellow with a median dark area. *Q. liriomyzae* female has F1 slightly shorter than F2, scape not reaching above the apex of vertex and both sexes have pronotum dorsally entirely dark. *Q. plaquoi* can be distinguished from *Q. citrella* as suggested above in *Q. citrella* description, and in the key below.









Figs. 18–22. 18–21, *Quadrastichus plaquoi*, female. 18, Head, frontal view. 19, Malar space. 20, Thorax. 21, Propodeum. 22, *Quadrastichus plaquoi*, male, scape.

DISCUSSION

Within the genus, *Q. citrella* and *Q. plaquoi* belong to the "*anysis* group" (see Graham 1991), with which they share extensive yellow markings on the body, frons usually with a median area rather than a median carina, malar sulcus curved and not foveate, pronotum uniformly sculptured and scutellum without an offset strip along its hind edge. Other species within this group are the European *Q. citrinus* (Thomson) and *Q. xanthosoma* (Graham), the North American *Q. flora* (Girault) and the Asian *Q. liriomyzae* Hansson and La Salle.

KEY TO OLD WORLD SPECIES OF THE "*ANYSIS* GROUP" OF *QUADRASTICHUS*

1. Both sexes: mesoscutum completely dark brown to black; speculum distinct and extending almost half of marginal vein length. Male: ventral plaque about 0.5× scape length ... ***Q. anysis* (Walker)**
– Both sexes: mesoscutum partially to totally yellowish. Other characters variable 2
2. Female: F1 ≥ 1.3× F2 3
– Female: F1 ≤ F2 4
3. Female: gaster 1.5× longer than hind tibia; thorax and gaster mainly blackish; last tergite 0.8–1.5× as long as broad (see Graham 1974, 1991) ..... ***Q. citrinus* (Thomson)**
– Female: gaster 2.0× longer than hind tibia; thorax and gaster mainly yellow; last tergite 1.3–2.0× as long as broad (see Graham 1974, 1991) ..... ***Q. xanthosoma* (Graham)**
4. Both sexes: pronotum mainly yellow with a dark spot medially. Female: F1 = F2. Male: ventral plaque (Fig. 22) placed medially and about 0.7× long as scape length ..... ***Q. plaquoi*, n. sp.**
– Female: F1 < F2; pronotum different, either entirely dark dorsally (*liriomyzae*) or entirely yellow (*citrella*). Male: pronotum entirely dark; ventral plaque on scape variable 5
5. Both sexes: speculum indistinct, area just distal to basal vein almost completely setose; area behind marginal vein setose for entire its length. Female: pronotum dark dorsally. Male: ventral plaque on scape about 0.6× as long as scape length ..... ***Q. liriomyzae* Hansson and La Salle**
– Both sexes: speculum present and extending below marginal vein for 0.2–0.3× its length; area behind marginal vein asetose for entire its length. Female: pronotum yellow dorsally. Male: ventral plaque (Fig. 9) about 0.1–0.2× as long as scape length ..... ***Q. citrella*, n. sp.**

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First Food Plant Record for *Lagideus* Konow (Hymenoptera: Pergidae), a New Species Feeding on *Fuchsia* and *Ludwigia* (Onagraceae) in Argentina

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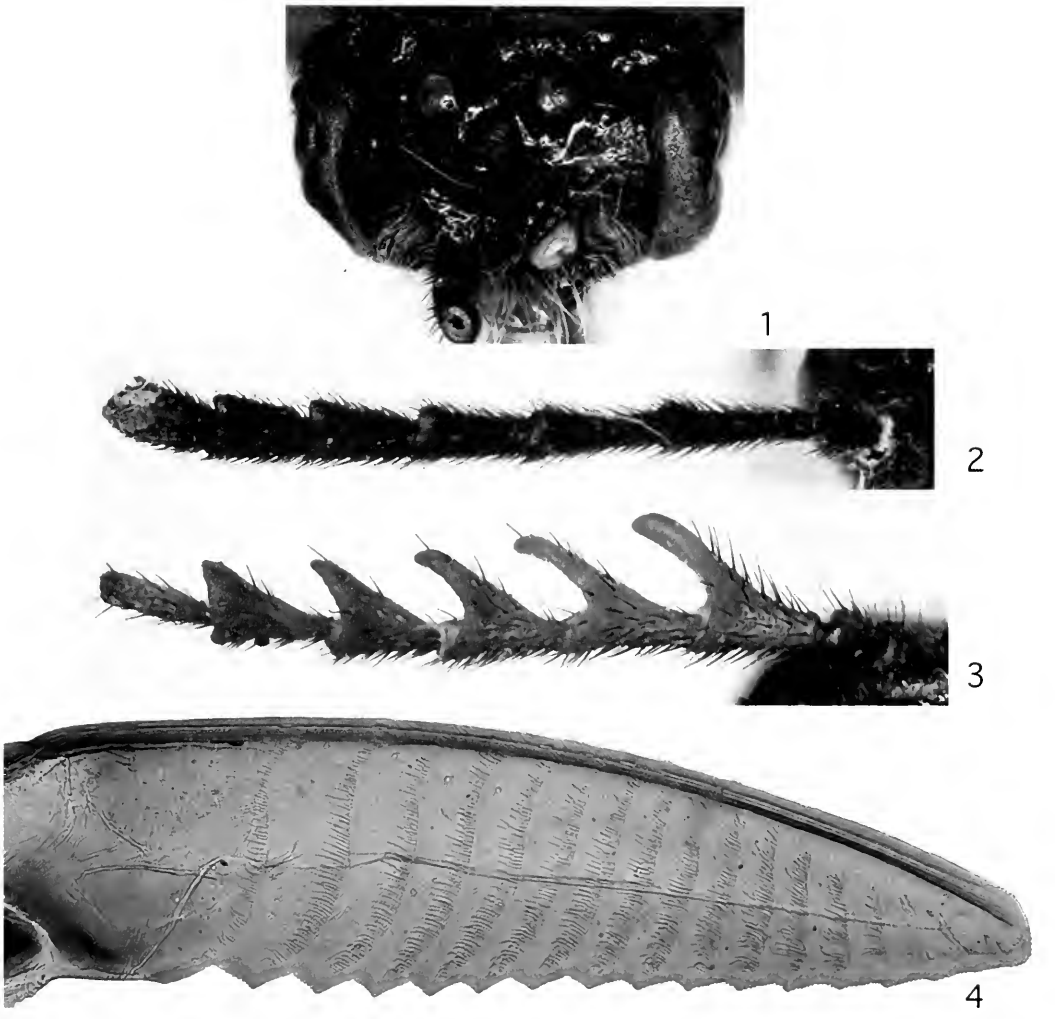
Abstract.—***Lagideus badoae* Smith, n. sp.** (Pergidae: Syzygoniinae), from Argentina and Uruguay is described and illustrated. Adults were reared from larvae feeding on *Fuchsia* sp. and *Ludwigia peploides* (Kunth) Raven (Onagraceae) in Buenos Aires, Argentina. This is the first food plant record for a species of *Lagideus*. The larva, bearing two long apical filaments, is similar to the larva of *Syzygonia cyanocephala* Klug of Brazil and resembles larvae of the Australian genus *Philomastix* Froggatt (Pergidae: Philomastiginae).

Lagideus Konow currently includes 22 species and occurs from southern Mexico to northern Argentina. Smith (1990) revised this exclusively Neotropical genus, separated it from the other three genera of Syzygoniinae, added 18 new species, and gave a key to the 22 species. Food plants for the genus have remained unknown until adults were reared from larvae feeding on *Fuchsia* sp. and *Ludwigia peploides* (Kunth) Raven (Onagraceae) in Buenos Aires, Argentina, by SGB. Members of *Lagideus* are not commonly collected, and most species are known only from a few specimens. Considering the scarcity of study material for *Lagideus*, its potential great diversity, and probable occurrence of many more undescribed species, it is not surprising that these reared specimens represent a new species.

The genus *Lagideus* is distinguished from other genera of Syzygoniinae by the 8-segmented antennae which are filiform or serrate in females and bipectinate or unipectinate in males, presence of three cubital cells in the forewing, carinate inner and upper margins of the antennal crests and usual carinate hind margin of the postocellar area, long apical hind tibial spines (usually more than half the length of the basitarsi), mostly sclerotized basal plates, and a small mesoscutellum. The base of vein M in the forewing (near Sc+R) is usually distinctly swollen. Sexual dimorphism in *Lagideus* species is especially evident in the antennae as described above. It is difficult to associate sexes, and it is possible a few of the described species represent opposite sexes of the same species. This new species and *L. townesi* Smith are the only two for which both sexes have been associated.

Lagideus badoae Smith, new species
(Figs. 1–9)

Female.—Length (holotype and paratypes), 6.0 mm. Antenna and head black. Thorax black with pronotum orange. Legs black with basal half of hind femur, extreme bases of fore- and midfemora, basal halves of tibiae, and entire fore- and midtarsi mostly white. Abdomen black with



Figs. 1–4. *Lagideus badoae*. 1, Head, dorsal view. 2, Female antenna. 3, Male antenna. 4, Female lancet.

orange lateral stripes. Wings hyaline; stigma and veins black. Antenna (Fig. 2) 8-segmented, segments 3–7 slightly serrate, each slightly expanded at apex; antennal length 1.8× head width; first and second segments each slightly longer than broad; third segment longer than fourth segment, segments 4–8 gradually decreasing in length. Malar space as broad as diameter of front ocellus. Lower interocular distance slightly shorter than eye length; eyes slightly converging below; upper interocular distance, to lower interocular distance, to eye length as 100:80:85. Head from above narrowing behind eyes (Fig. 1); distances between eye and hind ocellus, between hind ocelli, and from hind ocellus to posterior margin of head as 25: 25:15; postocellar area 3.7× broader than long, carinate behind. Hind basitarsus shorter than length of remaining tarsal segments combined, as 6:8; inner hind tibial spur about half length of hind basitarsus. Sheath (Figs. 5, 6) rounded in lateral view, slightly concave on ventro-apical margin, in dorsal view, thick at base and tapering evenly to acute apex, with long backward projecting hairs, many longer

than greatest breadth of sheath in dorsal view, and many curved at their apices. Lancet (Fig. 4) with short annular hairs evenly distributed on annuli, hairs present on each annulus (except at extreme apex); apex blunt, nearly truncate; serrulae pointed, those at base and center deeper than those near apex; each serrula with 6–9 fine anterior and posterior subbasal teeth; margin at apex with very fine teeth.

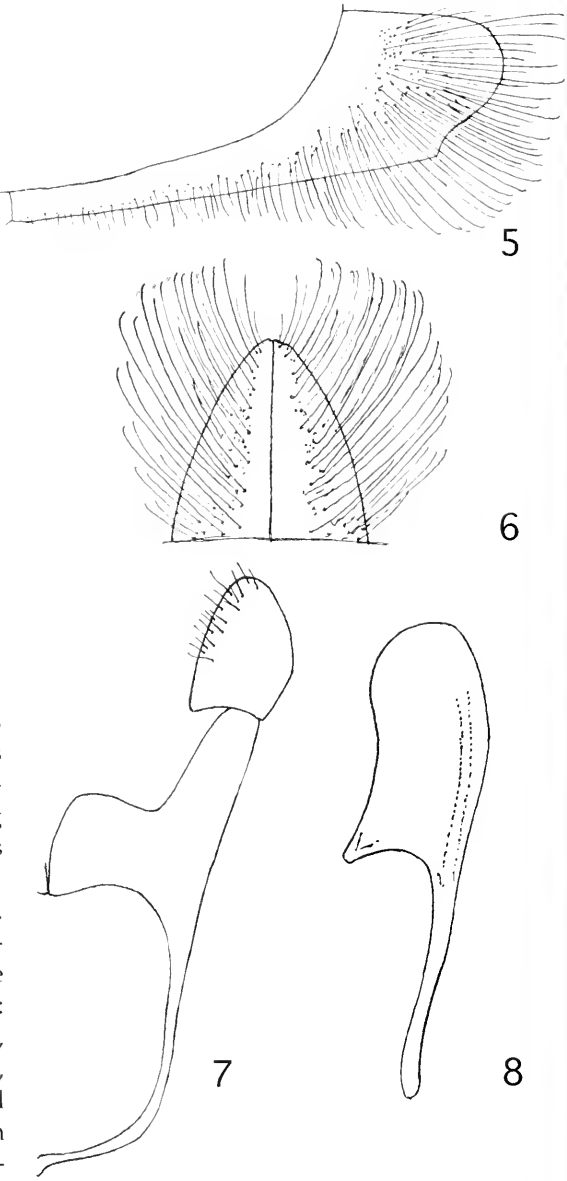
Male.—Length, 5.8 mm. Color like female but legs mostly white and antenna brownish. Antenna (Fig. 3) with segments 3–6 unipectinate; ramus of third segment long, subequal to length of segment; rami of segments 4–6 each shorter than length of respective segment; segment 7 triangular; segment 8 elongate, not expanded at apex. Genitalia (Figs. 7, 8) with harpe with long, stiff hairs on inner surface; parapenis about as long as broad, rounded at apex; penis valve oval.

Larva.—Flattened on leaf; thoracic legs directed laterally; abdominal segments with lateral lobes; abdominal segments 3-annulate; apical segment with two long filaments. (From photo, Fig. 9; specimens not saved for study.)

Types.—Holotype ♀, labeled "Cap. Fed. Arg. 05/2003," Deposited in Ciencias Naturales Museo, Universidad Nacional de La Plata, La Plata, Argentina. Paratypes: ARGENTINA: Same data as holotype (2♀, 1♂). URUGUAY: Montevideo, Rec'd 47, HL Parker (1♀). Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, and Universidad de Buenos Aires, Buenos Aires, Argentina.

Etymology.—Named after Ing. Agr. Silvina G. Bado, the co-author of this paper and discoverer of the larva and food plant.

Food plants and life history.—Adults were bred from larvae feeding on *Fuchsia* sp. and *Ludwigia peploides* (Kunth) Raven (Onagraceae). Larvae were collected in early April when they were about 1 cm long. Pupation occurred about 10 days after collection, and adults emerged about a week after pupation. Rearing conditions were 25 ± 3° C and 50–60% relative humidity. Larvae were gregarious feeders on the lower leaf surface, skeletonizing the leaves of both food plants.



Figs. 5–8. *Lagideus badoae*. 5, Female sheath, lateral view. 6, Female sheath, dorsal view. 7, Male genital capsule, ventral view of right half. 8, Male genitalia, lateral view of penis valve.

Remarks.—Of the 22 species treated by

Smith (1990) 15 are known only from the female and six only from the male. The single species for which both sexes are known is *L. townesi* Smith.

The female of *Lagideus badoae* is in the group that has hairlike annular armature rather evenly distributed the full length of each annulus of the lancet (Smith 1990: figs. 313–319, 323–324) (not clusters of long, stout spines on the dorsal half of the lancet as in figs. 318–322). From the ten species with annular hairs, the female of *L. badoae* is separated by having annular hairs on each annulus of the lancet except the extreme apex, the annuli subparallel, and the apex of the lancet nearly truncate, and by the black thorax with the pronotum orange and black abdomen with a lateral orange stripe. The second half of couplet 2 in Smith's (1990) key can be modified to include "abdomen black with lateral orange stripes." This would take *L. badoae* to couplet 12, the second half of which can be modified to add "abdomen orange with orange lateral stripes and thorax black with pronotum orange." Thus, *L. badoae* will key to *L. wygodzinskyi* Malaise, known from São Paulo and Rio de Janeiro, Brazil, from which it can be separated by the subparallel annuli and truncate apex of the lancet. The lancet of *L. wygodzinskyi* has the basal and apical annuli divergent and the apex acute (Smith 1990, fig. 313).

The male of *Lagideus badoae* will key to couplet 20 which includes *L. truncatus* Smith and *L. yantuus* Smith. Both these species have the hind basitarus longer than the length of the remaining tarsal segments combined and are different in color. *Lagideus truncatus* (described from Buenos Aires, Argentina), has dark orange antennae, the upper half of the mesepisternum, tegula, lateral spots on the mesoprescutum, and mesoscutellum orange, and the abdomen black with the first and second terga mostly orange. *Lagideus yantuus* (described from São Paulo, Brazil) has the antenna dark orange, the supraclypeal area, clypeus, and labrum whitish, lateral spots on the mesoprescutum orange, and an entirely black abdomen. The genitalia of *L. badoae* most closely resembles that of *L. truncatus* (Smith 1990: fig. 308).

Some other species described from southern South America are *L. albitarsus* Malaise (Santa Catarina, Brazil, and Uruguay), *L. crinitus* (Konow) ("Argentina"), *L. luticus* Smith (Tucumán, Argentina), and *L. townesi* Smith (Tucumán, Argentina). The male of *L. albitarsus* has considerable orange on the thorax and the ramus of the third segment is much longer than the length of the segment (Smith 1990: fig. 285); the female of *L. crinitus* has much of the thorax and abdomen (except apex) orange, the antenna only 1.5× the head width, the hind basitarsus longer than the length of the remaining tarsal segments combined, and the antenna with only segments 5–7 serrate; the females of *L. luticus* and *L. townesi* have a cluster of long spines on the dorsal half of the lancet (Smith 1990: figs. 318, 319), and the male of *L. townesi* has the ramus of the third segment much longer than the length of the segment (as in Smith 1990: fig. 285).

A photo of the larva was taken (Fig. 9), though no larvae were saved for further description. It is unusual, mainly by the presence of two long apical filaments at the apex of the abdomen; otherwise, the laterally protruding legs and lateral lobes of the abdominal segments resemble some North American *Acordulecera* Say (Pergidae: Acordulecerinae) larvae. The only other known larvae in the Neotropics with such long apical filaments is *Syzygonia cyanocephala* Klug which feeds on *Tibouchina* spp. (Melastomataceae) in Brazil (illustrated by Azevedo Marques 1933). Smith (1990) placed *Syzygonia* Klug and *Lagideus* in the same subfamily, the Syzygoniinae, based on adult characters. The similarity of the larvae may help support that conclusion.

Other sawfly larvae with similar long

Fig. 9. Larva of *Lagideus badoae* feeding on *Ludwigia* sp.

apical filaments are those of *Philomastix* sp. (Pergidae: Philomastiginae) in Australia (Froggatt 1901, fig. 6; Naumann 1991, fig. 42–13 A). In *Philomastix*, the long filaments protrude from the ninth segment, not the apical one; in the photo it appears that the filaments of *L. badoae* protrude from the apical segment.

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Description of the *Antistrophus rufus* (Hymenoptera: Cynipidae) Species Complex, Including Two New Species

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Abstract.—We describe the *Antistrophus rufus* species complex of gall wasps, including a redescription of ***A. rufus* Gillette** and descriptions of two new species: ***A. meganae* Tooker and Hanks** and ***A. jeanae* Tooker and Hanks.** Larvae of the three species develop in stem galls of different, but congeneric asteraceous plant species that are endemic to tallgrass prairies of midwestern North America, *A. rufus* in *Silphium laciniatum* L., *A. meganae* in *S. terebinthinaceum* Jacquin, and *A. jeanae* in *S. perfoliatum* L. Adults of the three species are very similar morphologically, but differ in structure of the antennae, length of ovipositors, depth of galls in plant tissues, and mass of mature larvae. An allozyme study confirmed that wasps from the three plant species are reproductively isolated from one another.

Antistrophus Walsh 1869 (Cynipidae: Aylacini) is a Nearctic genus currently comprising at least eight species, all of which form galls in asteraceous plants (Burks 1979, Nieves-Aldrey 1994). Six species form galls in species of *Silphium* and *Lygodesmia* that are endemic to tallgrass prairies of midwestern North America (Burks 1979, Gleason and Cronquist 1991). Larvae of *Antistrophus rufus* Gillette feed in small, single-chambered, ellipsoid galls (~3 mm in length) in flowering stems of *Silphium* species that do not affect the stem surface and so are not discernible externally (Gillette 1891, Beutenmüller 1910, Tooker et al. 2002, Tooker and Hanks 2004a, b, c).

Antistrophus rufus was originally described from specimens reared from *Silphium laciniatum* L. (Gillette 1891), but the species name also has been applied to specimens from *S. terebinthinaceum* Jacquin, *S. perfoliatum* L., and *S. integrifolium* Michaux (Beutenmüller 1910). In our studies of the ecology of *A. rufus* in prairies of central Illinois, we found evidence of reproductive isolation of populations inhabiting stems of *S. laciniatum* and *S. terebinthinaceum* due to phenological differences between host plants (Tooker et al. 2002). Wasps from the two plant species mate assortatively when brought into contact (unpublished data), and males preferentially respond to plant volatiles associated with their natal host species (Tooker et al. 2002). Allozyme studies confirmed that wasp populations inhabiting *S. laciniatum* and *S. terebinthinaceum* were reproductive isolated from one another, and a Nei's genetic distance of 0.56 further indicated that the populations actually represent different species (Tooker et al. 2002).

In this paper, we extend our studies of *Antistrophus* species by including a third population associated with *Silphium perfoliatum*. Differences in phenology between this population and those inhabiting *S. laciniatum* and *S. terebinthinaceum* (see below), again associated with host plant phenology, suggest limited gene flow. We confirm reproductive isolation of the *S. perfoliatum* population with allozyme studies, and also report that wasps from the three *Silphium* species differ in

the morphology of the antennae and ovipositors, depths of galls in host plants, and mass of mature larvae. On the basis of these genetic, morphological, and ecological differences, we conclude that *Antistrophus rufus* comprises a complex of at least three species, *A. rufus* Gillette in *S. laciniatum*, *A. meganae* Tooker and Hanks n. sp. in *S. terebinthinaceum*, and *A. jeanae* Tooker and Hanks n. sp. in *S. perfoliatum*. We provide here descriptions and morphological diagnoses for each species.

METHODS

To compare the morphology of *Antistrophus* populations, we reared adult gall wasps from *Silphium* stems we collected during the winters of 1998–1999 and 2001–2002 from prairie sites in central Illinois. We collected *S. laciniatum* from Fithian Railroad Prairie (FRP, Vermilion Co., N 40° 06.78, W 87° 54.10) and Buckley Railroad Prairie (BRP, Iroquois Co.; N 40° 34.88, W 88° 02.70), *S. terebinthinaceum* from East St. Joseph Railroad Prairie (ESJRP; N 40° 06.77, W 88° 00.48) and Paxton Railroad Prairie (PRP; Ford Co.; N 40° 26.17, W 88° 06.36), and *S. perfoliatum* from BRP and PRP. We measured dimensions of heads and antennae of females using digital photographs (e.g., Fig. 1) produced with microscopy (scanning electron- and compound microscopes) in conjunction with image analysis software (Image-Pro® Plus Version 4.5, Media Cybernetics, Inc., Silver Spring, MD). We dissected ovipositors from ten female wasps from each plant species and measured with a microscope micrometer the length from the tip to the second valvifer (see Fig. 2).

Terminology relating to morphology and wing venation follows Nieves-Aldrey (1994) and descriptions of sculpturing follow Harris (1979). Post-Ocellar Line (POL) is the distance between inner margins of lateral ocelli; Ocell-Ocular Line (OOL) is the distance from outer edge of a lateral ocellus to inner margin of the compound eye. Head height is measured in frontal view from top of stemmaticum to ventral margin of clypeus. Supraclypeal area is the medial area between clypeus and toruli.

To study how gall dimensions and mass of wasp larvae varied across plant species, we dissected stems of *S. perfoliatum*, collected in early Spring 2002 from BRP where all three *Silphium* species co-occurred. We extracted mature gall wasp larvae and weighed them, and measured the depth from the stem surface of galls with a microscope micrometer (N = 22 galls in twenty stems). Data for wasps in *S. perfoliatum* were compared with published data for wasps in *S. laciniatum* and *S. terebinthinaceum* (Tooker and Hanks 2004c).

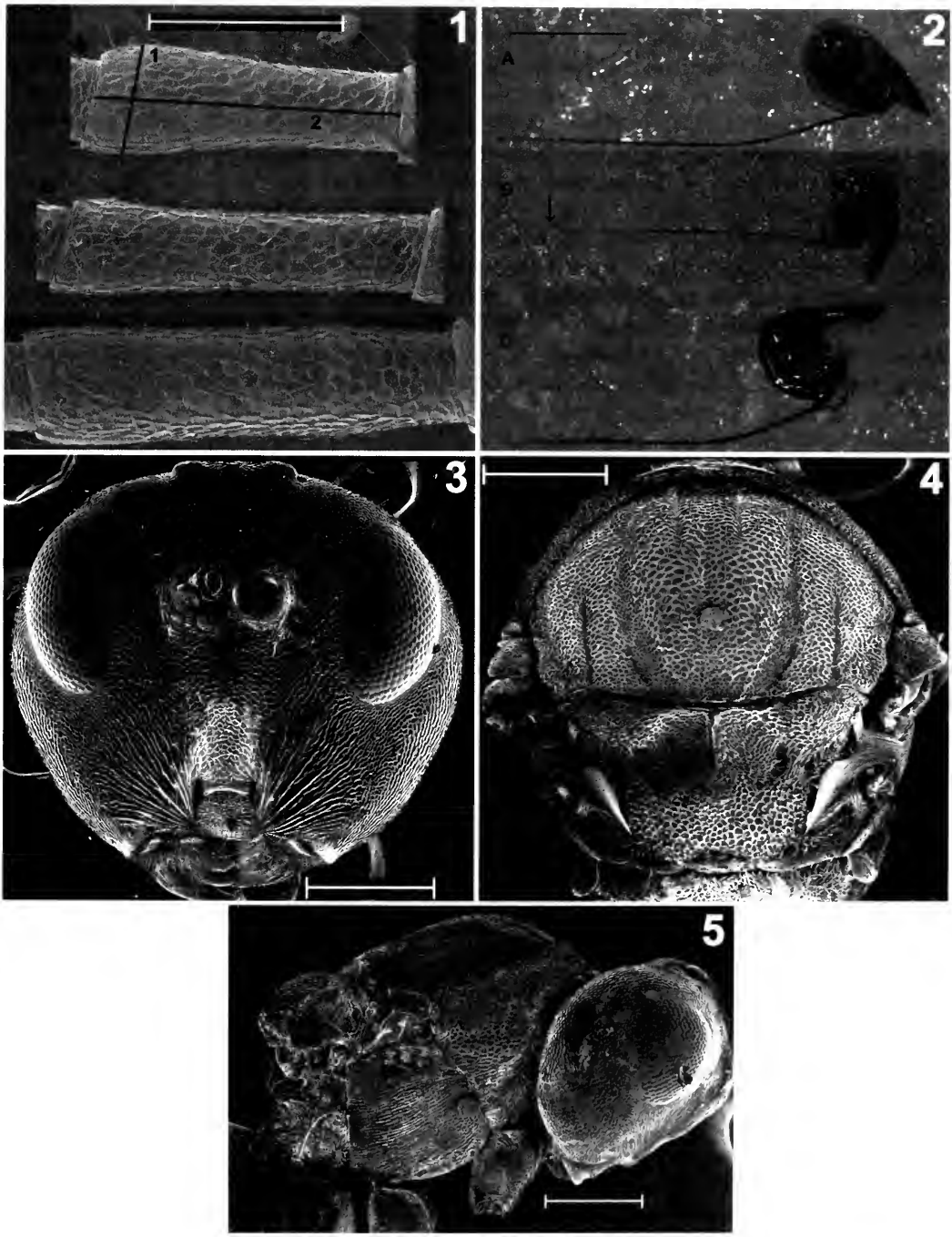
We compared differences between *Antistrophus* populations in means for morphological variables, gall depth, and larval mass with analysis of variance (ANOVA; Wiley 1981). Differences between individual means were tested with the LSD means separation test (Sokal and Rohlf 1995).

For the allozyme analysis, we reared *Antistrophus* adults from stems of *S. perfoliatum* collected at BRP, where all three plant species co-occurred. We conducted cellulose acetate electrophoresis for six loci using methods described by Tooker et al. (2002). We compared allele frequencies for the *S. perfoliatum* population with frequencies for the *S. laciniatum* and *S. terebinthinaceum* populations (from Tooker et al. 2002) using R×C contingency table tests (software ver. 2.1, Bill Engles, University of Wisconsin, Madison).

We present means ± 1 SE throughout.

Antistrophus rufus species complex (Figs. 1–8)

Diagnosis.—Galls developing in cambium and pith of flowering stems of *Silphium laciniatum*, *S. terebinthinaceum*, and *S. perfoliatum*. Second flagellomere longer than first. Notauli evident, but faint ante-



Figs. 1–5. *Antistrophus* species. 1, Second flagellomere of female A) *A. rufus*; B) *A. meganae*; C) *A. jeanae* (scale bar = 100 µm); lines 1 and 2 indicate length and width measurements, respectively. 2, Ovipositors of A) *A. rufus*; B) *A. meganae*; C) *A. jeanae* (scale bar = 1 mm); arrows indicate length measurement. 3, Head of *A. rufus* female (scale bar = 200 µm). 4, Mesonotum and metanotum of *A. rufus* female (scale bar = 200 µm). 5, Head and mesosoma of *A. rufus* male (scale bar = 200 µm).

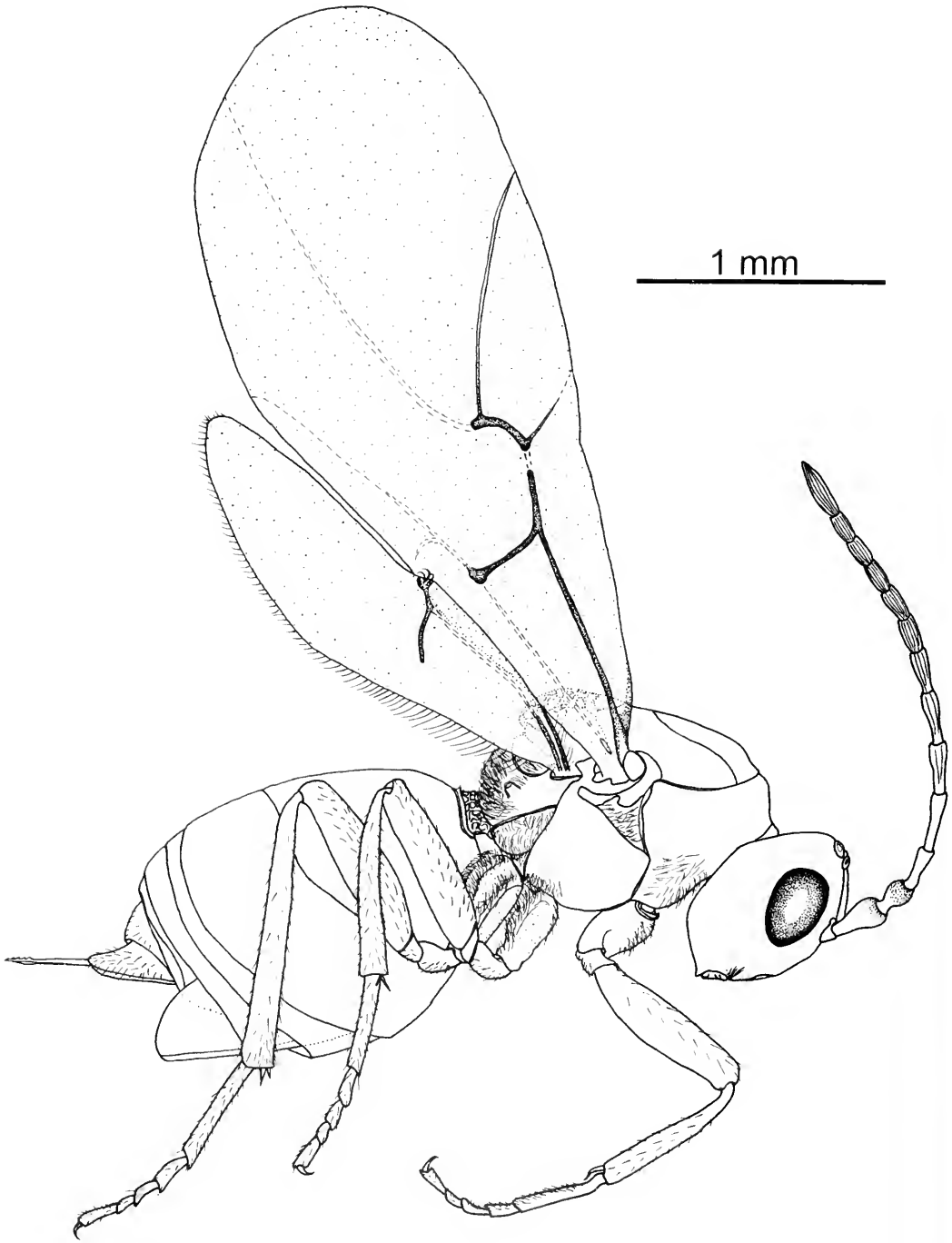


Fig. 6. *Antistrophus rufus* female (scale bar = 1 mm).

riorly. Distinct medial ridge separating scutellar fovae.

Description.—FEMALE. Length 2.6 ± 0.05 mm (Fig. 6). Light brown to amber often with darker (even black) areas in vertex, mesoscutum, and dorsum of metasoma. Antennae and legs same color as body. Head with fine areolate sculpturing and sparsely setose (Fig. 3, 5). Head in dorsal view 1.8× broader than long; in frontal view, 1.4× broader than high; head height 2× compound eye height. POL slightly shorter than OOL and 2× greatest diameter of lateral ocellus. Malar space 0.8× eye height. Face with laterally radiating striae. Supraclypeal area with two pronounced tentorial pits. Antennae 13-segmented and imbricate, distal flagellomere 2× longer then flagellomere 10 (Fig. 7). First flagellomere 0.75× as long as second. Pronotum finely areolate, setose, prominent lateral expansions, and distinct submedial pits (Fig. 4). Mesoscutum finely areolate; anterior fourth of notauli faint, moderately convergent posteriorly. Median mesoscutal impression faint to prominent, but most evident in posterior third. Two faint submedial impressions in anterior fourth and parallel to median mesoscutal impression. Two additional mesoscutal impressions lateral to notali and most evident in posterior third (Fig. 4). Scutellum finely areolate. Scutellar fovae prominent and rounded, separated from each other by distinct medial ridge. Mesopleuron setose and finely areolate (Fig. 5). Propodeum finely areolate and densely setose laterally. Propodeal carinae moderately divergent posteriorly. Metasoma nitid. In lateral view, length of metasoma approximately equal to or slightly shorter than head + mesosoma + propodeum (Fig. 6). Metasomal tergites I and II occupy more than half of abdomen. Hypopygidial spine very short. Ovipositor 2.8 ± 0.08 mm long. Wings hyaline with pale brown venation: R1 and Rs of forewing not extending to wing margin, radial cell open, Rs curved slightly anteriorly (Fig. 6). MALE. Differs from female in shape and size of metasoma (Fig. 8). Antennae longer, with 14 antennomeres (Fig. 7).

GALL. Small (~3 mm in length), ellipsoid, and monothalamous, hidden in cambium and pith of flowering stems of *Silphium*, not evident in external view.

Material examined.—We examined the holotype in the Insect Collection of the Illinois Natural History Survey, Champaign, IL (INHS), which was reared from *S. laciniatum*, as well as 10 females and 5 males that we reared from stems of each of three *Silphium* species (*S. laciniatum*, *S. terebinthinaceum*, and *S. perfoliatum*) collected from prairies in central Illinois (see above). Depositories for specimens are INHS and the National Museum of Natural History, Smithsonian Institution, Washington, DC (NMNH).

Comments.—Previous work revealed that no alleles were shared between gall wasps reared from *S. laciniatum* and *S. terebinthinaceum* (Table 1, Tooker et al. 2002). New data (Table 1) show that gall wasps reared from *S. perfoliatum* had alleles at all six loci that were not represented in wasps from either *S. laciniatum* or *S. terebinthinaceum*, and in fact, 48 and 71% of alleles at loci *MDH* and *ME*, respectively, were unique to *S. perfoliatum* wasps. Moreover, locus *IDH* was fixed for unique alleles in all three wasp populations (Table 1). R-C contingency tables tests for each locus were highly significant ($P < 0.001$), suggesting a lack of gene flow between populations of gall wasps inhabiting different *Silphium* species. These data strongly support the morphological evidence that these populations represent different species.

Antistrophus rufus Gillette
(Figs. 1–8)

Antistrophus rufus Gillette 1891: 195.

Diagnosis.—Distinguished from other species in complex by the following characters: 1) Larvae developing in galls in

Table 1. Allelic frequencies of *A. rufus* species complex reared from stems of *Silphium laciniatum* ("*S. lac.*") and *S. terebinthinaceum* ("*S. ter.*") and *Silphium perfoliatum* ("*S. per.*") from three prairies in central Illinois. Sample sizes are in parentheses. The most anodal band was assigned "A" with electrophoretic mobilities of other bands relative to this band on starch and cellulose acetate gels. Populations are named after their prairies (see Materials and Methods). Data from gall wasp populations in *S. laciniatum* and *S. terebinthinaceum* are from Tooker et al. (2002).

Locus/ mobility	LCP		MP		BRP		
	S. lac. (30)	*S. ter.* (30)	*S. lac.* (10)	*S. ter.* (10)	*S. lac.* (15)	*S. ter.* (15)	*S. per.* (30)
GPI							
A	0.000	0.000	0.000	0.000	0.000	0.000	0.033
B	1.000	0.000	1.000	0.000	1.000	0.000	0.633
C	0.000	1.000	0.000	1.000	0.000	1.000	0.333
PGM							
A	0.000	0.000	0.000	0.000	0.000	0.000	0.058
B	0.000	0.483	0.000	0.550	0.000	0.679	0.250
C	1.000	0.000	1.000	0.000	1.000	0.000	0.462
D	0.000	0.517	0.000	0.450	0.000	0.321	0.231
G3PDH							
A	1.000	0.000	1.000	0.000	1.000	0.000	0.150
B	0.000	1.000	0.000	1.000	0.000	1.000	0.750
C	0.000	0.000	0.000	0.000	0.000	0.000	0.100
MDH							
A	1.000	0.000	1.000	0.000	1.000	0.000	0.069
B	0.000	0.000	0.000	0.000	0.000	0.000	0.034
C	0.000	1.000	0.000	1.000	0.000	1.000	0.448
D	0.000	0.000	0.000	0.000	0.000	0.000	0.448
ME							
A	0.000	0.000	0.000	0.000	0.000	0.000	0.333
B	0.000	0.000	0.000	0.000	0.000	0.000	0.300
C	1.000	0.000	1.000	0.000	1.000	0.000	0.200
D	0.000	0.000	0.000	0.000	0.000	0.000	0.083
E	0.000	1.000	0.000	1.000	0.000	1.000	0.083
IDH							
A	1.000	0.000	1.000	0.000	1.000	0.000	0.000
B	0.000	1.000	0.000	1.000	0.000	1.000	0.000
C	0.000	0.000	0.000	0.000	0.000	0.000	1.000

cambium and pith of flowering stems of *S. laciniatum*, 2) ratio of width/length of first flagellomere intermediate to others in species complex and ratio of width/length of second flagellomere greater than other species in complex (Table 2, Fig. 1), 3) ovipositor longest in complex (Table 3, Fig. 2), 4) size of mature larvae larger than others in species complex (Table 3).

Redescription.—FEMALE. Same as species complex, but ratio of width/length of first flagellomere significantly different and intermediate to that of *A. meganae* and *A. jeanae* (Table 2). Ratio of width/length of second flagellomere significantly larger than both *A. meganae* and *A. jeanae* (Table 2, Fig. 1). Ovipositor significantly longer than in other species in complex (Table 3, Fig. 2). GALL: Depth of galls in stems significantly greater than in other species (Table 3). LARVAE: Mass of mature, overwintering larva significantly greater than in other species (Table 3).

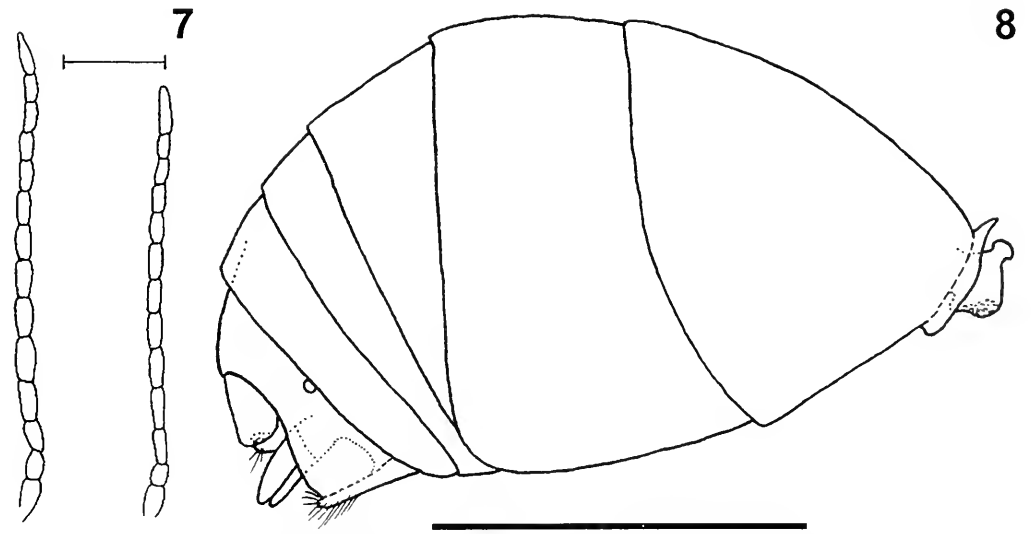
Types.—Holotype at INHS, reared from *S. laciniatum* in Illinois (Gillette 1891). We deposited an additional 10 females and

Table 2. Comparison of width, length, and width/length ratio of first and second flagellomeres (Fig. 1) for three members of the *A. rufus* species complex and ANOVA results. We measured flagellomeres of 20 female wasps reared from each of the three plant species, averaging the values from each antennae to generate mean measurements for each individual. Values within column with different letters are significantly different (LSD $P < 0.05$). Significant P values for ANOVA indicated by "*" ($P < 0.05$), "***" ($P < 0.0001$).

Species	First flagellomere			Second flagellomere		
	Width (mm)	Length (mm)	Width/Length	Width (mm)	Length (mm)	Width/Length
A. rufus	0.08 ± 0.002 b	0.20 ± 0.008 a	0.41 ± 0.011 b	0.09 ± 0.003 a	0.24 ± 0.008 b	0.36 ± 0.006 a
A. meganae	0.08 ± 0.003 b	0.22 ± 0.010 a	0.38 ± 0.001 c	0.08 ± 0.003 a	0.31 ± 0.014 a	0.27 ± 0.005 c
A. jeanne	0.09 ± 0.004 a	0.22 ± 0.007 a	0.43 ± 0.021 a	0.09 ± 0.004 a	0.32 ± 0.011 a	0.29 ± 0.005 b
	$F_{2,59} = 3.86$*	$F_{2,59} = 1.42$	$F_{2,59} = 14.4$***	$F_{2,59} = 2.06$	$F_{2,59} = 13.8$***	$F_{2,59} = 77.7$***

five males at INHS that we reared in Spring 2002 from stems of *S. laciniatum* from FRP (five females and three males) and BRP (five females and two males) in INHS; We also deposited three females and one male from FRP and two females and one male from BRP in NMNH.

Biology.—Larvae develop within galls in flowering stems of *S. laciniatum* (for biology, see Tooker et al. 2002, Tooker and Hanks 2004a). They overwinter in dead stems, pupate in the early spring, and adults emerge in late May through late June. Although adults of both sexes have fully developed and functional wings, they do not fly readily but rather walk, occasionally taking hopping flights to nearby plants. Males emerge before females and search for mates on dead stems of the previous season, guarding areas of stem where females eventually emerge, and driving off competitors by charging or butting with the head. Females mate immediately upon emerging and then move to nearby developing stems of *S. laciniatum* where they oviposit in axils. As many as 20 females oviposit in a stem at the same time and require less than one minute to insert an egg. Egg load upon emergence averages ~165 eggs per female. Densities of galls commonly reach hundreds per stem. Parasitic wasps are



Figs. 7–8. *Antistrophus* species. 7, Antennae of adult A) male and B) female *A. rufus* (scale bar = 500 μm). 8, Metasoma of adult male *A. rufus* (scale bar = 500 μm).

the most significant source of mortality for *A. rufus* larvae with rates of parasitism often exceeding 90% (Tooker and Hanks 2004a). Species of parasitoids reared from *A. rufus* galls include eurytomids (*Eurytoma lutea* Bugbee and an unidentified *Eurytoma* species), an ormyrid (*Ormyrus labotus* Walker), eupelmids (*Eupelmus vesicularis* [Retzius] and two unidentified *Brasema* species), and a pteromalid (unidentified *Homoporus* species; Tooker and Hanks 2004a). Populations of gall wasps are decimated when prairies are burned, but quickly recolonize (Tooker and Hanks 2004b).

Antistrophus meganae Tooker and Hanks, new species
(Figs. 1B, 2B)

Diagnosis.—Larvae developing in galls in cambium and pith of flowering stems of *S. terebinthinaceum*. See description for further details.

Description.—FEMALE. Generally same as others in species complex, but width/length ratio of first and second flagellomeres significantly smaller than in both *A. rufus* and *A. jeanae* (Table 2, Fig. 1B). Ovipositor significantly shorter than in *A. rufus* (Table 3, Fig. 2B). GALL: Significantly closer to the stem surface than other species in complex (Table 3). LARVAE: Mass of mature, overwintering larvae intermediate to that of *A. rufus* and *A. jeanae* (Table 3).

Types.—Holotype reared in June 2002 from stems of *S. terebinthinaceum* collected at ESJRP and deposited in INHS. We deposited nine female and five male paratypes reared from stems of *S. terebinthinaceum* collected in Spring 1999 from PRP (four females, three males) and Spring 2002 from ESJRP (five females and two males) in INHS. We deposited five female paratypes (three from ESJRP, two from PRP) and three male paratypes (two from ESJRP and one from PRP) in NMNH.

Etymology.—Named in honor of Megan Weaver Tooker, spouse of the first author.

Biology.—Similar to *A. rufus*, but larvae develop within galls in flowering stems of *S. terebinthinaceum*. Adults begin emerging from stems in mid-June and continue to emerge for approximately 20 days (Tooker and Hanks 2003a). Females oviposit in stem internodes of *S. terebinthinaceum* after bolting. Similar to *A. rufus*, *A. meganae* larvae can suffer high parasitism rates and the same guild of parasitoids appears to attack both species (Tooker and Hanks 2004a).

Antistrophus jeanae Tooker and Hanks, new species
(Figs. 1C, 2C)

Diagnosis.—Larvae developing in galls in cambium and pith of flowering stems of *S. perfoliatum*. See description for further details.

Description.—FEMALE. Generally same as others in species complex, but width/length ratio of first flagellomere significantly larger, and that of second flagellomere intermediate to other species in complex (Table 2, Fig. 1C). Ovipositor significantly shorter than that of *A. rufus* (Table 3, Fig. 2C). GALL: Intermediate in depth to other species in the complex (Table 3). LARVAE: Mass of mature, overwintering larva significantly lower than in *A. rufus* and *A. jeanae* (Table 3).

Types.—Holotype reared in May 2002 from stems of *S. perfoliatum* collected at BRP and deposited with INHS. We deposited nine female and five male paratypes reared from stems of *S. perfoliatum* collected in Spring 1999 from PRP (four females, three males) and Spring 2002 from BRP (five females, two males) in INHS. We deposited five female paratypes (three from PRP and two from BRP) and three male paratypes (two from PRP and one from BRP) in NMNH.

Etymology.—Named in honor of Jean Michelle Hanks, spouse of third author LMH.

Biology.—Similar to *A. rufus*, but larvae develop within flowering stems of *S. per-*

Table 3. Comparison of ovipositor length, gall depth, and mass of larvae for the *A. rufus* species complex, and ANOVA results. Values within column with different letters are significantly different (LSD $P < 0.05$). Significant P values for ANOVA indicated by "*" ($P < 0.01$), "**" ($P < 0.001$), "***" ($P < 0.0001$).

Species	Ovipositor length (mm)	Gall depth (mm)	Larval mass (mg)
A. rufus	3.19 ± 0.07 a	2.20 ± 0.06 a	2.29 ± 0.13 a
A. meganae	2.54 ± 0.15 b	1.05 ± 0.03 c	1.66 ± 0.09 b
A. jeanae	2.68 ± 0.09 b	1.76 ± 0.10 b	0.88 ± 0.16 c
	$F_{2, 29} = 9.44$*	$F_{2, 24} = 57.9$***	$F_{2, 24} = 6.77$**

foliatum. Adults emerge from stems for a period of about 20 days beginning in mid-May and females oviposit in stem internodes after bolting. Similar to other species in the complex, parasitoids can inflict high levels of mortality on *A. jeanae* larvae.

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The Neotropical Species of *Deuterixys* Mason (Hymenoptera: Braconidae)

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Abstract.—The neotropical species of the braconid wasp genus *Deuterixys* Mason are revised for the first time. Seven species are recognized, four of which are new to science: ***D. colombiana, D. erythrocephala, D. hansoni,* and *D. tehuantepeca.*** The remaining three species, *D. bennetti* Whitfield, *D. pacifica* Whitfield and *D. quercicola* Whitfield, were previously known from the Nearctic region but are found to range into the Neotropical. An illustrated identification key is presented for the New World species.

Our taxonomic knowledge of parasitoid wasps in tropical parts of the world, including the Neotropical Region, is notoriously incomplete. It is especially so for parasitoids whose hosts are also less well understood, for example the microlepidoptera as a group. Small caterpillars tend to be less conspicuous and more difficult to identify than larger host insects, and thus relatively few accurate host-parasite records are available for them, except in well-surveyed areas. As an example of this, Whitfield and Mason (1994) described a new subfamily of braconid wasps that appears to attack concealed microlepidopterans, and this subfamily now is known to contain at least 10–15 species distributed from South America to the southeastern U. S., some of which are still being discovered every few years (Valerio and Whitfield, 2000; Yamada and Penteado-Dias, 2002; Valerio and Whitfield, 2002). Several genera of the subfamily Microgastrinae are estimated to contain at least 100 neotropical species, only a handful of which are currently described (Mason, 1981, Whitfield, 1997). Thus it comes as no surprise that the revision presented here for the species of *Deuterixys* Mason in the Neotropical Region began with absolutely no published information about any of the species in the area under study.

The genus *Deuterixys* was erected by Mason (1981) to house the species previously assigned by Nixon (1965) to the *carbonarius*-group of *Apanteles* Foerster. By 1985, four Palearctic species (Papp, 1983) and three Nearctic species (Whitfield, 1985, 1995) were known, to which Austin and Dangerfield (1992) added one Australian species. All host records so far assembled suggest that *Deuterixys* spp. always attack caterpillars in the genus *Bucculatrix* (Bucculatricidae), which in turn feed on a wide variety of plant families, most notably on Asteraceae (Whitfield, 1985). The wasps pupate within the elongate ribbed cocoons of their hosts, lining the host cocoon with some silk of their own. The revision we present below contains no host records from the Neotropical Region, but the best current guess is that the known pattern of specialization on *Bucculatrix* will be found to be true of this area as well.

Below we describe several new species of *Deuterixys* from the Neotropical region from specimens that we have found in major collections, and compare these putative new species to the previously known species of the genus. While we can make no pretense that the survey we are presenting is complete, it is intended to provide a first treatment of this distinctive genus, and should serve to make the included species more recognizable to neotropical scientists.

This is a difficult genus in which to delimit species, especially due to the limited material for some species, the small body size, and substantial intraspecific variability in body coloration and intensity of sculpturing. We recommend using the key below first, but strongly recommend following this by checking the resulting identifications by consulting the descriptions and the figures.

The genus appears to be generally uncommon wherever it occurs in the world, although individual species can sometimes be easily collected once their host is located.

MATERIALS AND METHODS

Specimens for this study were originally sorted and brought together from several collections by the late W. R. M. Mason, and supplemented by specimens sorted by the senior author from several other collections. The collections and curators responsible for loaning these specimens are thanked in the *Acknowledgments*. Museum abbreviations in the *Specimens Examined* sections are as follows: AEI: American Entomological Institute, Gainesville; CNC: Canadian National Insect Collection, Ottawa; Humboldt: Humboldt Institute, Villa de Leyva, Colombia; INBio: Instituto Nacional de Biodiversidad, Costa Rica; MCZ: Museum of Comparative Zoology, Harvard University; TAMU: Texas A and M University, College Station); UKY: University of Kentucky, Lexington; USNM: National Museum of Natural History, Washington, D. C.; UWYO: University of Wyoming, Laramie.

Wing drawings were prepared by temporarily dry slide-mounting wings from ones side of selected specimens, and projecting these using a Ken-A-Vision X1000 microprojector onto paper for tracing and recording veins and pigmentation patterns.

Morphological terminology (including wing vein nomenclature) follows that of Sharkey and Wharton (1997) and Whitfield (1997). A diagram of this venational scheme as applied to *Deuterixys* is presented in Fig. 1.

Names of new species are to be attributed to both authors.

KEY TO NEW WORLD SPECIES OF *DEUTERIXYS* MASON

1. Tergite I of metasoma weakly hourglass-shaped, narrowing slightly in anterior half then widening again posteriorly (Fig. 9) ..... ***Deuterixys colombiana*, n. sp.**
   Known so far only from mountains of the northern Andes and Santa Marta (Colombia) Ranges.
- Tergite I either narrowing or broadening posteriorly, or relatively parallel-sided, but not narrowest near midlength (Figs. 10, 11, 13, 14) 2
2. Tergite I of metasoma strongly narrowing posteriorly; tergite III less strongly sculptured than tergite II (Fig. 14) ..... ***Deuterixys pacifica*** Whitfield
   North America, ranging well south in Mexico in mountains.
- Tergite I of metasoma either broadening posteriorly (Fig. 16), barrel-shaped (Fig. 15), or relatively parallel-sided; tergite III as strongly sculptured as tergite II 3
3. Tergite I at posterior end nearly as broad as anterior margin of tergite II, and broadening slightly posteriorly (Fig. 16); tergite III nearly as long medially as tergite II ..... ***Deuterixys quercicola*** Whitfield

Western North America, ranging well south in Mexico in mountains.

– Tergite I posteriorly much narrower than anterior margin of tergite II, and more or less barrel-shaped or parallel-sided (Figs. 10, 12, 13, 15) 4

4. Tegulae strongly yellowish ..... ***Deuterixys bennetti*** Whitfield
Gulf coast of U. S., Florida, widespread in Caribbean.

– Tegulae deep brown to blackish 5

5. Fore wing length > 2.3 mm; mesoscutum slightly depressed along courses of notauli, so that there is a suggestion of notauli in dorsal view; R1 (metacarp) only slightly longer than stigma (Fig. 5); tergite III of metasoma strongly and abruptly broader than tergite II, and only about 0.83as long as tergite II (Fig. 15) ..... ***Deuterixys hansoni*, n. sp.**
Known from Costa Rica, tentatively also from Bolivia (both high elevation localities).

– Fore wing length < 2 mm; mesoscutum with no hint of notauli; R1 (metacarp) usually approximately 1.53 as long as stigma, sometimes shorter (Figs. 4, 8); tergite III of metasoma slightly broader than tergite II, usually nearly as long as tergite II medially (Figs. 10, 12) 6

6. Scutellum and posterior 0.2 of mesoscutum polished and nearly impunctate; much or all of head and anterior portions of mesosoma often deep reddish-brown rather than black ..... ***Deuterixys erythrocephala* n. sp.**
Lower elevations in Antilles and Trinidad; questionably also from Argentina.

– Scutellum, and usually also posterior 0.2 of mesoscutum with distinct punctation; head black and thorax mostly black(Veracruz) ..... ***Deuterixys tehuantepeca* n. sp.**
So far known from mountains of southern Mexico and Central America.

Deuterixys bennetti Whitfield
Figs. 2, 13

The neotropical specimens of this previously described species are redescribed for comparison with the other species.

Female and male.—Body size: Overall length 1.9 mm; fore wing length 1.9 mm. *Head:* Antennae approximately same length as body; scapes and pedicels vivid yellow, remainder of antennae fulvous-brown; basal 9 flagellomeres with black basal, distal and intermediate patches; apical 6–7 flagellomeres with only one rank of placodes; 2nd flagellomere 3× as long as broad; 14th and 15th flagellomeres approximately 1.5× as long as broad. Head dark brownish black. Clypeus and genae reddish brown; labrum and mandibles, except brown teeth, vivid yellow; glossa and palpi whitish yellow. Frons nearly 1.25× as broad at midheight as midlength; inner margins of eyes weakly converging towards clypeus. Punctation of head indistinct. *Mesosoma:* Prosternum fulvous with yellow margins. Mesoscutum black, with lateral dark fulvous patches posteriorly; shallowly punctate, becoming less distinctly and more scarcely punctate posteriorly. Scutellar disc sparsely, shallowly punctate throughout. Propodeum dark reddish brown with margins and medial longitudinal carina black, highly polished, virtually unsculptured except for medial and lateral longitudinal strong carinae and very weak transverse ridging in immediate vicinity of longitudinal carina midbasally. *Legs:* Legs mainly yellowish, with prothoracic coxae and trochanters, mesothoracic coxae and trochanters and metathoracic trochanters pale. Distal half of mesothoracic tibiae and mesothoracic tarsi fulvous. Metathoracic legs with distal extreme of femora and tibiae, and tarsi fully brown. Hind apical tibial spurs short, whitish, subequal in length. *Wings:* Tegulae vivid yellow. Stigma 2.8× as long as broad. Metacarp (R1) of fore wing slightly longer than pterostigma; r and 2Rs subequal in length and meeting at rounded, approximately 135 degree angle. Venation of fore wing, including stigma translucent pale yellow-brown. Costa and margin of

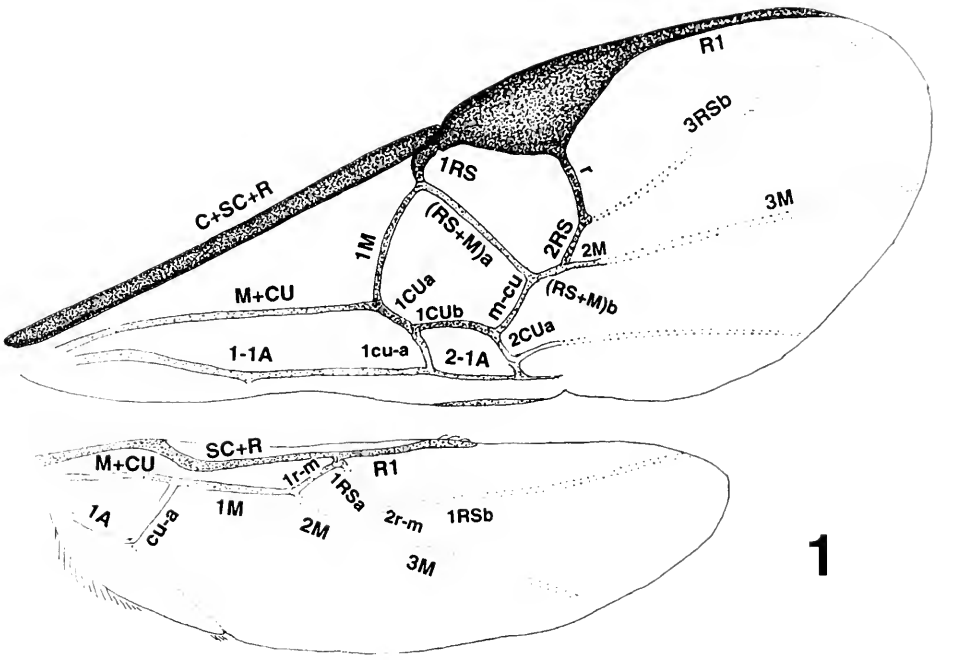


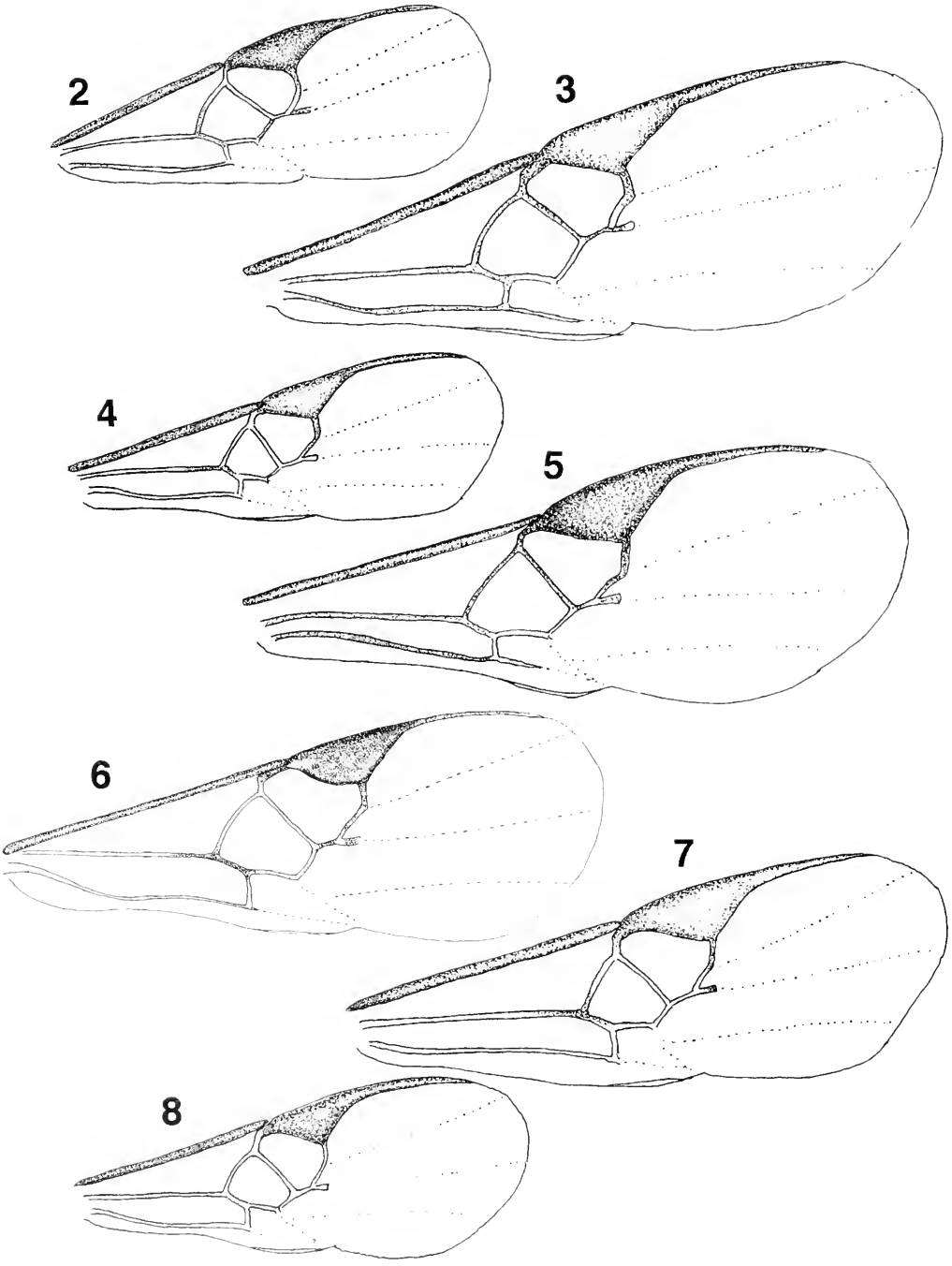
Fig. 1. Labelled diagram of wing veins, using the nomenclature adopted in Wharton et al. (1997) and in this paper.

pterostigma brown. *Metasoma:* Tergite I nearly 1.7× as long as posterior width, subparallel-sided, virtually parallel-sided, very slightly divergent anteriorly with strong longitudinal groove over anterior 0.3; coarsely aciculorugose over posterior 0.7. Tergite II and III subequal in length. Tergite II approximately 1.8× as broad anteriorly as long and a little more than 1.6× as broad posteriorly as long, with sharp anterolateral corners and posterior half virtually parallel sided; surface coarsely aciculorugose, medial raised portion sometimes distinctly demarcated by ridges. Tergite III separated from II by crenulate furrow, abruptly widening, becoming broader than tergite II at broadest point; surface longitudinally aciculorugose. Hypopygium short, blunt, with long hairs subapically. Ovipositor sheaths short, about as long as third metathoracic tarsomere, decurved, polished, with hairs concentrated apically. Tergites I, II and III black, rest of tergites brown. Laterotergites and apical margin of tergite III whitish. Apical margins of tergite IV and following tergites brownish yellow. Basal sternites yellowish, distal sternites and hypopygium fulvous-brown.

Material examined.—1♂, CUBA: Santa Clara Prov., San Juan Mts., Jan.–Feb. 1927 C. T. and B. B. Brues (MCZ); 1♀, DOMINICAN REPUBLIC: Loma el Penon, 676m, 23-III-1979, L. Masner (CNC); 1♀, 1♂, JAMAICA: Moneague, June, W. S. Brooks (MCZ).

Hosts.—Along the Gulf Coast of North America, *Bucculatrix* sp. (Lepidoptera: Bucculatricidae) on *Baccharis halimifolia* L. (Asteraceae) serves as host (Whitfield 1985); in the Neotropical region, the hosts are so far unknown.

Comments.—No other known species of New World *Deuterixys* has the tegulae so vividly yellowish, and the third metasomal tergite is also more evenly finely striate in sculpturing than other species in this Hemisphere. The Jamaican specimens are exceedingly small and less brightly colored than appears to be typical for the



Figs. 2–8. Fore wings. 2, *Deuterixys bennetti* Whitfield. 3, *D. colombiana* n. sp. 4, *D. erythrocephala* n. sp. 5, *D. hansoni* n. sp. 6, *D. pacifica* Whitfield. 7, *D. quercicola* Whitfield. 8, *D. tehuantepeca* n. sp.

species; it is possible that these represent a distinct species but our best guess at present, based on both morphology and distribution, is that they are dwarfed *D. bennetti*.

Deuterixys colombiana Whitfield and Oltra, n. sp.

Figs. 3, 9

Female and male.—Body size: Overall length 2.5–3.0 mm; fore wing length 2.5–3.0 mm. *Head:* Black, with palpi whitish amber. Antennae slightly longer than body, scapes dark brown yellow infuscate and pedicels brown, remainder of antennae brown. Apical 6 flagellomeres with only one rank of placodes. Second flagellomere 3.5–4.2× as long as broad, 14th and 15th flagellomeres 1.3× as long as broad. Inner margins of eyes weakly converging towards clypeus. Punctation of head indistinct. *Mesosoma:* Mesoscutum black, shallowly punctate anteriorly, becoming less distinctly and more sparsely punctate posteriorly. Scutellar disc sparsely, shallowly punctate throughout. Propodeum highly polished, virtually unsculptured except for medial and lateral longitudinal strong carinae, and weak transverse ridging in inmediate vicinity of longitudinal carina. Propodeum with basal half brownish black and distal half dark reddish brown. *Legs:* Prothoracic legs brown except whitish trochanters and yellowish fulvous distal half of femora and entire tibiae. Mesothoracic and metathoracic legs mainly brown, except tarsomeres darker and fulvous trochanters, apical extreme intermediate femora and basal extreme tibiae. Apical spurs of hind tibiae short, whitish, subequal in length. *Wings:* Tegulae dark brown. Stigma 2.8–3× as long as broad. Metacarp (R1) of fore wing slightly longer than stigma; r and 2Rs subequal in length and meeting at rounded to weakly angular, approximately 135 degree angle. Venation of fore wing light yellowish brown, stigma opaque, pale yellowish white; translucent and light brown in one exemplar. Costa and margin of stigma brown. *Metasoma:* Tergite I 1.8–1.9× as long as posterior width, narrowing in basal 0.4, with strong longitudinal groove over anterior 0.5–0.6; coarsely aciculorugose over posterior 0.6. Tergite II and tergite III subequal in length. Tergite II subquadrate, slightly broader anteriorly than posteriorly, approximately 1.7× as broad as long, surface coarsely aciculorugose, with parallel dense striations longitudinally, medial raised portion distinct. Tergite III separated from tergite II by crenulate groove, becoming abruptly wider than tergite II; surface longitudinally aciculorugose and medial raised portion as tergite II. Hypopygium short, blunt, with long hairs mainly concentrated apically. Ovipositor sheaths short, about as long as apical metathoracic tarsomere, decurved, polished, with hairs concentrated apically. Tergites I, II and III black, tergite IV dark brown and rest of tergites brown. Sternites fulvous-brown. Laterotergites, apical margins of tergite III and following tergites, and intersegmental membranes mainly whitish.

Hosts.—Unknown.

Material examined.—Holotype ♀: COLOMBIA: Caldas, 3300–3500m, 5°15'N, 76°25'W 3-IV-1973, J. Helava, (CNC). PARATYPES: 5♀, 6♂, same data, also 1♂, Antioquia, 1800m, 7°5'N, 76°30'W, 18-22-IV-1973, J. Helava, (CNC), 1♂, Putumayo, 2900m, 1°10'N, 77°15'W, 2-XII-1972, J. Helava (CNC). Other material: 2♀, 1♂, COLOMBIA: Magdalena, PNN S. Nevada de Santa Marta, El Ramo, 2500m, 24-30-VI-2000, J. Castillo, J. Varela (Humboldt, UKY). ECUADOR: 1♂, Napo, above Papallacta, 3500m, 21-II-1983 (AEI), L. Masner; 1♂, Napo, above Papallacta, 3200m, 14-II-1983, Masner and Sharkey (AEI); 1♂, Pimo (N. Cañar), 3200m, 10-12-XII-1970, L. E. Peña (AEI). PERU: 1♀, San Jeronimo, 10 km E. Cusco, Feb.–Mar. 1978, P. M. Marsh (USNM).

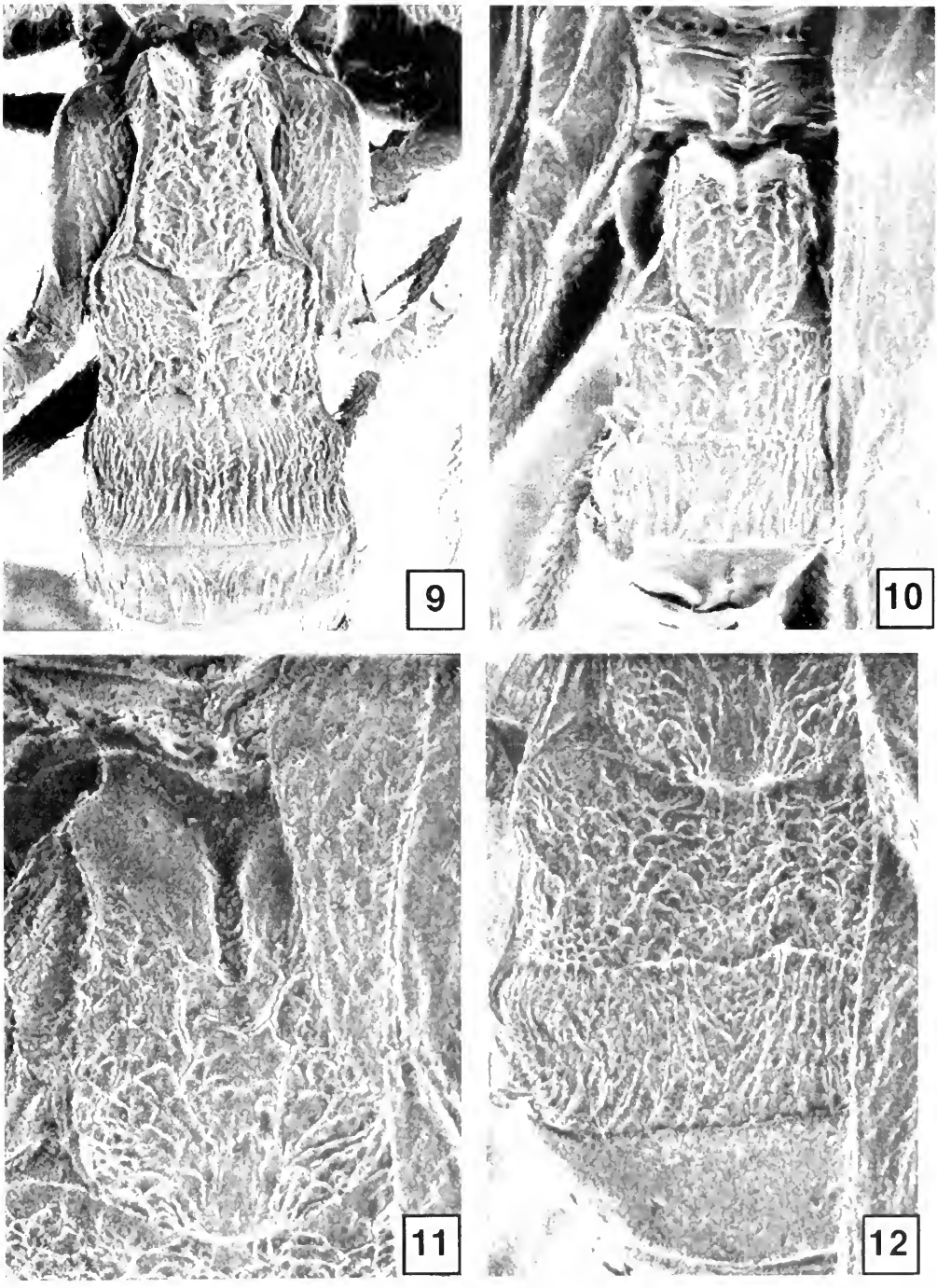
Comments.—Tergite I of this species is similar to some specimens of *D. rimulosa*

(Niez.) from the east of Spain, but it can be easily distinguished from this Palaearctic species by its possession of the combination of following features: 1) metacarp longer than stigma, 2) metasomal tergite I with strong narrowing in basal half, forming an hourglass shape in females (more parallel-sided in males), and 3) coarsely aciculorugose surface of tergites II and III. The relatively long tergite II, in combination with the very coarse sculpturing, is diagnostic for this species in the New World fauna. This species is known currently only from the northern Andes, and from the isolated Santa Marta range in northern Colombia.

Deuterixys erythrocephala Whitfield and Oltra, n. sp.

Figs. 4, 10

Female.—Body size: Overall length 1.7–1.8 mm; fore wing length 1.8–1.9 mm. *Head:* Antennae approximately as long as body; scapes and pedicels fulvous in upper part and vivid yellow in lower part, remainder of antennae brown; basal 8 flagellomeres with black basal, distal and intermediate patches; apical 8–9 flagellomeres with only one rank of placodes; 2nd flagellomere 3–4× as long as broad; 14th and 15th flagellomeres from 1.2× up to nearly 1.7 as long as broad. Head dark reddish brown in dorsal view; frons, clypeus deep fulvous to brown; labrum and mandibles, except brown teeth, vivid yellow; glossa and palpi whitish yellow. Frons from 1.3×–1.5× as broad at midheight as midlength; inner margins of eyes virtually parallel to slightly divergent ventrally towards clypeus. Punctation of head indistinct in dorsal view, punctation of face superficial, giving impression of even rugosity. *Mesosoma:* Prosternum dark fulvous to reddish brown. Mesoscutum mostly dark fulvous to reddish brown, with lateral and medial black patches posteriorly; shallowly punctate, becoming impunctate over posterior 0.2. Scutellar disc punctate virtually throughout, evenly convex. Propodeum dark reddish brown with margins and medial longitudinal carina black, highly polished, virtually unsculptured except for medial and lateral longitudinal strong carinae and transverse ridging in inmediate vicinity of three carinae. *Legs:* Prothoracic legs whitish yellow except fulvous distal tarsomere. Mesothoracic legs with trochanters light yellow, coxae and femora fulvous, tibiae light fulvous and tarsi yellowish except fulvous distal tarsomere. Metathoracic legs mostly dark fulvous, except yellowish white trochanters and basal third to half of tibiae, and brown zones of tibiae and tarsi more dark. Apical spurs of hind tibiae short, whitish, subequal in length. *Wings:* Tegulae dark fulvous to brown. Stigma 2.75× as long as broad. Metacarp (R1) of fore wing up to 1.3× length of stigma; r and 2Rs subequal in length and meeting at slightly rounded, approximately 135 degree angle. Venation of fore wing, including stigma, translucent, very pale to yellowish brown (stigma can appear opaque whitish in some preserved specimens). Costa and margin of pterostigma brown. *Metasoma:* Tergite I from 1.5 × up to 2× as long as posterior width, virtually subparallel-sided, broadening shallowly in distal third and narrowing slightly posteriorly, with strong longitudinal groove over anterior 0.3–0.4; coarsely aciculorugose over posterior 0.6–0.8. Tergite II slightly longer than III. Tergite II parallel-sided, from 1.6× up to 2× as broad as long; surface coarsely aciculorugose, medial raised portion almost indistinct. Tergite III separated from II by crenulate furrow, abruptly widening, becoming broader than tergite II; surface longitudinally aciculorugose. Hypopygium short, blunt, with scattered long hairs subapically. Ovipositor sheaths short, about as long as second /third metathoracic tarsomere, decurved, polished, with hairs concentrated apically. Tergites I, II and III black, occasionally shading more reddish brown, rest of tergites brown. Laterotergites and ster-



Figs. 9–12. Metasomal tergites, dorsal view: 9, *Deuterixys colombiana* n. sp. 10, *D. cruthroccphala* n. sp. 11, 12, *D. tehuantepeca* n. sp.

nites whitish, distal sternites and hypopygium fulvous-brown.

Material examined.—HOLOTYPE ♀: TRINIDAD: Curepe, 21-VII-1978, malaise trap (no collector given) (CNC). PARATYPES: 1♀, same data but XII. 1977 (CNC); 1♀, DOMINICAN REPUBLIC: La Cumbre, 400m, 21-III-1978, L. Masner (CNC). More doubtful determination: ARGENTINA: 1♀, Tucumán, Horco Molle, 10-15-V-1968, no collector listed (MCZ).

Hosts.—Unknown.

Comments—This species can be easily distinguished from the other species in the New World by its possession of the following combination of features: 1) tegulae dark brown, 2) posterior 0.2 of mesoscutum and scutellum virtually impunctate, and 3) portions of head and mesosoma reddish brown rather than black. This latter feature gives the species its name. The specimen from Argentina seems virtually identical in structural details, but is darker in general coloration. The Trinidad specimens differ in some minor details (especially coloration) from the Dominican Republic specimen, but we consider them conspecific due to their joint possession of the distinctive features listed above.

Deuterixys hansoni Whitfield and Oltra, n. sp.

Figs. 5, 15

Female.—Body size: Overall length about 2.1 mm; fore wing 2.5 mm. *Head:* Length of antennae 2.5 mm; antennae dark brown, pedicels infuscate of dark fulvous; apical 6 flagellomeres with only one rank of placodes; 2nd flagellomere 3.3× as long as broad; 14th flagellomere about 1.5× as long as broad. Head black, clypeus dark brown, labrum and mandibles light fulvous infuscate with brown; glossa and palpi yellowish white. Frons about 1.5× as broad at midheight as midlength; inner margins of eyes virtually parallel towards clypeus. Punctation of head superficial, dense, giving impression of even rugosity, especially in the face. *Mesosoma:* Prosternum black. Mesoscutum black; punctation shallow and dense, becoming impunctate near posterior margin; courses of notauli somewhat depressed, so there is a suggestion of notauli. Scutellar disc black, sparsely and very shallowly punctate, evenly convex. Propodeum black, mostly polished, sculptured by medial and lateral longitudinal strong carinae and transverse ridging of three carinae giving impression of even irregularity. *Legs:* Prothoracic and mesothoracic coxae dark brown, metathoracic coxae black. Prothoracic legs with trochanters and femora yellow, femora dark brown, infuscate basally; with tibiae and tarsi dark fulvous, distal tarsomere brown. Mesothoracic legs with trochanters reddish brown, femora dark brown and yellowish distally, tibiae gradually changing from fulvous basally to brown distally, tarsi light brown with distal tarsomere dark brown. Metathoracic legs with trochanters and femora dark brown, femora reddish infuscate, approximately basal third tibiae fulvous with the rest dark brown-fulvous, with tarsi dark brown. Hind apical tibial spurs short, whithish, subequal in length. *Wings:* Tegulae black. Stigma 2.4× as long as broad. Metacarp (R1) of fore wing as long as stigma, r and 2Rs subequal in length and meeting at about 130 degree angle. Venation of fore wing mostly brown, discoloured basally; stigma opaque, whitish yellow; costa and margins of stigma brown. *Metasoma:* Tergite I 2.2× as long as posterior width, barrel-shaped, very weakly widening posteriorly, with strongly rounded apical corners so than greatest width of distal third is nearly 1.5× as broad as distal width; with strong longitudinal groove over anterior 0.4; coarsely rugose over posterior 0.8. Tergite II slightly longer than III, with subparallel sides, shallowly divergent anteriorly, with strong anterolateral corners; surface coarsely aciculorugose, medial raised portion almost indistinct and narrow. Tergite II about 1.6× as broad as long. Tergite III separated from II by cren-

ulate furrow, abruptly widening, becoming broader than tergite II at broadest point; surface longitudinally aciculorugose. Tergite IV shallowly rugose, remaining tergites polished. Hypopygium short, blunt, with long hairs apically. Ovipositor sheaths short, about as long as second metathoracic tarsomere, decurved, polished, with hairs concentrated in apical half. Tergites I, II, III and IV black, rest of tergites dark reddish brown. Laterotergites and apical margins of tergites III and IV whitish, basal sternites fulvous-brown. Distal sternites and hypopygium brown.

Material examined.—HOLOTYPE ♀: COSTA RICA: San Jose, 16 km S. Empaime, 2600m, II-IV-1989, P. Hanson and I. Gauld (UWYO). More doubtfully associated: BOLIVIA: 1♀, La Paz, Rio Zongo, 3200m, 22-X-1984, L. Peña (AEI).

Hosts.—Unknown.

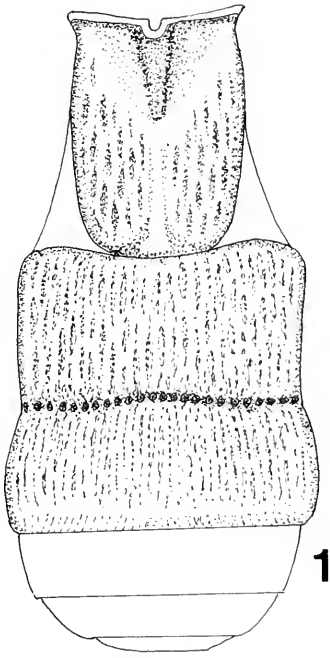
Comments.—This is one of the larger species of *Deuterixys*. It differs from the superficially similar species such as *D. bennetti*, *D. erythrocephala* and *D. tehuantepeca* by its possession of the following combination of features: 1) weak suggestion of notauli on mesoscutum, 2) metacarp about as long as stigma, 3) tergite I weakly widening posteriorly, 4) tergite III abruptly wider than tergite II and about 0.75 length of tergite II. In general the anterolateral corners of tergite II are also more rectangular than in the other species. The Bolivian specimen appears to be distributionally disjunct, but since the specimens are from high elevation and rarely collected this may not mean much. The species is named for Dr. Paul Hanson, of the University of Costa Rica, who has contributed substantially to our knowledge of Costa Rican Hymenoptera.

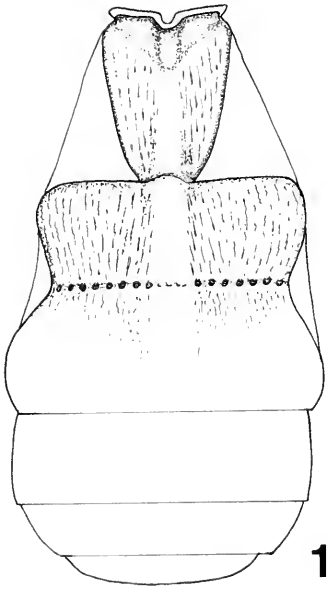
Deuterixys pacifica Whitfield

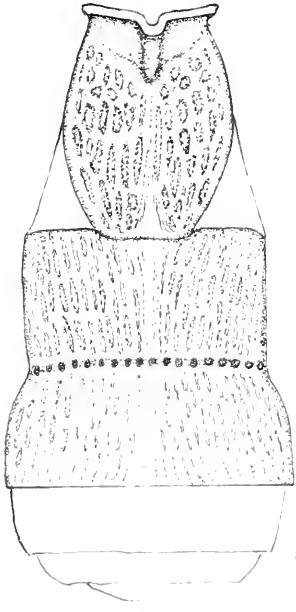
Figs. 6, 14

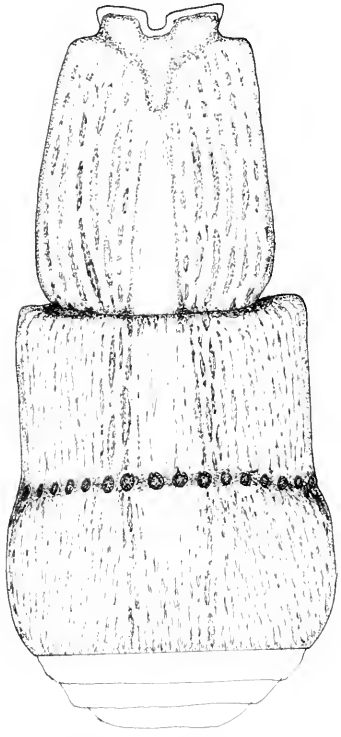
Neotropical specimens of this previously described Nearctic species redescribed for comparison.

Female and male.—Body size: Overall length about 1.9 mm; fore wing approximately 2 mm. *Head:* Antennae nearly as long as body; apical 8 flagellomeres with only one rank of placodes; 2nd flagellomere 2× as long as broad; 14th and 15th flagellomeres about 1.4× as long as broad. Antennae brown. Head black in dorsal view, brown in frontal view, labrum and mandibles, except light fulvous teeth, fulvous-brown; glossa whitish fulvous; palpi light brown. Frons 1.3× as broad at midheight as midlength; inner margins of eyes virtually parallel towards clypeus. Punctation of head virtually indistinct in dorsal view, punctation of face superficial, crowded, giving impression of even rugosity. *Mesosoma:* Mesosoma mainly black dorsally and ventrally; axillae adjacent to scutellum, metanotum and propodeum dark reddish brown. Punctation of mesoscutum shallow and fine, rough and more crowded in courses of notauli. Scutellar disc shallowly punctate, punctation crowded giving impression of even rugosity laterally and posteriorly. Propodeum dark reddish brown with black margins and mid-longitudinal carina, very polished, virtually unsculptured except for strong medial and lateral longitudinal carinae and very little, superficial, transverse ridging in immediate vicinity of medial carina. *Legs:* Generally for the most part brown, more reddish from coxae through femora inclusive; prothoracic femora distally and metathoracic tibiae basally yellowish. Hind apical tibial spurs short, whitish, subequal in length. *Wings:* Tegulae black. Stigma 2.4× as long as wide. Metacarp (R1) and stigma of fore wing subequal in length; 2Rs 1.25× as long as r and meeting at about 130 degree angle. Venation of fore wing mostly light brown, paler basally; stigma opaque, brown, more light basally; costa brown. *Metasoma:* Tergite I 3.4× as long as posterior width; subparallel-sided anteriorly, evenly and weakly narrowing over about posterior 0.7, rounded, convergent posteriorly; with strong longitudinal groove about over an-









Figs. 13–16. Metasomal tergites, dorsal view. 13, *Deuterixys bennetti* Whitfield. 14, *D. pacifica* Whitfield. 15, *D. hansoni* n. sp. 16, *D. quercicola* Whitfield.

terior 0.5; coarsely rugose over posterior 0.6. Tergite III 1.4× as long medially as II. Tergite II about 2.2× as broad medially as long, virtually parallel-sided, narrowing slightly posteriorly; surface evenly rugose, medial raised portion little evident. Notch between tergites II and III evident. Tergite III separated from II by narrow crenulate furrow, rounded laterally, becoming broader than tergite II at broadest point; surface weakly rugose. Hypopygium short, blunt, with long hairs subapically. Ovipositor sheaths short, near as long as third and fourth metathoracic tarsomeres together, decurved, polished, with hairs concentrated apically. Tergites I, II and III mostly black, except reddish brown smooth zone basally on tergite I and fulvous zone subdistally on tergite III; rest of tergites brownish fulvous. Dorsal portions of laterotergites fulvous. Remaining area of laterotergites and apical margin of tergites III, IV and V whitish. Sternites brown, sterna of basal segments little lighter, hypopygium fulvous-brown.

Material examined.—1♀, MEXICO: Michoacan, 2 mi. S. Carapan, 6-VII-1985, Woolley and Zolnerowich (TAMU); 1♂, San Luis Potosi, 7.2 mi. E. San Luis Potosi, 3-VII-1987, G. Zolnerowich (TAMU). Three specimens have also been seen from the Rocky Mountains in Wyoming (material in UWYO collection), adding to the range from the original description.

Hosts.—In western North America, this species attacks *Bucculatrix* spp. on sagebrush and a broad range of other composites (Whitfield 1985); possibly this also goes for the Mexican material.

Comments.—This species is distinctive among the New World species in having the first tergite so strongly narrowed, and in having the third tergite much less strongly sculptured than the second. It resembles the Palearctic *D. rimulosa* Niez., but has the first tergite more strongly narrowed posteriorly.

Deuterixys quercicola Whitfield
Figs. 7, 16

Neotropical specimens of this previously described species are redescribed for comparison.

Female and male.—Body size: Overall length approximately 2 mm; fore wing about 2 mm. *Head:* Antennae as long as body, black, 2nd flagellomere 4× as long as broad, 14th flagellomere approximately 1.4× longer than broad. Head black, clypeus black, labrus and mandibles reddish brown; glossa brownish yellow, palpi yellowish white. Posterior ocelli brownish red, opaque; anterior ocellus yellow, translucent. Frons nearly 1.2× as broad at midheight as midlength; inner margins of eyes divergent towards clypeus. Head in dorsal view smooth and very polished; punctation of face superficial, crowded, giving impression of even, shallow rugosity. *Mesosoma:* Mesosoma black dorsally and ventrally. Punctation of mesoscutum shallow, becoming impunctate posteriorly. Scutellar disc mostly smooth and very polished, with light punctation anterolaterally. Propodeum black, very polished, shining, virtually unsculptured except for medial and lateral longitudinal strong carinae, and weak, little extensive, transverse ridging in inmediate vicinity of carinae. *Legs:* Prothoracic legs mostly brownish yellow with coxae, basal two thirds of femora and last tarsomere blackish. Mesothoracic legs with black coxae and femora, tibiae brown and tarsi yellowish brown. Metathoracic legs mainly black, with two fifth basal of tibiae fulvous. Apical outer spur of hind tibiae shorter than half length of tibia. *Wings:* Tegulae black. Metacarp (R1) and stigma of fore wing subequal in length; 2Rs sligthly longer than r and meeting at rounded, approximately 135 degree angle. Stigma about 2.7× as long as wide. Venation of fore wing brown, stigma translucent yellowish brown. Costa dark brown. *Metasoma:* Tergite I 1.5× as long as posterior

width, subparallel-sided, slightly broadening in distal 0.4, with strong longitudinal groove over anterior 0.3; coarsely aciculorugose longitudinally over about distal 0.8 with a smooth and polished zone mid-longitudinally. Tergite II and III subequal in length. Tergite II subparallel-sided, about 1.7× as broad as long; sculpture coarsely aciculorugose, more densely so laterally, medial raised portion almost indistinct. Notch between tergites II and III barely evident. Tergite III separated from II by crenulate furrow, becoming shallowly broader than tergite II; sculpture longitudinally aciculorugose, more fine and dense posteriorly. Of remaining tergites, only tergites IV and V visible, tergite V short and overlapped by IV. Tergite IV with fine longitudinal sculpturing over most of its surface. Hypopygium short, blunt, with sparse long hairs. Ovipositor sheaths short, near as long as second metathoracic tarsomere, decurved, apically hairy. Metasoma mostly black, basal sternites dark fulvous.

Material examined.—1♀, MEXICO: Tamaulipas, Mun. Tula, La Presita, Canon de Coyote, 1900m. 16-III-1987, P. Kovarik, R. Jones, R. Trivino (TAMU). 1♂, MEXICO: Durango, 6 mi. W. La Ciudad, 9000', 11-VI-1964, W.R.M. Mason (CNC).

Hosts.—In western North America, this species parasitizes *Bucculatrix* spp. primarily on oaks (*Quercus* spp.). This is possibly true also for the Mexican material, but there are no rearing records there.

Comments.—No other New World *Deuterixys* species has the posterior margin of the first metasomal tergite nearly as broad as the second tergite. This species seems to range widely especially in scrubby savannah-like vegetation south from North America well into southern Mexico.

Deuterixys tehuantepeca Whitfield and Oltra, n. sp.

Figs. 8, 11, 12

Female and male.—Body size: Overall length about 1.9 mm; fore wing approximately 1.9 mm. *Head:* Antennae as long as body; scapes and pedicels fulvous in upper part with brown distal half of pedicels, and yellow in lower part, remainder of antennae brown; apical 8 flagellomeres with only one rank of placodes; 2nd flagellomere approx. 3× as long as broad; 14th and 15th flagellomeres 1.25× and 1.4× as long as broad respectively. Head black frontally and dorsally, clypeus brown; labrum and mandibles, except brown teeth and infuscate basal part of mandible, yellow; glossa and palpi whitish. Frons slowly broader at midheight than midlength; inner margins of eyes divergent towards clypeus. Punctation of head virtually indistinct in dorsal view, punctation of face superficial, crowded, giving impression of even rugosity. *Mesosoma:* Mesosoma generally black to dark reddish brown dorsally and ventrally. Punctation of mesoscutum shallow, becoming impunctate posteriorly. Scutellar disc sparsely and very shallowly punctate, evenly convex. Propodeum dark reddish brown with margins and medial-longitudinal carina black, polished, virtually unsculptured except for medial and lateral longitudinal strong carinae and transverse ridging in immediate vicinity of the three carinae. *Legs:* Prothoracic legs mostly yellowish white, with coxae basally and tarsi distally fulvous infuscated. Mesothoracic legs with coxae fulvous ventrally, brown dorsally; trochanters yellowish fulvous; fulvous femora infuscate basally and dorsally; tibiae and tarsi whitish yellow, apical tarsomeres fulvous. Metathoracic legs mainly brown except trochanters and basal two-thirds of tibiae yellowish fulvous. Apical spurs of hind tibiae short, whitish, subequal in length. *Wings:* Tegulae dark reddish brown. Stigma from 2.5× up to near 2.8× as long as wide. Metacarp (R1) of fore wing almost 1.2× as long as stigma; r and 2Rs subequal in length and meeting at rounded, approximately 135 degree angle. Venation of fore wing mostly light brown, paler basally; stigma opaque, pale

to light brown; costa brown. *Metasoma:* Tergite I about 2–2.2× as long as posterior width, parallel-sided to slightly broadening posteriorly, posterior corners rounded, with strong longitudinal groove over anterior 0.5; coarsely aciculorugose over posterior 0.7. Tergite II slightly longer medially than III, about 1.75× as broad medially as long, with virtually parallel sides; surface scrobiculate, medial raised portion almost indistinct, wide. Notch between tergites II and III barely evident. Tergite III separated from II by crenulate furrow, this more evident medially; tergite III becoming slightly broader than tergite II; sculpture longitudinally aciculorugose. Hypopygium short, blunt, with long hairs subapically. Ovipositor sheaths short, near as long as distal metathoracic tarsomere, decurved, with hairs concentrated apically. Tergites I, II and III dark brown to black. Tergites IV, V and VI brownish fulvous, polished; rest of tergites fulvous. Laterotergites and apical margin of tergites IV, V and VI whitish. Basal sternites yellowish, remaining sternites and hypopygium fulvous-brown.

Material examined.—HOLOTYPE ♀: GUATEMALA: Antigua, 1500–1600m, VII-1980, N. L. H. Krauss (CNC). PARATYPES: 1♂, same data; 1♀, MEXICO: Oaxaca, 5.7 mi. SE Quiotepec, 2100′, 21-VII-1987, Woolley and Zolnerowich 87/053 (TAMU), 1♀, Veracruz, 3 mi. E. Huatusco, 23-VII-1984, J. B. Woolley 84/049b (TAMU).

Hosts.—Unknown.

Comments.—This species differs from *D. erythrocephala* in the distinctness of the punctation posteriorly on the mesoscutum and on the scutellum, and in having the mesosoma completely dark; from *D. bennetti* it differs in having dark tegulae, and from *D. hansoni* in being much smaller, having a slightly longer metacarp and in having the third metasomal tergite not so strongly broader than the second. It is not similar enough to the other species to be confused. So far it has only been found in the general region of the Isthmus of Tehuantepec, hence the specific epithet.

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Revision of the Genus *Pseudognaptodon* Fischer (Hymenoptera: Braconidae: Gnamptodontinae)

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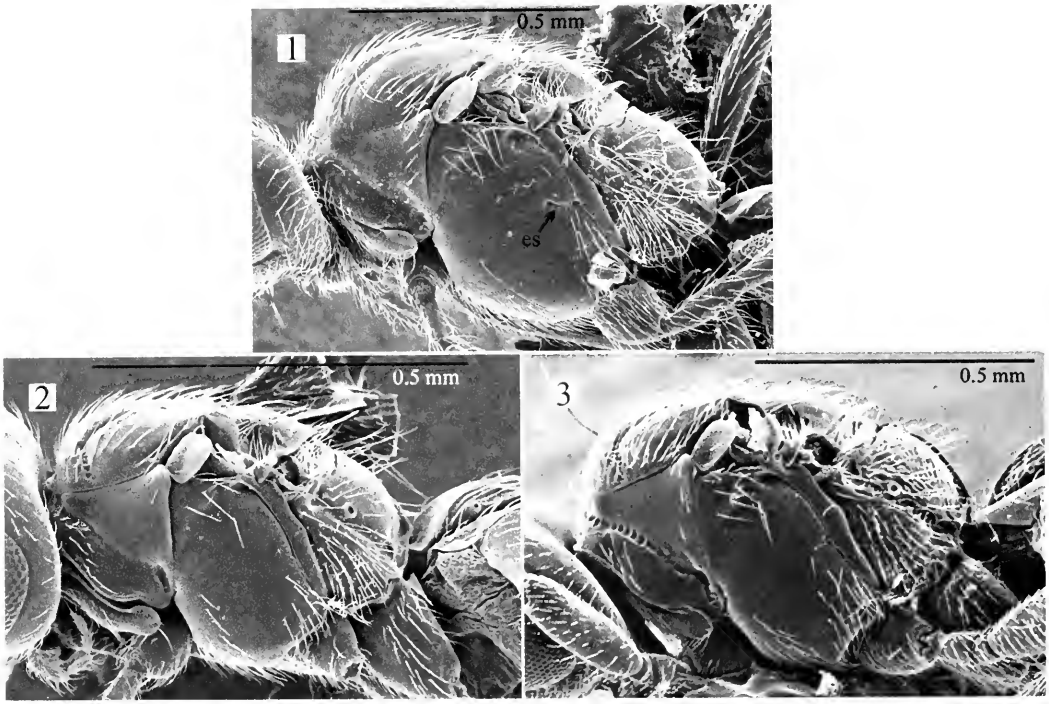
Abstract.—The New World genus *Pseudognaptodon* has three previously described species, *P. curticauda* Fischer, *P. minutus* Ashmead, and *P. omissus* Fischer. ***Pseudognaptodon attenuatus, P.brevis, P. conjunctus, P. carinatus, P. gibsoni, P. gouleti, P. hemicolor, P labrus, P. langori, P. minimus, P. nitidus, P. ocellatus, P. shawi, P. striatus, P. whartoni, P. whitfieldi,*** and ***P. xanthus,*** are described here as new. A key is given to the species of *Pseudognaptodon*. Problems in the phylogenetic relationship between *Gnamptodon* and *Pseudognaptodon* are discussed.

Fischer (1965) described the genus *Pseudognaptodon* (Braconidae: Gnamptodontinae) and included two new species, *P. omissus* and *P. curticauda*, each of which was described from only two specimens from the Nearctic. He subsequently (Fischer 1967) included *P. minutus* Ashmead, based on the study of 13 specimens. These three species are very similar to species of *Gnamptodon*, but differ by the absence of the forewing r-m vein. Fischer (1977) treated both *Gnamptodon* (as *Gnaptodon*) and *Pseudognaptodon* as genera of the Opiinae. They were subsequently transferred to the new subfamily Gnaptodontinae by van Achterberg (1983). Wharton (1997), and Whitfield and Wagner (1991), have published taxonomic works and keys to the gnamptodotine genera, including *Pseudognaptodon*, but no further species-level work has been done on the genus since the original descriptions from limited material. Since that time more material has accumulated through biodiversity studies in Central America (S.R. Shaw, R. Wharton, pers. comm.) and studies of the parasitoids of Nearctic leaf-mining Lepidoptera (Whitfield and Wagner 1991), representing new species and a much wider range of morphological variation than previously documented. The purpose of this study is to describe these species and discuss characters that may be useful in phylogenetic analysis.

The species of *Pseudognaptodon* are here divided into two species groups, the *curticauda*-group and the *omissus*-group, which are united by wing venation but otherwise no more similar to one another than either is to *Gnamptodon* (Williams, unpublished data). A conservative approach is taken in light of the uncertainty of phylogenetic relationships within the Gnamptodontinae, so no new genus-group names are proposed here.

METHODS

Terms follow Wharton *et al* (1997), with some details clarified as follows: The basal raised area is the anterior portion of the second metasomal tergite (T2), which is separated from the posterior portion by a groove (the defining synapomorphy of the Gnamptodontinae) (Figs. 22, 32, 42). This portion is higher posteriorly than anteriorly in lateral view, and higher than the posterior portion of the tergite, even in species where the groove is somewhat effaced. The anterolateral grooves of the third metasomal tergite (T3) are those on



Figs. 1–3. *Pseudognaptodon* species, metasoma in lateral view. 1, *P. attenuatus:* es = epicnemial scrobe. 2, *P. minutus* (Ashmead). 3, *P. carinatus.*

either side of the anterior margin that join the suture between the second and third metasomal terga, and separate the anterolateral corners from the remainder (Figs. 22, 32, 42). The knob of the hind wing R vein refers to the remnant of the base of the RS vein, which may be absent, or visible as a variously developed convexity or bump (Figs. 7, 18).

Most measurements are taken as the greatest length of the body part measurable (e.g. femur length, clypeus height, etc.). Other measurements used in descriptions are:

Eye length: the greatest width of the eye in lateral view, along the line of greatest head width (Fig. 6).

Eye height: the greatest height of the eye in lateral view, measured perpendicular to the eye length (Fig. 6).

Gena width: the width of the gena measured on the same line as for eye length (Fig. 6).

Head height: the greatest distance between the vertex and ventral margin of the gena in lateral view (Fig. 6).

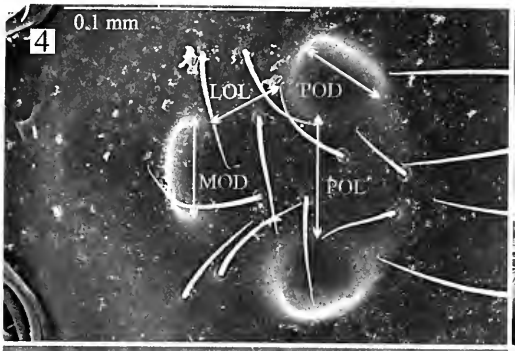
Head length: measured from the anteriormost projection of the middle of the face to a line intersecting the posteriormost curve of the occiput (Fig. 5). This method avoids error introduced by variation in occiput indentation.

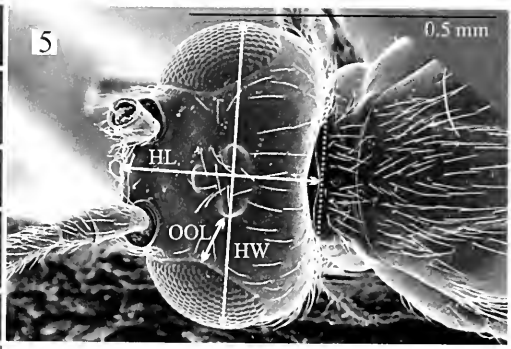
Head width: the greatest distance across the head in dorsal view, including the eyes (Fig. 5).

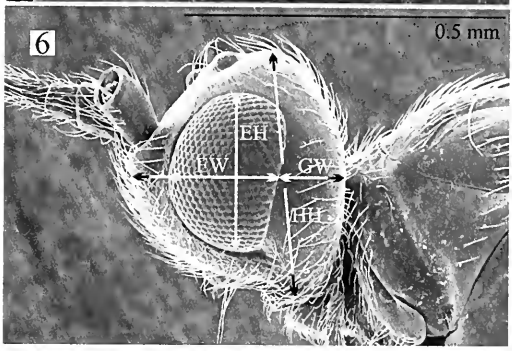
Diameter of median ocellus (MOD): the greatest diameter of the median ocellus (Fig 4).

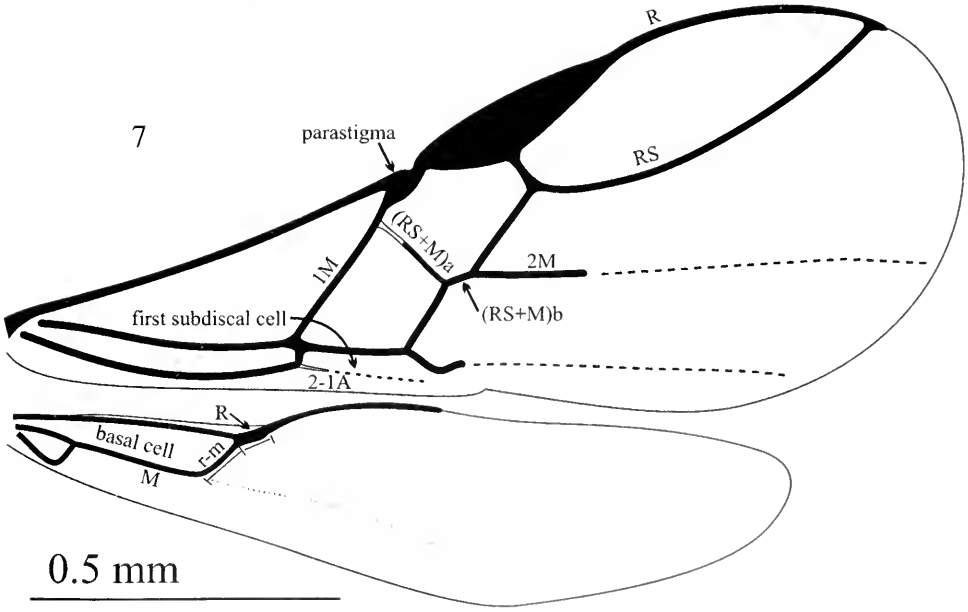
Diameter of lateral (or posterior) ocellus (POD): the greatest diameter of the left ocellus, usually measured about 45 degrees from the long axis of the body (Fig. 4).

Lateral ocellar length (LOL): The least distance between the median ocellus and the left lateral ocellus (Fig. 4).









Figs. 4–7. *Pseudognaptodon attenuatus*. 4, Ocelli in dorsal view. LOL = lateral ocellar length, MOD = diameter of median ocellus, POD = diameter of lateral ocellus, POL = posterior ocellar length. 5, Head in dorsal view. HL = head length, HW = head width, OOL = ocello-ocular length. 6, Head in lateral view. EH = eye height, EW = eye width, GW = gena width, HH = head height. 7, Wings.

Ocello-ocular length (OOL): the shortest distance between the left lateral ocellus and the closest point on the dorsal eye margin (Fig. 5).

Posterior ocellar length (POL): the least distance between the lateral ocelli (Fig. 4).

Metasomal T1 length: the distance from the posteriormost point of the tergite to a line drawn through the narrowest point immediately posterior to its' attachment point to the propodeum (Fig. 10).

Metasomal T1 width: the greatest distance of it's posterior margin (Fig. 10).

Metasomal T2 and T3 length: measured on the midline (Fig. 22).

Wing vein lengths: vein junctions are gradual thickenings with curved margins. Lengths are measured at the midpoint of the curve between the veins (Fig. 7, R and r-m).

Descriptions are based on females, and are not identical in format between the species groups, although most characters are shared. Characters that are invariable in a species group are excluded from species treatments. The shape and sculpture of the first three metasomal tergites are diagnostic for most *Pseudognaptodon* species. Males tend to show greater similarity among species than females for these characters. Males generally have metasomal tergites that are longer, narrower, and less distinctly sculptured than in females, so the application of these characters in the key or diagnoses must be used with caution. Characters of color and other body parts apply equally to both sexes, and effort has been made to include these characters in the key.

Structures were illustrated with scanning electron micrographs where possible. Because of their minute size specimens are easily damaged by any attempt to manipulate them. So, specimens for S.E.M. were left on their points and unaltered, except for the removal of wings, which were mounted on a separate card and later repinned with the specimen. Points were mounted directly to S.E.M. stubs, and gold–coated along with the specimens. Micrographs are somewhat variable in quality and position of illustrated structures because of this. For species described from few specimens it was not desirable to alter specimens by removal of appendages or gold coating. Photographs of holotypes of these species were taken with a stereomicroscope and digital camera. These photographs were of insufficient quality for publication, and so were rendered into line drawings by tracing.

Specimens were obtained from the following collections, with the name of the originator of the loan:

BMNH The Natural History Museum, Cromwell Road, London, SW7 5BD, ENGLAND, Suzanne Lewis.

CNCI The Canadian National Collection of Insects, ECORC, K.W. Neatbly Bldg.–CEF, Ottawa, Ontario, K1A 0C6, CANADA, Henri Goulet.

DJMW Daryl J. Williams Collection, Northern Forestry Centre, Edmonton, Alberta, T6H 3S7, CANADA.

ESUW Department of Plant, Soil, and Insect Science, University of Wyoming, Laramie, 82071, USA, Scott Shaw.

FSCA Florida State Collection of Arthropods, Division of Plant Industry, Florida Department of Agriculture, Gainesville, 32602, USA, Lionel Stange.

JWCI James Whitfield Collection, Department of Entomology, University of Illinois at Urbana-Champaign, Urbana, 61801, USA.

RNHL Rijksmueum von Natuurlijke Historie, Raamsteeg 2, Postbus 9517, 2300 RA Leiden, NETHERLANDS, Kees van Achterberg.

TAMU Department of Entomology, Texas A&M University, College Station, 77843-2475, USA, Robert Wharton.

USNM United States National Museum of Natural History, Smithsonian Institution, Washington, DC, 20560-0168, USA, David Smith.

Pseudognaptodon Fischer

Pseudognaptodon Fischer 1965:182. Fischer 1967: 973; Fischer 1977:983; Shenefelt 1975:133; Marsh 1979:175; van Achterberg 1983:26; Wharton 1997:258; Type species *Pseudognaptodon curticauda* Fischer by original designation.

Relationships.—Some questions exist about the validity of *Pseudognaptodon*, which is separated from *Gnamptodon* only by the loss of the forewing r-m vein. While this character has practical utility in identification it's phylogenetic reliability has yet to be assessed. Both genera are speciose with substantial morphological variation that has yet to be phylogenetically analyzed, and the distribution of states of some of these characters in the two genera may suggest relationships among species and groups of species. Wharton (1997) suggested that generic concepts based primarily on the old world species do not account for undescribed variation in new world species, and may have to be revisited. He also suggested that *Pseudognaptodon* might prove to be one or more species groups of *Gnamptodon*. I tend to support that view. The *omissus*- and *curticauda*-groups each have characters that are more similar to species of *Gnamptodon* than to each other. An example of this is the state of the anterolateral grooves of the third metasomal tergite. These grooves are well defined and slightly to moderately crenulate in the *omissus*-group. A similar state is found in *Gnamptodon vlugi* van Achterberg from Europe (van Achterberg 1983, Fig. 72), and other undetermined North American *Gnamptodon* species I have examined (Wharton 1997, Fig. 3). The grooves are absent or partially, faintly impressed and smooth in the *curticauda*-group. This state is found in most other *Gnamptodon* species (van Achterberg 1983, Fig. 63). Another example is the state of the epicnemial scrobe. It is present, and joined to the posterior margin of the mesopleuron by a cuticular fold in species of the *omissus*-group, and poorly developed or absent in species of the *curticauda*-group. I have examined specimens of *Gnamptodon* with either of these two states, and others with the epicnemial scrobe present as a depression of varying shape and depth (van Achterberg 1983). A comprehensive phylogenetic analysis of the subfamily is needed in order to discover monophyletic assemblages, identify synapomorphies, and elucidate phylogenetic relationships among species. For this reason I have made a conservative choice and retained *Pseudognaptodon* as a separate taxon. A phylogenetic analysis of *Pseudognaptodon* is not presented here since the genus may not be a monophyletic unit, and outgroup selection would be problematic at this level.

Diagnosis.—Species of *Pseudognaptodon* may be separated from other genera of Gnamptodontinae by the absence of the forewing vein r-m.

Description.—*Head:* Oval in anterior view; eyes slightly protuberant, with rounded but parallel inner margins, straight to slightly concave adjacent to antennal sockets but margins otherwise convex; face convex, wider than high, with curved setae, directed dorsally and dorsomedially; clypeus arcuate, with straight ventral and convex dorsal margin, surface convex dorsally, concave ventrally, with a ventral setose rim. *Mesosoma:* Length about 1.5× height, smooth; notauli deeply impressed anteriorly, increasingly obsolete posteriorly; mesonotum and metapleuron setose, mesosternum and propodeum with sparse, scattered setae. *Wings:* Forewing with 2 submarginal cells, r-m of forewing absent (Fig. 7); first abscissa of

M present as a short spur, shorter than 2RS; RS+Ma and RS+Mb less pigmented and thinner than other veins, base of RS+Ma obsolete in some species. Hind wing with RS and second of M present as folds, 2r-m present as fold or absent. Subbasal cell less than ½× as long as basal cell, first of abscissa M nearly twice as long as M+Cu. *Metasoma:* T1 about as long as or slightly longer than apical width, constricted immediately posterior to junction with propodeum, convex medially in both lateral and posterior view, with sinuate carinae originating posterior to constriction, the carinae laterally produced on basal ⅓ of tergite and convergent on remainder. T2 with basal 0.2–0.4 raised, higher posteriorly than anteriorly, smooth, defined posteriorly by a crenulate, striate, or granulate groove; disc of T2 posterior to basal raised area granulate, granulostriate, or striate, rarely smooth. T3 separated from T2 by a well developed, smooth to crenulate, evenly curved or laterally decurved groove; T3 smooth to sculptured on basal ⅓ with similar sculpture to T2. Ovipositor barely exserted to nearly as long as hind basitarsus. *Legs:* Legs stout, hind femur length 3.0–5.0 greatest width. Femur, tibia, and tarsus about equally long.

Hosts.—One species reared from leafmining larvae of the family Nepticulidae (Lepidoptera).

KEY TO FEMALES OF SPECIES OF *PSEUDOGNAPTODON* FISCHER

1. Episternal scrobe present as a curved, distinct crease (Fig. 1). T3 of metasoma with anterolateral grooves complete, distinctly impressed, and partially to completely crenulate (complete but smooth in *P. attenuatus* new species) (Figs. 22, 42). Ovipositor distinctly exserted, setose portion of sheath 0.5–0.9× as long as hind basitarsus (Fig. 13). *omissus*-group 2
– Episternal scrobe absent (Fig. 2), or present as a shallow impression in *P. carinatus* new species (Fig. 3). T3 of metasoma usually without anterolateral grooves, rarely with faint grooves near lateral tergal margins or with anterolateral areas partially defined by microsculpture (Figs. 104, 207). Ovipositor barely exserted, setose portion of sheath less than 0.5× as long as hind basitarsus (Fig. 115). ***curticauda* group** 9
2. Head and mesosoma yellow to light orange with brown patches 3
– Head and mesosoma brown to black, rarely with lighter patches on head and/or lighter pronotal collar 4
3. Propodeum smooth medially (Fig. 81). Basal cell of hind wing narrow, r-m 0.5–1.0× as long as R (Fig. 79). Mesothorax and metasoma unicolorous or with slightly darker areas dorsally ..... ***P. xanthus* new species**
– Propodeum striate medially (Fig. 39). Basal cell of Hind wing wide, r-m 2.5× as long as R (Fig. 38). Mesothorax with sharply contrasting brown areas dorsally and ventrally, and metasoma with brown spot mid-dorsally ..... ***P. langori* new species**
4. Appendages elongate, basal flagellomere 4.8–5.0× as long as wide and hind femur 4.5–5.5× as long as wide (Fig. 13). T1–T3 of metasoma smooth (Fig. 12) ..... ***P. attenuatus* new species**
– Appendages relatively shorter, basal flagellomere 3.0–4.5× as long as wide and hind femur 3.0–4.0× as long as wide. T1 of metasoma usually striate medioapically, and usually T2 and T3 partially striate or granulate (Figs. 22, 52) 5
5. T3 of metasoma with anterolateral corners joined by a thin carina, the groove between T2 and T3 appearing double (Fig. 22) ..... ***P. conjunctus* new species**
– T3 of metasoma with anterolateral corners separate, the groove between T2 and T3 single (Figs. 42, 52) 6
T2 of metasoma posterior to basal raised area and base of T3 between anterolateral corners

coarsely striate (Fig. 73). Hind wing with angle of M and r-m with a faintly pigmented, posteriorly directed spur (Fig. 69) ..... ***P. striatus*** **new species**

– T2 of metasoma granulate or finely striate and T3 smooth or with faint microsculpture (Figs. 42, 52). Hind wing with angle of M and r-m without spur or with faint, unpigmented crease (Fig. 47) 7

7. Head bicolored, face orange and remainder of head brown. T1 of metasoma with length greater than apical width (Fig. 30) ..... ***Pseudognaptodon gouleti*** **new species**

– Head brown, some specimens with lighter markings around dorsal margin of eye. T1 of metasoma with length and apical width about equal (Fig. 50) 8

8. Anterior tergites of metasoma uniform brown, concolorous with rest of body. POD shorter than to as long as LOL and shorter than POL (Fig. 44). T3 of metasoma with grooves defining anterolateral corners mostly crenulate (Fig. 52.) ..... ***P. ocellatus*** **new species**

Anterior 2 or 3 tergites of metasoma lighter than remainder of body. POD about as long as LOL and POL (Fig. 55). T3 of metasoma with grooves defining anterolateral corners mostly smooth (Fig. 63) ..... ***P. omissus*** **Fischer**

9. Propodeum with apical cell triangular, median carina complete (Fig. 101) ..... ***P. carinatus*** **new species**

– Propodeum with apical cell arcuate or incomplete, median carina absent (Fig. 111) 10

10. Body length about 1 mm. T1 of metasoma triangular, posterior margin wider than length, nearly flat, with basal carinae and striae obsolete (Figs. 152, 153) ..... ***P. minimus*** **new species**

– Body length usually greater than 1.5 mm. T1 of metasoma with shape various, convex medially with distinct basal carinae, and usually striate or granulate on apical half or more (Figs. 112, 113, 163, 164) 11

11. Labrum as large as clypeus, apically truncate, brown (Fig. 138). Forewing vein 2M markedly longer than RS+Ma (Fig. 140) ..... ***Pseudognaptodon labrus*** **new species**

– Labrum smaller than clypeus, semicircular or traingular, concolorous with other mouthparts. Forewing vein 2M shorter than RS+Ma (Fig. 120) 12

12. Forewing vein R shorter than stigma along anterior wing margin, RS evenly sharply curved (Fig. 90) ..... ***Pseudognaptodon brevis*** **new species**

– Forewing vein R as long as or longer than stigma along antrior wing margin, RS variable, in most specimens straighter apically than basally or decurved (Fig. 120) 13

13. Lateral margins of T1 to entire metasoma yellow to light honey-brown, contrasting with head and mesosoma 14

– Metasomal tergites unicolorous, medium red-brown to black, concolorous with head and mesosoma or slightly lighter 16

14. Tergites of metasoma uniformly yellow, or with slightly darker shade posterior ..... ***P. gibsoni*** **new species**

– Tergites of metasoma with lighter color on at most T1–T3, remainder brown or red-brown 12

15. Junction of 1M and RS+Ma at or basal to midlength of discal cell, RS+Ma about as long as 1M (Fig. 130). Body dark brown to black with yellow anterior metasomal tergites ..... ***P. hemicolor*** **new species**

– Junction of 1M and RS+Ma apical to midlength of discal cell, RS+Ma clearly shorter than 1M (Fig. 192). Body reddish-brown with yellow to light honey-brown anterior metasomal tergites ..... ***P. whartoni new species***

16. Metasoma with disc of T2 with granulate microscuplture posterior to basal raised area, from a small area immediately posterior to basal raised area to covering most of tergum (Fig. 114) ..... ***P. curticauda*** **Fischer**

– Metasoma with disc of T2 striate or granulostriate, or smooth with posterior margin of basal raised area crenulate (Figs. 175, 186) 17

17. Metasoma with most of T2 and base of T3 coarsely striate, the anterolateral corners of T3 defined by sculpture (Figs. 175, 207) 18

– Metasoma with T2 partly to mostly striate, T3 smooth or with some striae mid-basally, the anterolateral corners not defined (Figs. 165, 186) 19

18. Vertex with granulate microsculpture obsolete, appearing smooth (Figs. 167, 168). Ocellar triangle large, both LOL and POL3 as long as POD (Fig. 167). Metasomal T1 basal raised area with median projection (Figs. 173, 175) ..... ***P. nitidus* new species**

– Vertex with well developed granular microsculpture (Figs. 199, 200). Ocellar triangle small, LOL shoter than to as long as POD (Fig. 199). Metasomal T1 basal raised area evenly curved or irregular at midline (Fig. 207) ..... ***P. whitfieldi* new species**

19. T2 of metasoma finely striate or granulostriate, rarely smooth (Fig. 165); groove between T2 and T3 evenly crenulate throughout, rarely slightly widened medially, T3 smooth (Fig. 635). POD about as long as LOL (Fig. 156) ..... ***P. minutus* (Ashmead)**

– T2 of metasoma coarsely striate (Fig. 186); groove between T2 and T3 wider and more strongly crenulate medially than laterally, with striae extending onto disc of T3 (Fig. 186). POD3 as long as LOL (Fig. 177) ..... ***P. shawi* new species**

OMISSUS GROUP

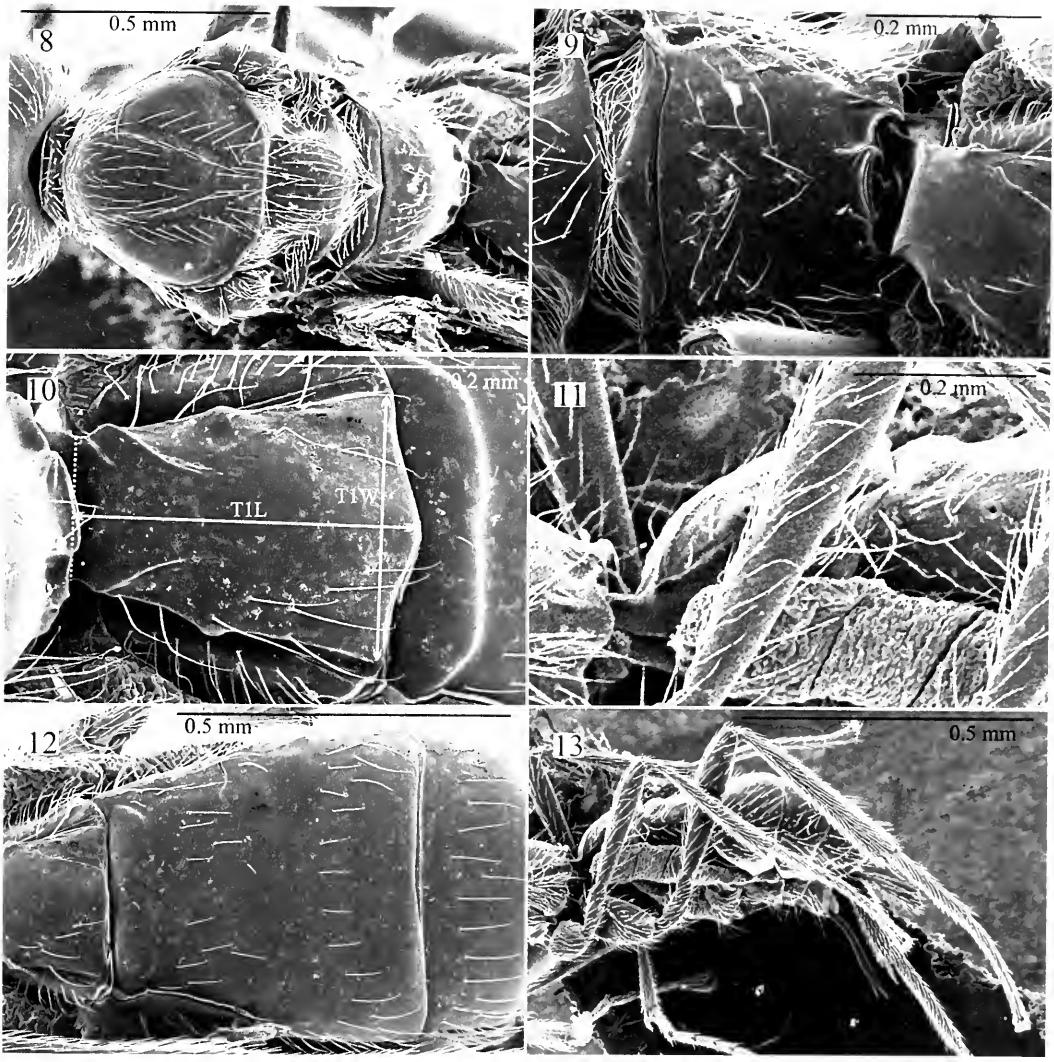
Included species.—This species group includes *Pseudognaptodon omissus* Fischer and the following new species: *P. attenuatus, P. conjunctus, P. gouleti, P. langori, P. ocellatus, P. striatus,* and *P. xanthus.*

Remarks.—Species of this group are separated from the *curticauda* group by the following combination of characters: Frons smooth or with areas of faint granulate sculpture between ocelli and antennal sockets (Fig. 5). Episternal scrobe present as a sharp, curved groove linked to posterior margin of mesopleuron (Fig. 1). Propodeum with a small depression and/or area of fine wrinkles mediobasally (Fig. 19). T3 of metasoma with anterolateral grooves complete and partially to completely crenulate (complete but smooth in *P. attenuatus*) (Fig. 42). Ovipositor conspicuously exserted, with setose portion of sheath at least half as long as hind basitarsus (Fig. 13).

Pseudognaptodon attenuatus Williams, new species
(Figs. 4–13)

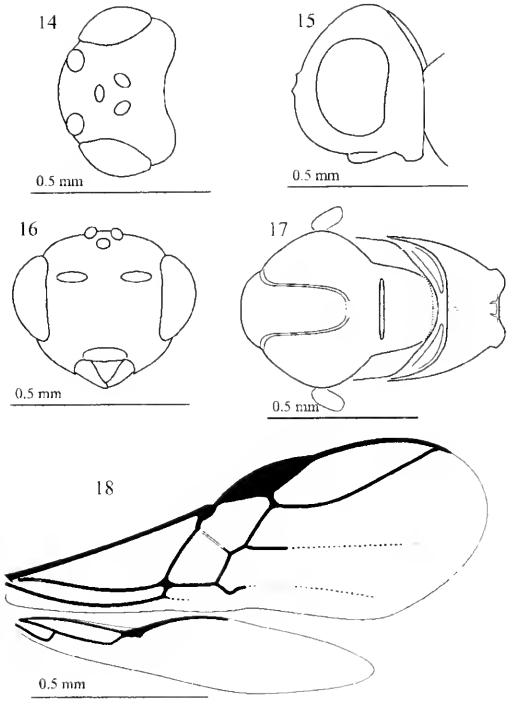
Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: antenna elongate, with basal flagellomere 4.8–5.03 as long as wide; T1 of metasoma smooth, with protuberant spiracles (Fig. 10); T2+T3 of metasoma, including grooves, smooth and shining (Fig. 12); legs elongate, femur 4.5–5.53 as long as greatest width (Fig. 13).

Female.—*Color:* Body uniformly medium to dark brown except as follows: Ventral or ventral and interior surfaces of scape light brown; pronotal collar light to medium brown; mesopleuron with a narrow light brown band near ventral surface in some specimens; legs with forecoxa, trochanter, ventral surface of femur, and basal ⅓ to ⅔ of tibia yellow to light brown. *Head:* Length of antennal scape 1.67–2.00× width; flagellum with 18–20 flagellomeres: L/W of first three flagellomeres 4.8–5.0, 3.67–4.00, 3.00–3.67; L/W of apical flagellomere 3.67–3.75; MOD 0.86–1.07× as long as POD; POD 0.75–1.03× as long as LOL, and 0.60–0.80× as long as POL (Fig. 4); OOL 2.00–2.25× as long as POL (Fig. 5); head length 0.64–0.67× width in dorsal view; occiput moderately indented (Fig. 51); head L/H 0.90–0.94 in lateral view; eye L/H 0.65–0.71, eyeH/headH 0.67–0.69, eye width/gena width 1.44–1.88; gena wider ventrally than dorsally (Fig. 6); face granulate on lateral ⅓ and smooth on median ⅓, most setae as long as clypeus height, clypeus W/H 2.00–2.44, clypeus width 1.11–1.38× as long as malar space. *Wings:* Forewing with RS vein evenly curved, less at apex than at base; RS+Ma

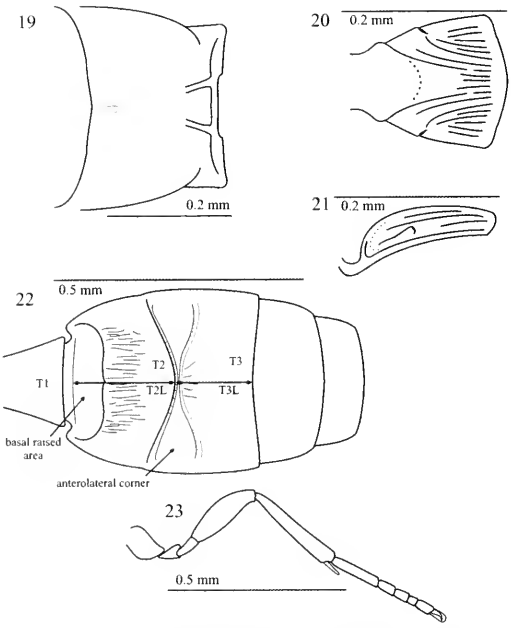


Figs. 8–13. *Pseudognaptodon attenuatus*. 8, Mesosoma in dorsal view. 9, Propodeum in dorsal view. 10, T1 of metasoma in dorsal view. T1L = T1 length, T1W = T1 width. 11, T1 of metasoma in lateral view. 12, Anterior end of metasoma in dorsal view. 13, Hind leg.

unpigmented on basal ⅓, tubular throughout length, distance between point of attachment of RS+Ma to M and parastigma 0.63–0.80× as long as RS+Mb; 2M spur 3.0–5.03 as long as RS+Mb; 2-A1 tubular on basal quarter, remainder obsolete and faintly pigmented, first subdiscal cell closed by obsolete veins (Fig. 7). Hind wing with r-m 1.4–2.0× as long as R; angle of M and r-m without a spur or thickened area; apex of R evenly narrowed apically, knob faint or absent (Fig. 7). *Mesosoma:* Notauli wide but shallow, merged with posterior median depression (Fig. 8); propodeum smooth, medioapical carinae short, straight, slightly convergent, medioapical cell open (Fig. 9). *Metasoma:* T1 length 1.04–1.15× as long as apical width, lateral margins concave posterior to spiracle, the spiracle moderately protuberant, lateral carinae about 0.3 tergum length, smooth and shining throughout, (Figs. 10,



Figs. 14–18. *Pseudognaptodon conjunctus*. 14, Head in dorsal view. 15, Head in lateral view. 16, Head in anterior view. 17, Mesosoma in dorsal view. 18, Wings.



Figs. 19–23. *Pseudognaptodon conjunctus*. 19, Propodeum in dorsal view. 20, T1 of metasoma in dorsal view. 21, T1 of metasoma in lateral view. 22, Anterior end of metasoma in dorsal view. T2L = T2 length. T3W = T3 length. 23, Hind leg.

11); basal raised area of T2 0.23–0.24 of total T2 length, the posterior margin of basal raised area evenly curved, rarely somewhat obsolete; T2 smooth and shining; T3 0.66–0.86× as long as T2, smooth, with anterior and lateral grooves smooth and somewhat effaced laterally (Fig. 12). *Legs:* Hind femur length 4.5–5.53 maximum width, it's ventral hairs as long as or longer than width of femur at point of attachment (Fig. 13).

Material examined.—5♀, 1♂. HOLOTYPE ♀ (UWYO), labelled as follows: "Costa Rica: San Jose, Cerro Muerte 20 km S Empalme 2800m iii-vi 1990 P. Hanson". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon attenuatus* Williams Holotype det. D. Williams 2003". PARATYPES: **Costa Rica: San Jose:** 16 km S. Empalme, 2500m, III-IV-1989, P. Hanson & I. Gauld, 1♀, 1♂, (UYWO). Cerro Muerte, 20 km S. Empalme, 2800m, III-IV-1989, (1♀), VII-VIII-1989, (2♀), P. Hanson, (UWYO).

Etymology.—The name *attenuatus* refers to the elongate appendages, particularly the legs, of this species.

Pseudognaptodon conjunctus Williams, new species
(Figs. 14–23)

Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: Head bicolored orange and brown, remainder of body uniform light brown; metasomal T1 length 1.21–1.363 apical width (Fig. 20); groove between metasomal T2 and T3 appearing double, separated by a partial to complete fine carina (Fig. 22).

Female.—Color: Body and appendages medium brown except as follows: Scape yellow to light honey-brown, face and lower part of gena light orange-brown;

pronotal collar usually light brown; legs entirely yellow, with hind tarsi slightly darker. *Head:* Length of antennal scape 1.4–1.6× width; flagellum with 16–17 flagellomeres, first flagellomere slightly curved and narrower than others, L/W of first three flagellomeres 3.0–3.5, 2.6–3.2, 2.5–2.7; L/W of apical flagellomere 3.2–3.5; MOD 0.91–1.00× as long as POD, POD 1.00–1.33× as long as LOL, and 1.00–1.33× as long as POL (Fig. 14); OOL 2.00–2.33× as long as POL (Fig. 14); head length 0.64–0.68× width in dorsal view; occiput narrowly and sharply indented (Fig. 14); head L/H 0.79–0.84 in lateral view; eye L/H 0.69–0.71, eyeH/headH 0.59–0.64, eye width/gena width 1.69–2.00; gena uniformly wide over most of eye height (Fig. 15); face completely covered by granular microsculpture, setae as long as clypeus height, clypeus W/H 2.25–2.66, clypeus width 1.00–1.07× as long as malar space (Fig. 16). *Wings:* Forewing with RS vein straighter near apex than base, slightly decurved at point of attachment to R; RS+Ma unpigmented, basal ⅓ thinner than remainder, point of attachment to M almost obsolete, distance between point of attachment of RS+Ma to M and parastigma 0.50–0.56× as long as RS+Mb; 2M spur 2.00–2.50× as long as RS+Mb; 2–1A vein present as a crease on basal ⅔, first subdiscal cell open (Fig. 18). Hind wing with r-m 1.0–1.1× as long as R; angle of M and r-m without spur or thickened area; apex of R moderately knobbed (Fig. 18). *Mesosoma:* Notauli impressed, nearly merged posteriorly in a U-shape (Fig. 17); propodeum smooth, medioapical carinae short, anteriorly convergent, medioapical cell open (Fig. 19). *Metasoma:* T1 length 1.21–1.36× as long as apical width, lateral margins straight to slightly concave posterior to spiracle, lateral carinae complete on entire tergum length or present on basal half but continued by a raised median area on apical half, sculpture coarsely striate lateral to carinae and smooth between carinae (Figs. 20, 21); basal raised area of T2 0.31–0.40 of total T2 length, the posterior margin of basal raised area irregular, slightly concave, produced medially; T2 striate near basal raised area margin, rarely with a few coarse striae extending posteriorly; T3 0.75–0.86× as long as T2, smooth or with a few striae mediobasally, with anterior and lateral grooves smooth, median part of groove doubled, with fine complete or partial ridge joining lateral areas (Fig. 22). *Legs:* Hind femur length 3.22–3.50× maximum width, ventral hairs shorter than femur width at point of attachment (Fig. 23).

Material examined.—3♀. HOLOTYPE ♀ (TAMU), labelled as follows: "MEXICO: Jalisco 16 mi. S. Autlan on Hwy. 80, 8-VII-1984, J.B. Woolley". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon conjunctus* Williams Holotype det. D. Williams 2003". PARATYPES: **Mexico: Jalisco:** 16miS. Autlan on hwy. 80, 8-VII-1984, J.B. Woolley, 1♀ (TAMU). **Mexico: Guerrero:** 32miS.E. Petalan, 10-VII-1985, Woolley and Zolnerowich, 1♀ (TAMU).

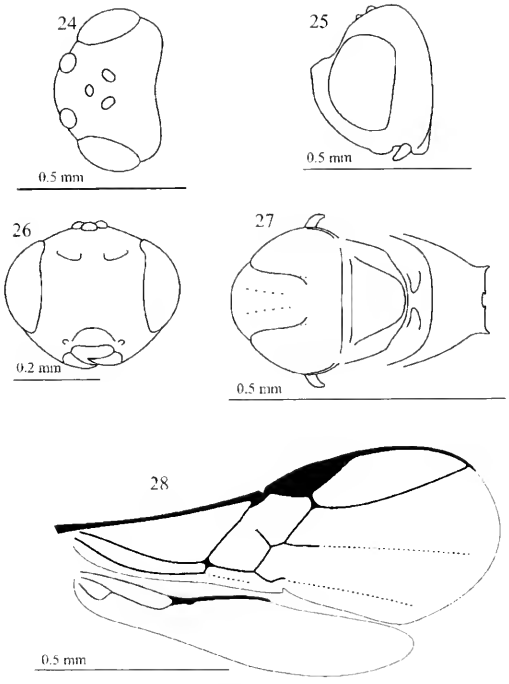
Etymology.—The name *conjunctus* refers to the fine carina that connects the anterolateral areas of T3 of the metasoma.

Pseudognaptodon gouleti Williams, new species

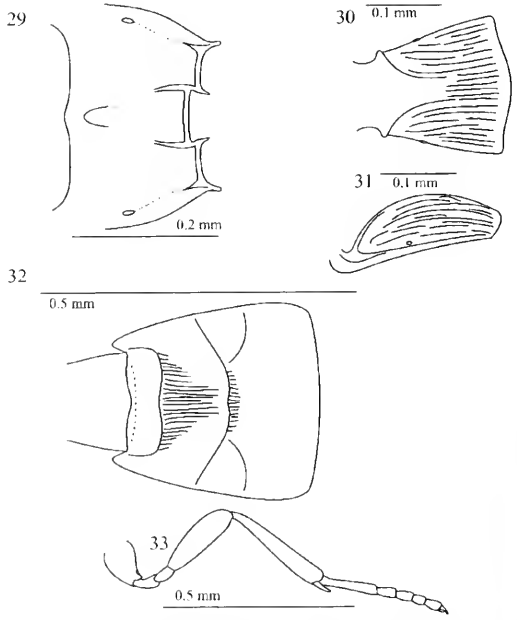
(Figs. 24–33)

Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: Head brown with face orange, mesosoma and metasoma brown; ocellar triangle small, with POD equal to or greater than interocellar distances and OOL 2.0 time as long as POL (Fig. 24); T1 of metasoma longer than apical width (Fig. 30); hind wing with r-m vien as long as R (Fig. 28).

Holotype female.—Color: Body brown except as follows: face and margin of eyes light orange; scape light brown; pronotal collar light brown; legs yellow with base of hind coxa, dorsal surface of femur, and hind tarsus darker. *Head:* Length of anten-

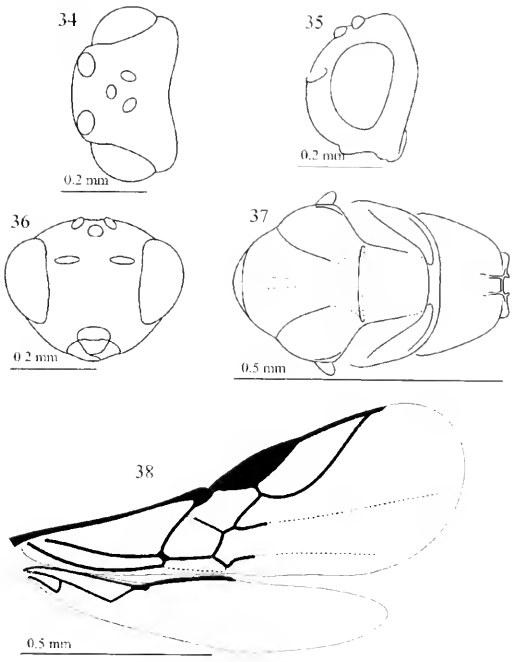


Figs. 24–28. *Pseudognaptodon gouleti.* 24, Head in dorsal view. 25, Head in lateral view. 26, Head in anterior view. 27, Mesosoma in dorsal view. 28, Wings.

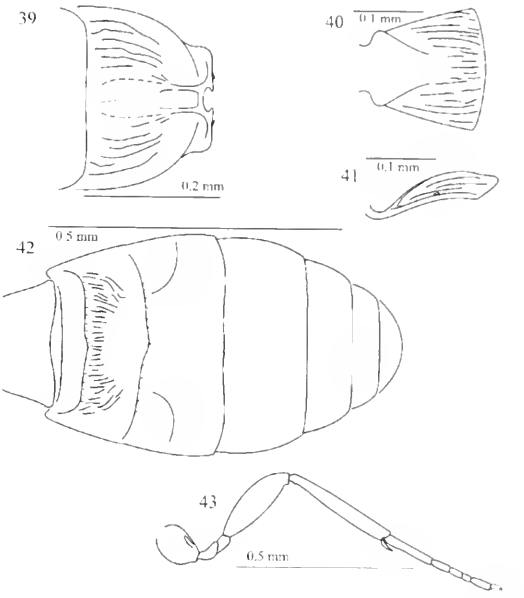


Figs. 29–33. *Pseudognaptodon gouleti.* 29, Propodeum in dorsal view. 30, T1 of metasoma in dorsal view. 31, T1 of metasoma in lateral view. 32, Anterior end of metasoma in dorsal view. 33, Hind leg.

nal scape 1.6 width; flagellum with 17 flagellomeres; L/W of first three flagellomeres 3.75, 2.43, and 2.43; L/W of apical flagellomere 3.00; MOD 0.88× as long as POD; POD 1.14× as long as LOL, and as long as POL (Fig. 24); OOL 2.00× as long as POL (Fig. 24); head length 0.63× width in dorsal view; occiput slightly evenly indented (Fig. 24); head L/H 0.90 in lateral view; eye L/H 0.60, eyeH/headH 0.64, eye width/gena width 2.0; gena wider ventrally than dorsally (Fig. 25); face completely covered by granular microsculpture except for narrow median stripe, setae as long as clypeus height, clypeus W/H 2.50, clypeus width 1.1× as long as malar space (Fig. 26). *Wings:* Forewing with RS vein straighter near apex than base; RS+Ma unpigmented on basal half, basal ⅓ thinner than remainder, point of attachment to M obsolete; distance between point of attachment of RS+Ma to M and parastigma 0.60× as long as RS+Mb; 2M spur 1.77× as long as RS+Mb; 2–1A vein present as a faintly pigmented crease on basal ⅔, first subdiscal cell open (Fig. 28). Hind wing with r-m as long as R; angle of M and r-m without spur or thickened area; apex of R moderately knobbed (Fig. 28). *Mesosoma:* Notauli deep, merged with posterior median depression (Fig. 27); propodeum smooth, medioapical carinae short, straight, medioapical cell open (Fig. 29). *Metasoma:* T1 length 1.2× as long as apical width, lateral margins straight posterior to spiracle, lateral carinae 0.5 of tergum length, finely striate lateral to carinae and at apex between carinae (Figs. 30, 31); basal raised area of T2 0.26 of total T2 length, posterior margin of basal raised area slightly irregular; T2 striate on basal half posterior to basal raised area margin, with scattered fine striae reaching to posterior margin of tergum; T3 0.80× as long as T2, finely striate medially near anterior



Figs. 34–38. *Pseudognaptodon langori*. 34, Head in dorsal view. 35, Head in lateral view. 36, Head in anterior view. 37, Mesosoma in dorsal view. 38, Wings.



Figs. 39–43. *Pseudognaptodon langori*. 39, Propodeum in dorsal view. 40, T1 of metasoma in dorsal view. 41, T1 of metasoma in lateral view. 42, Anterior end of metasoma in dorsal view. 43, hind leg.

groove, with anterior and lateral grooves smooth to slightly crenulate (Fig. 32). *Legs:* Hind femur length 3.6maximum width, ventral hairs shorter than femur width at point of attachment (Fig. 33).

Material examined.—HOLOTYPE ♀ (CNCI), labelled as follows: "PANAMA, Panama 8°40'N, 19°50'W 850m, Cerro Campana J. Helava 7–14.8.73". Also red label "HOLOTYPE", and bordered label "*Pseudognaptodon gouleti* Williams Holotype det. D. Williams". PARATYPE: **Mexico: Jalisco:** Chamela, PT, 4-9-VII-1983, M. Sharkey 1♀ (CNCI).

Remarks.—The above desciption is based on the holotype only. The paratype from Mexico agrees closely with these characters, but is not intact and has been poorly mounted.

Etymology.—This species is named for Henri Goulet, who has contributed numerous specimens to this study.

Pseudognaptodon langori Williams, new species

(Figs. 34–43)

Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: Mesothorax yellow with brown areas dorsally and ventrally; T1 of metasoma with posterior half not raised between lateral carinae (Fig. 40); hind wing with r-m vien 2.5× as long as R (Fig. 38); central disc of propodeum striate (Fig. 39).

Holotype female.—Color: Body and appendages yellow to orange-yellow except as follows: pedicel and flagellum light brown; ocellar triangle brown; mesoscutum except for parts of notauli and posteromedial depression brown; ventral surface of mesothorax brown; propodeum brown; metasoma yellow with brown spot on posterior half of T3 and anterior half of T4; Legs entirely yellow. *Head:* Length of antennal scape 1.6 width; L/W of first three flagellomeres 3.71, 2.63, and 2.5; MOD 0.84× as long as POD; POD 1.25×

as long as LOL, and 1.11× as long as POL (Fig. 34); OOL 2.22× as long as POL (Fig. 34); head length 0.65× width in dorsal view; occiput moderately indented (Fig. 34); head L/H 0.78 in lateral view; eye L/H 0.79, eyeH/headH 0.60, eye width/gena width 2.38; gena uniformly wide over most of eye height (Fig. 35); face completely covered by granular microsculpture except for narrow median stripe, setae as long as or slightly longer than clypeus height, clypeus W/H 2.22, clypeus width as long as malar space (Fig. 36). *Wings:* Forewing with RS vein straighter near apex than base, slightly decurved at point of attachment to R; RS+Ma almost entirely pigmented, basal ⅓ slightly thinner than remainder but well developed; distance between point of attachment of RS+Ma to M and parastigma 0.60× as long as RS+Mb; 2M spur 2.6× as long as RS+Mb; 2–1A vein present as a faintly pigmented crease and 2cu-a present as a pigmented spur, first subdiscal cell nearly closed (Fig. 38). Hind wing with r-m 2.5× as long as R; angle of M and r-m without spur or thickened area; apex of R strongly knobbed (Fig. 38). *Mesosoma:* Notauli shallow, narrow, merged with posterior median depression (Fig. 37); propodeum striate laterally with slightly raised median area confluent with medioapical cell, medioapical carinae straight or slightly divergent, ending in fine wrinkles, medioapical cell open (Fig. 39). *Metasoma:* T1 length as long as apical width, lateral margins slightly convex posterior to spiracle, lateral carinae 0.6 of tergum length, not raised between carinae, sculpture striate lateral to carinae, weakly striate at apex between carinae (Figs. 40, 41); basal raised area of T2 0.36 of total T2 length, posterior margin of basal raised area slightly irregular but evenly curved; T2 sculpture granulostriate on basal half posterior to basal raised area margin; T3 0.84× as long as T2, smooth, with anterior and lateral grooves smooth to slightly crenulate (Fig. 42). *Legs:* Hind femur length 3.15 maximum width, ventral hairs shorter than femur width at point of attachment (Fig. 43).

Material examined.—HOLOTYPE ♀ (TAMU), labelled as follows: "Texas: Gonzales Co. Palmetto State Park I-IV-1984 J. Woolley". Also red label "HOLOTYPE", and bordered label "*Pseudognaptodon langori* Williams Holotype det. D. Williams".

Remarks.—The single specimen of this species is the only known specimen in the species group with a striate propodeum. The color pattern of mixed yellow and brown patches on the thorax is unique. Both flagella are broken, and have 16 flagellomeres present.

Etymology.—This species is named for David Langor, who has allowed me to continue working on the systematics of Braconidae when I should be working on weevils.

Pseudognaptodon ocellatus Williams, new species

(Figs. 44–53)

Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: Head, thorax and metasoma dark brown to black; ocellar triangle large, LOL and POL larger than MOD and POD, and OOL 1.3–1.6× as long as POL (Fig. 44); occiput deeply and evenly indented, head appearing C-shaped in dorsal view (Fig. 45).

Female.—Color: Dark brown to black except as follows: Scape light brown, or light brown basally and darker brown apically; pronotal collar light brown or with light brown patches; legs yellow to orange-yellow, rarely with base of hind coxa, dorsal surface of femur, and hind tarsus darker. *Head.*—Length of antennal scape 1.4–1.9× width; flagellum with 16–18 flagellomeres, first flagellomere slightly curved in some specimens, L/W of first three flagellomeres 3.3–4.5, 2.7–3.9, 3.0–3.9; L/W of apical flagellomere 2.8–3.3; MOD 0.8–1.0× as long as POD, POD 0.8–1.0× as long as LOL, and 0.6–0.8× as long as POL (Fig. 44); OOL 1.3–1.8× as long as POL (Fig.

45); head length 0.6–0.7× width in dorsal view; occiput deeply indented, head C-shaped in dorsal view (Fig. 45); head L/H 0.7–0.8 in lateral view; eye L/H 0.6–0.7, eyeH/headH 0.6–0.7, eye width/gena width 1.6–2.2; gena wider ventrally than dorsally (Fig. 46); face granulate laterally with smooth medial stripe to smooth on the medial ½, with a polished, setae as long as clypeus height, clypeus W/H 2.2–3.0, clypeus width 1.2–1.4× as long as malar space. *Wings:* Forewing with RS vein evenly curved, or straighter near apex than base and slightly decurved at point of attachment to R, rarely with RS thinner and irregular at some points; RS+Ma unpigmented to pigmented on apical half, basal ⅓ thinner than remainder, point of attachment to M almost obsolete in some specimens, distance between point of attachment of RS+Ma to M and parastigma 0.5–0.8× as long as RS+Mb; 2M spur 1.5–3.0× as long as RS+Mb; 2–1A vein present as a crease on basal ⅔, first subdiscal cell open (Fig. 47). Hind wing with r-m 1.3–1.8× as long as R; angle of M and r-m without spur, rarely slightly thickened; apex of R moderately knobbed (Fig. 47). *Mesosoma:* Notauli deep, merged with posterior median depression (Fig. 48); propodeum smooth, medioapical carinae short, straight, medioapical cell open (Fig. 49). *Metasoma:* T1 length 0.9–1.1× as long as apical width, lateral margins slightly concave to straight posterior to spiracle, lateral carinae present on basal ⅓ to ½ but continued by a raised median area on apical half or coalesced into a single median ridge, striate lateral to carinae and smooth between carinae, striate across apex in specimens without raised median area (Figs. 50, 51); basal raised area of T2 0.3–0.4 of total T2 length, posterior margin of basal raised area straight but irregular or slightly concave; T2 striate near basal raised area to striate on most of tergum with fine wrinkles extending to apex; T3 0.7–0.8× as long as T2, smooth, with anterior and lateral grooves crenulate (Fig. 52). *Legs:* Hind femur length 3.3–3.9 maximum width, ventral hairs shorter than femur width at point of attachment (Fig. 53).

Material examined.—HOLOTYPE ♀ (TAMU), labelled as follows: "Mexico: Oaxaca 6miles NE Mitla 20-VII-1985 J. Woolley G. Zolnerowich". Also red label "HOLOTYPE", and bordered label "*Pseudognaptodon ocellatus* Williams Holotype det. D. Williams 2003". PARATYPES: **Mexico: Oaxaca:** 6miles N.E. Mitla, 20-VII-1985, J. Woolley G. Zolnerowich 3♂, 2♀ (TAMU). 4miW. Miltepec, 21-VII-1984, J.B. Woolley 1♀ (TAMU). 8mi N.E. El Punto, 18-VII-1985, Woolley & Zolnerowich, 6♀, 1♂ (TAMU). **Mexico: Guerrero:** 1mi N.E. Laguna, elev. approx. 5000', 17-VII-1984, J.B. Woolley, 1♀ (TAMU). 6mi N.E. Tixtla, 16-VII-1984, J.B. Woolley, 1♀ (TAMU). 6miE. Xochilapa, 18-VII-1984 1♀ (TAMU). 15mi W. Chichihualco, elev. approx. 1500', 15-VII-1984, J.B. Woolley, 1♀ (TAMU). **Mexico: Veracruz:** Los tuxtles Bio. Station (Malaise), 15-22-VII-1984, G. Steck, 1♂ (TAMU). **Mexico: Puebla:** 5mi S.E. Izucar de Matamoras, 20-VII-1984, J.B. Woolley, 1♀ (TAMU). **Panama: Fortuna:** Chiriqui, 8° 44'N: 82° 15'W, 1050m, 31-VIII-6-IX-1977, H. Wolda, at light, 1♀ (RNHL).

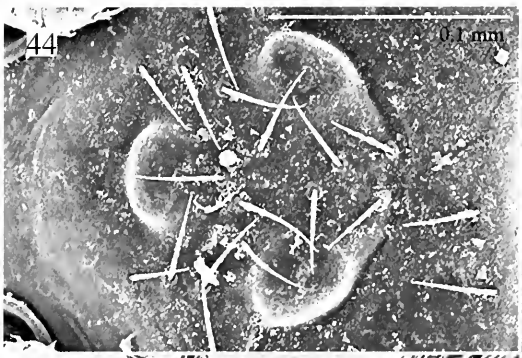
Remarks.—The specimen from Panama is anomalous in having the posterior ocelli placed close together (about the length of the median ocellus apart), but falls within the range of variation of *P. ocellatus* in all other characters. It is provisionally assigned to this species.

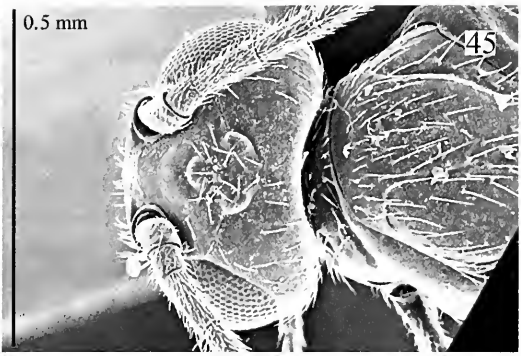
Etymology.—The name *ocellatus* refers to the ocellar triangle that is distinctly larger than other species in this species group.

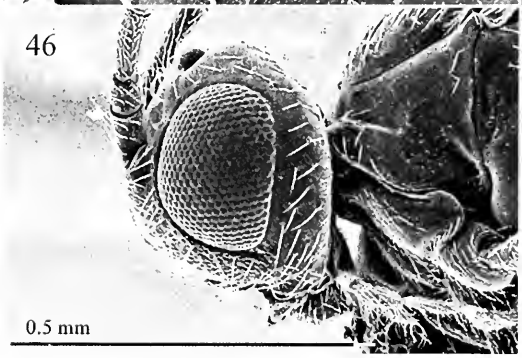
Pseudognaptodon omissus Fischer 1965
(Figs. 54–64)

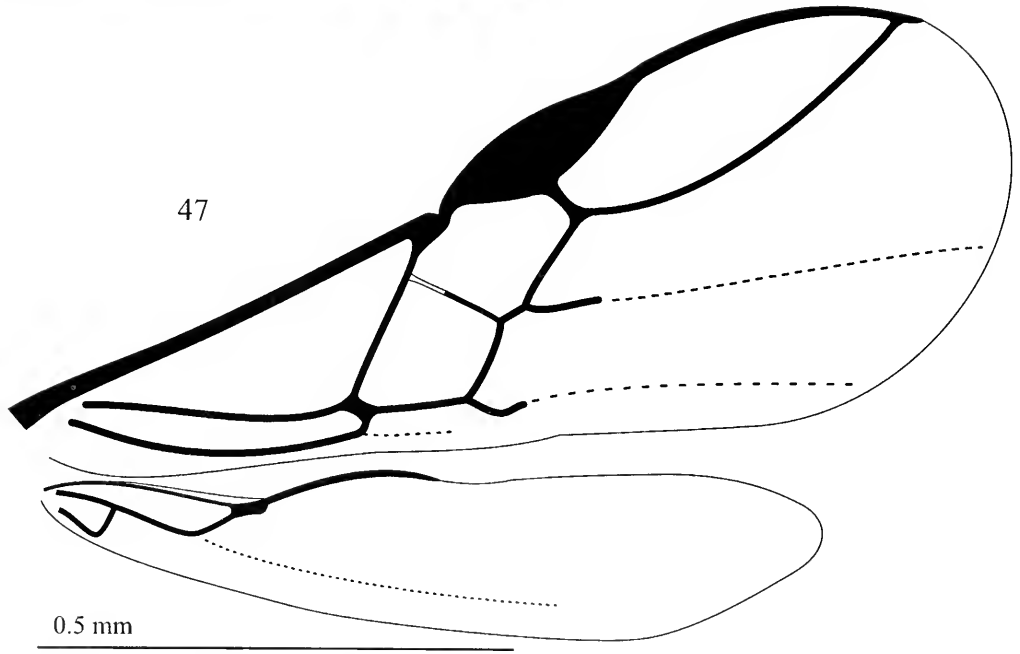
Holotype female.—Okalosa Co., Fla. (USNM). Examined.

Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: Head, thorax, and posterior part of metasoma brown, face and anterior part of me-

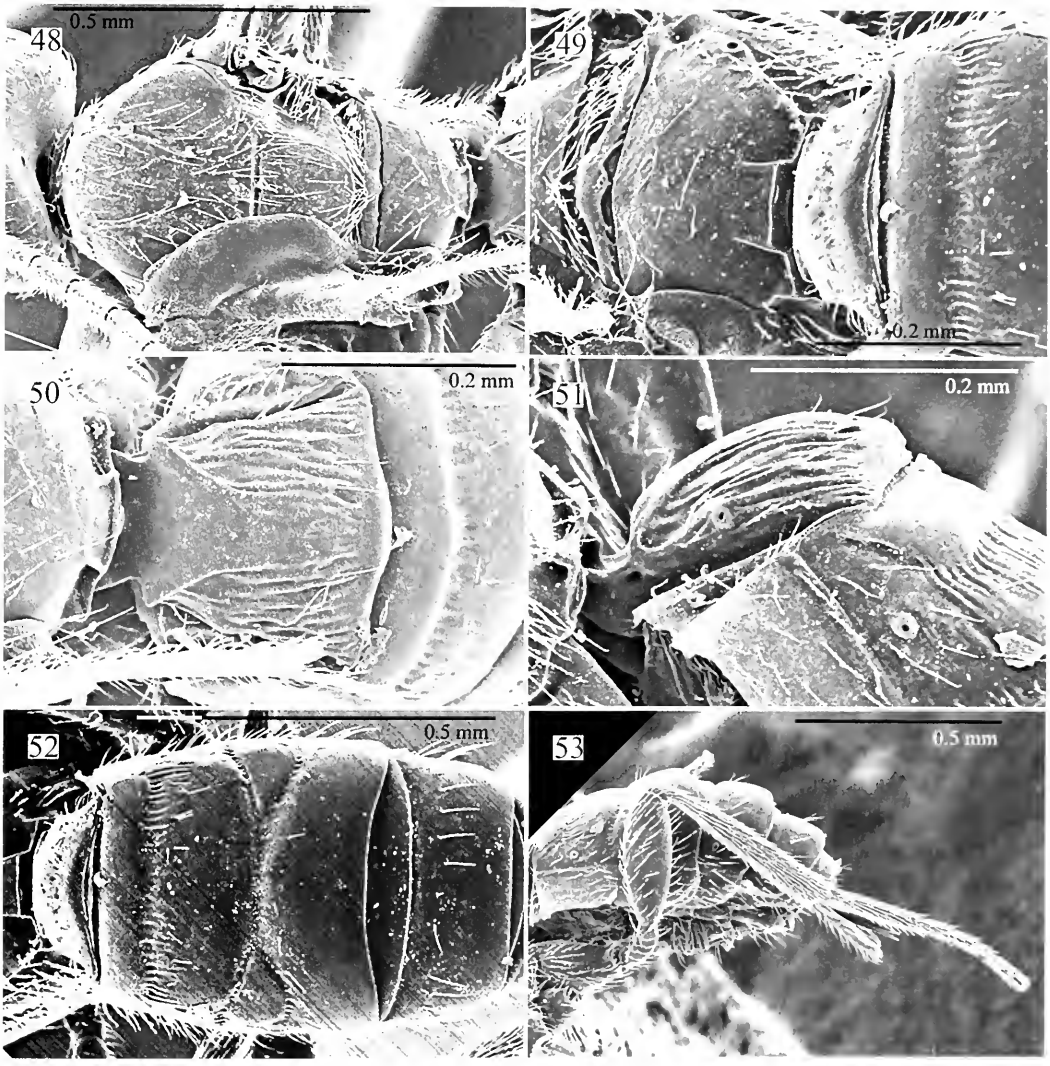








Figs. 44–47. *Pseudognaptodon ocellatus* new species. 44, Ocelli in dorsal view. 45, Head in dorsal view. 46, Head in lateral view. 47, Wings.



Figs. 48–53. *Pseudognaptodon ocellatus* new species. 48, Mesosoma in dorsal view. 49, Propodeum in dorsal view. 50, T1 of metasoma in dorsal view. 51, T1 of metasoma in lateral view. 52, Anterior end of metasoma in dorsal view. 53, Hind leg.

tasoma yellow to light brown; T2 of metasoma smooth or granulostriate near basal raised area margin and smooth on remainder; Hind wing basal cell narrow, r-m 0.7–0.12× as long as R (Fig. 58).

Female.—Color: Body and appendages medium brown except as follows: Scape yellow to light honey-brown; usually with face, narrow band around dorsal eye margin, and lower part of gena light orange-yellow to light orange-brown, rarely with face concolorous with rest of head except near eye margins, ocellar triangle dark brown; pronotal collar light brown in most specimens; metasoma yellow with brown spot on disc of T1 to medium brown with yellow T2+T3. Legs entirely yellow, rarely with hind tarsi slightly darker. *Head:* Length of antennal scape 1.4–1.6× width; flagellum with 16–18 flagellomeres, L/W of first three flagellomeres 3.6–4.7, 3.0–3.9, 2.8–3.4; L/W of api-

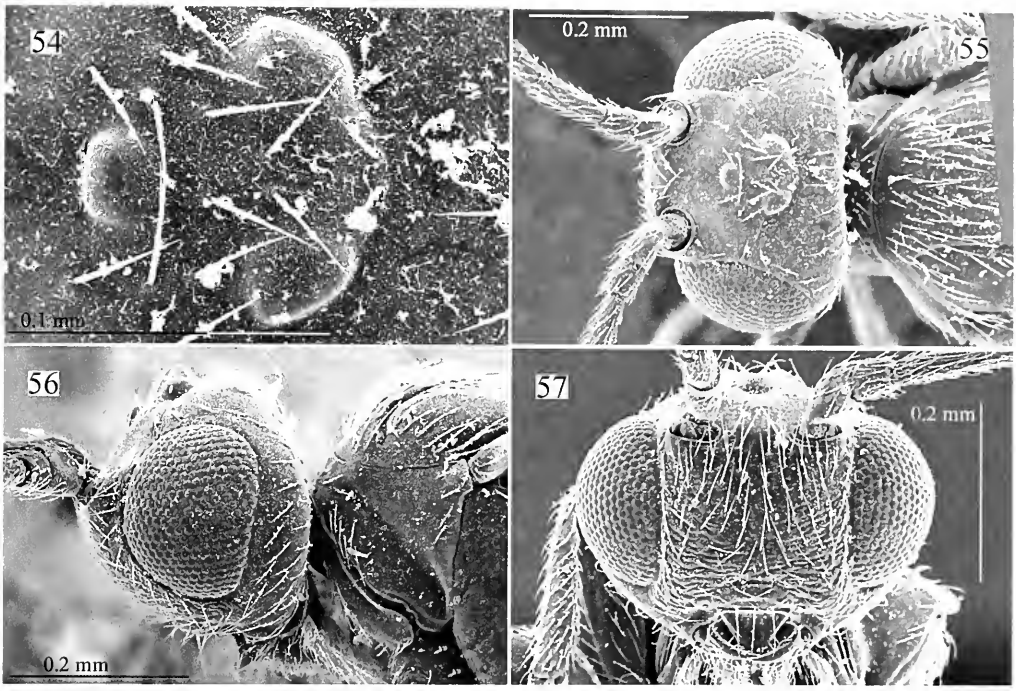
cal flagellomere 3.0–3.4; MOD 0.61–0.86 POD, POD 0.88–1.20× as long as LOL, and 0.72–1.14× as long as POL (Fig. 54); OOL 1.40–2.00× as long as POL (Fig. 55); head length 0.64–0.67× width in dorsal view; occiput slightly indented (Fig. 55); head L/H 0.76–0.86 in lateral view; eye L/H 0.65–0.81, eyeH/headH 0.55–0.66, eye width/gena width 2.42–3.17; gena uniformly wide over most of eye height to slightly widened ventrally (Fig. 56); face completely covered by granular microsculpture except for narrow median stripe which is slightly raised on dorsal half of face, setae as long as clypeus height, clypeus W/H 2.57–2.66, clypeus width 1.14–1.33× as long as malar space (Fig. 57). *Wings:* Forewing with RS vein straighter near apex than base, slightly decurved at point of attachment to R; RS+Ma with basal ⅓–⅔ unpigmented, basal ⅓ thinner than remainder, point of attachment to M almost obsolete in some specimens, distance between point of attachment of RS+Ma to M and parastigma 0.45–0.86× as long as RS+Mb; 2M spur 1.40–2.57× as long as RS+Mb; 2–1A vein present as a crease to present but obsolete on basal ⅓, first subdiscal cell open (Fig. 58). Hind wing with r-m 0.7–1.2× as long as R; angle of M and r-m without spur or thickened area; apex of R slightly knobbed (Fig. 58). *Mesosoma:* Notauli shallow, merged with posterior median depression (Fig. 59); propodeum smooth, medioapical carinae short, convergent, medioapical cell open (Fig. 60). *Metasoma:* T1 length 0.83–1.1× as long as apical width, lateral margins straight to slightly concave posterior to spiracle, lateral carinae 0.5–0.6 of tergum length, convergent basally but parallel apically, striate lateral to carinae and smooth to weakly striate at apex between carinae (Figs. 61, 62); basal raised area of T2 0.3–0.5 of total T2 length, posterior margin of basal raised area irregular, slightly concave medially to evenly curved; T2 sculpture smooth to granulostriate near basal raised area margin; T3 0.65–0.75× as long as T2, smooth, with anterior and lateral grooves smooth to slightly crenulate (Fig. 63). *Legs:* Hind femur length 3.41–3.87 maximum width, ventral hairs shorter than femur width at point of attachment (Fig. 64).

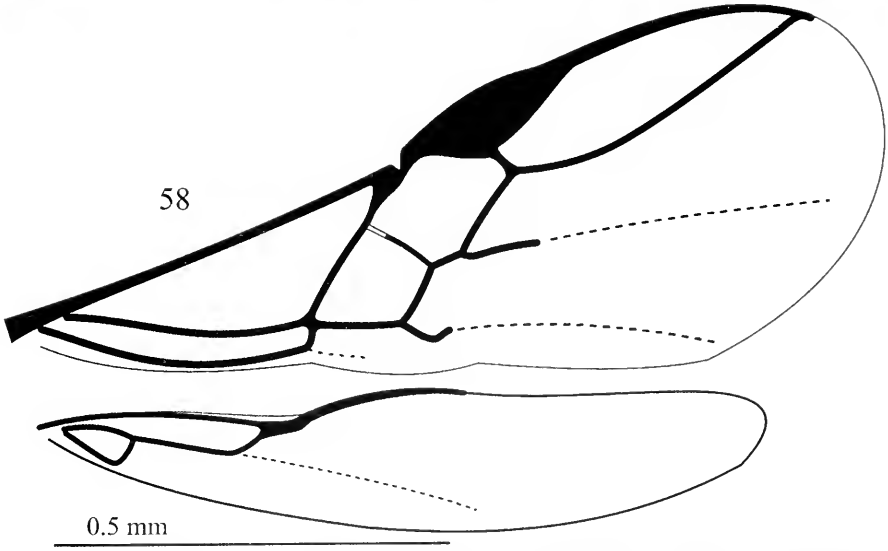
Material examined.—**Mexico: Guerrero:** 32miS.E. Petalan, 10-VII-1985, Woolley & Zolnerowich, 2♂ (TAMU). **Mexico: Jalisco:** 16miS. Autlan on Hwy. 80, 8-VII-1984, J. Woolley, 1♀ (TAMU). **USA: California: Contra Costa Co.:** Mt. Diablo, ex. *Coptodisca* on *Q. lobata*, 4-XI-1984, D. Wagner, 1♂, 1♀ (JWCI). Mt. Diablo, ex. *Coptodisca* on *Q. douglasii*, 4-21-XI-1985, D. Wagner, 1♀ (JWCI). **Texas: Brazos Co.:** College Station, Lick Creek Park, 22-XI-6XII-1987, Wharton, Praetorius, 1♀ (TAMU). **Brewster Co.:** Big Bend National Park, Cottonwood campsite, 2300', 13-14-VII-1982, G. Gibson 1♀ (DJMW). **Comal Co.:** Guadalupe River State Park, 18-VIII-1988, J. Woolley, 1♀ (TAMU). **Hidalgo Co.:** Bensten Rio grande State Park, 15-XII-1983, J. Woolley, H. Browning, 1♀ (TAMU). **Jim Wells Co.:** 8miW. Ben Bolt, La Copita Research Sta., 20-V-1987, J. Woolley, 1♂ 5♀ (TAMU). **Arizona: Santa Cruz Co.:** 4.5miN.E. Patagonia, Hwy. 83, sweeping *Bacharis glutinosa* and *Chrysothamnus* sp., G. Gibson, 1♀ (DJMW).

Remarks.—The holotype female has more developed striae on metasomal T2 than other specimens examined, but is within the range of variation of other specimens in the other characters assessed. Specimens from Big Bend National Park and College Station Texas are larger and darker than others, with occiput more deeply indented and head somewhat C-shaped in dorsal view.

Pseudognaptodon striatus Williams, new species
(Figs. 65–74)

Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: Head capsule bicolored, with face light brown

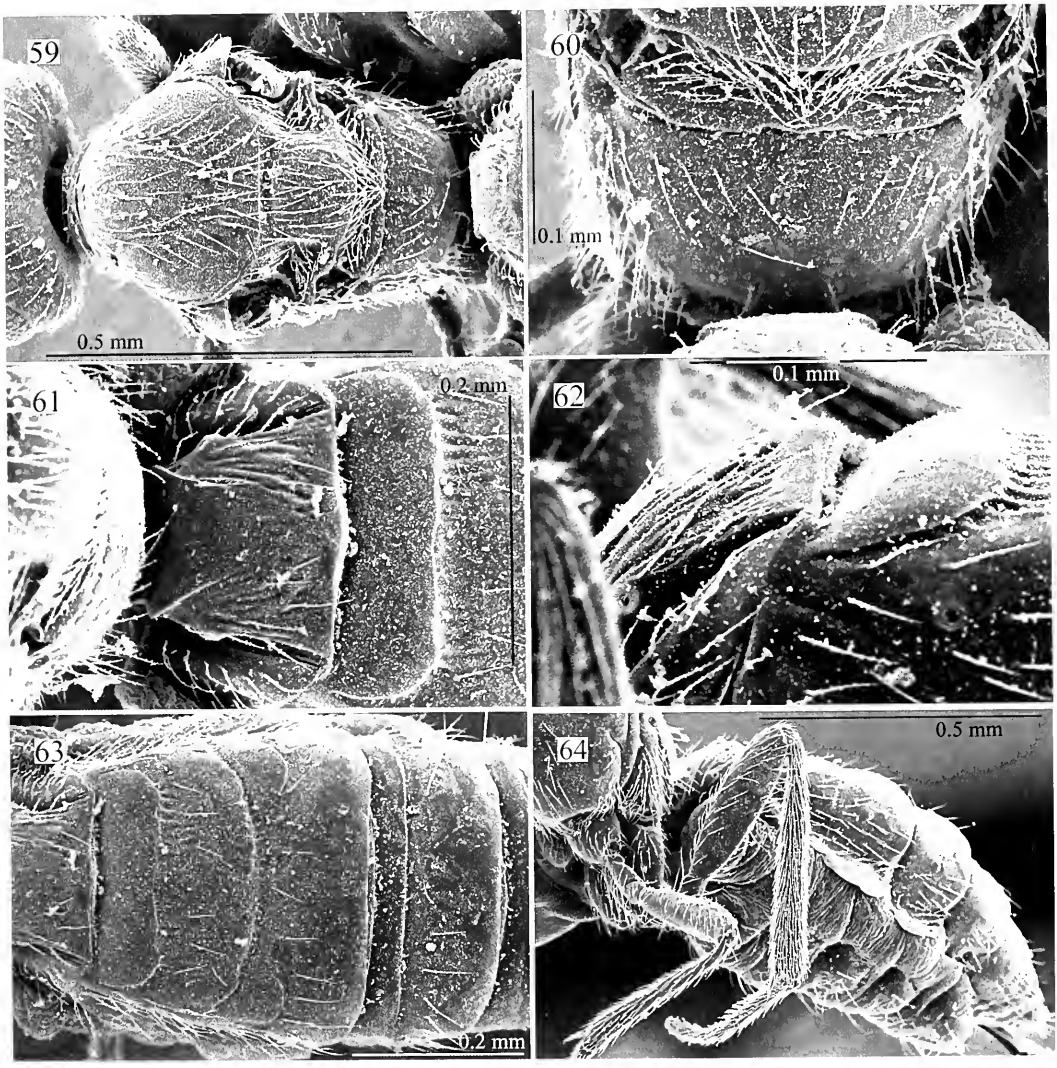




Figs. 54–58. *Pseudognaptodon omissus* Fischer. 54, Ocelli in dorsal view. 55, Head in dorsal view. 56, Head in lateral view. 57, Head in anterior view. 58, Wings.

and remainder dark brown; metasomal T1 covered with fine striae (Fig. 71); most of T2 posterior to basal raised area and base of T3 covered with very coarse, heavy striae, anterolateral corners of T3 defined by grooves (Fig. 73); Hind wing with spur on angle of M and r-m (Fig. 69).

Holotype female.—Color: Body dark brown except as follows: Scape of antenna and face light orange-brown; ventral collar



Figs. 59–64. *Pseudognaptodon omissus* Fischer. 59, Mesosoma in dorsal view. 60, Propodeum in dorsal view. 61, T1 of metasoma in dorsal view. 62, T1 of metasoma in lateral view. 63, Anterior end of metasoma in dorsal view. 64, Hind leg.

of pronotum with light and medium brown areas; legs yellow, except apical tarsomere of fore- and middle leg and entire tarsus of hind leg which are dark brown. *Head:* Length of antennal scape 1.83× width; flagellum with 19 flagellomeres; L/W of first three flagellomeres 3.43, 3.14, 3.14; L/W of apical flagellomere 4.0; MOD 0.80× as long as POD; POD as [illegible] as LOL, and 0.80× as long as POL [illegible]; OOL 2.00× as long as POL; head length 0.65× width in dorsal view; occiput slightly evenly curved (Fig. 65); head L/H 0.81 in lateral view; eye L/H 0.63, eyeH/headH 0.67, eye width/gena width 1.88; gena wider ventrally than dorsally (Fig. 66); face completely covered by granular microsculpture, setae as long as clypeus height, clypeus W/H 2.44, clypeus width 1.20× as long as malar space (Fig. 67). *Wings:* Forewing with RS vein straighter near apex than base; RS+Ma

with basal ⅓ unpigmented, thinner than remainder, point of attachment to M almost obsolete, distance between point of attachment of RS+Ma to M and parastigma 0.60× as long as RS+Mb; 2M spur 3.6× as long as RS+Mb; 2–1A vein present but obsolete and very faintly pigmented on basal ⅓, first subdiscal cell open (Fig. 69). Hind wing with r-m 1.8× as long as R; angle of M and r-m with posteriorly directed, obsolete, and faintly pigmented spur; apex of R moderately knobbed (Fig. 69). *Mesosoma:* Notauli shallow, not convergent posteriorly, merged with lateral edges of posterior median depression (Fig. 68); propodeum smooth, medioapical carinae straight, medioapical cell open (Fig. 70). *Metasoma:* T1 length 1.04× as long as apical width, lateral margins straight posterior to spiracle, lateral carinae about half of tergum length, finely striate throughout except near base between carinae, (Figs. 71, 72); basal raised area of T2 0.21 of total T2 length, posterior margin of basal raised area irregularly bisinuate; basal ⅔ of T2 beyond basal raised area coarsely striate; T3 0.64× as long as T2, coarsely striate between lateral grooves, with anterior and lateral grooves crenulate (Fig. 73). *Legs:* Hind femur length 3.46 maximum width, ventral hairs shorter than femur width at point of attachment (Fig. 74).

Material examined.—HOLOTYPE ♀ (TAMU), labelled as follows: "Venezuela: Aragua 22 km. south Colonia Tovar 900 meters December 23, 1985 P. Kovarik, R. Jones". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon striatus* Williams Holotype det. D. Williams 2003".

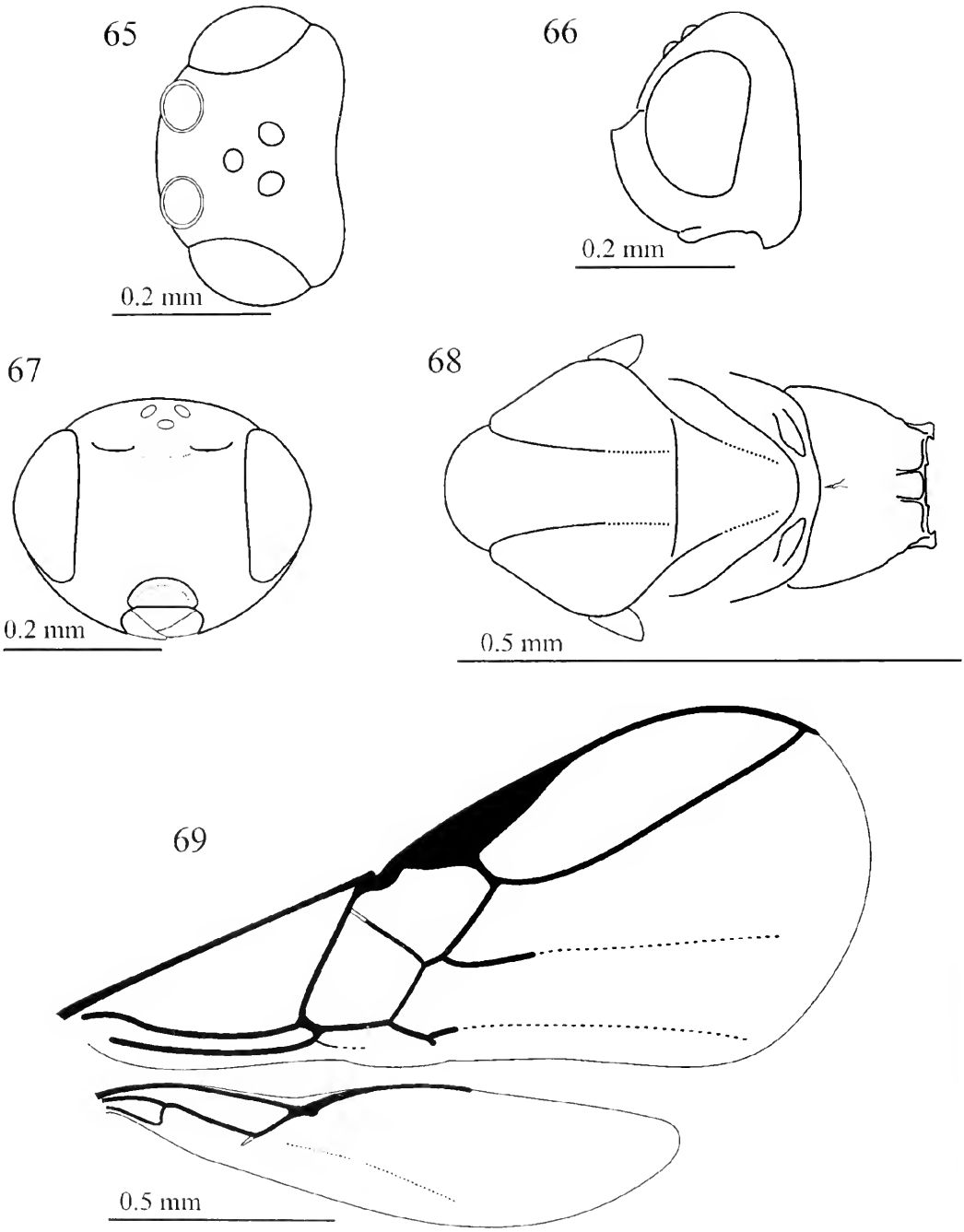
Remarks.—This species is known only from the holotype. The metasomal sculpture and hind wing spur on the M/r-m angle are distinctive characters that support the separation of this specimen from other *Pseudognaptodon* species.

Etymology.—The name *striatus* refers to the sculpture of T2 and T3 of the metasoma.

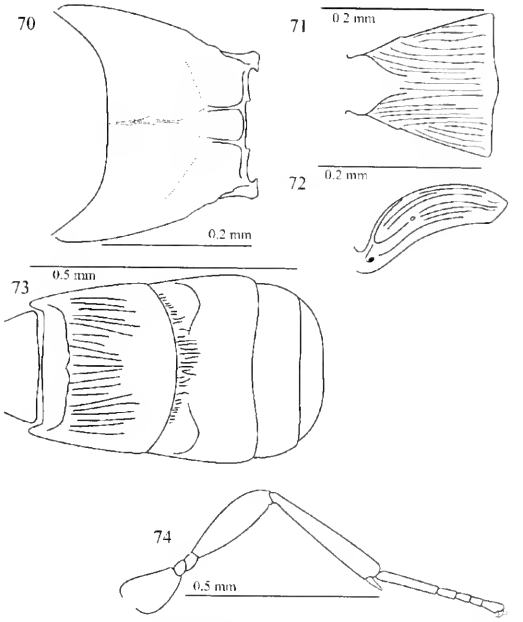
Pseudognaptodon xanthus Williams, new species
(Figs. 75–85)

Diagnosis.—This species is separated from other *omissus*-group species by the following combination of characters: Body pale yellow to light honey-brown; ocelli finely pitted on medial side (Fig. 75); T1 and T2 of metasoma with grooves smooth and microsculpture somewhat obsolete (Figs. 82, 84).

Female.—Color: Body and appendages pale yellow to honey-brown, most darker specimens darker dorsally than laterally or ventrally, except as follows: Flagellum of antenna brown in most specimens; ocellar triangle brown; propodeum light brown in most specimens; rarely scutum of thorax and terga of abdomen with various light brown patches or deeper shades. *Head:* Length of antennal scape 1.5–1.6 width; flagellum with 17–18 flagellomeres; L/W of first three flagellomeres 3.3–3.8, 3.3–3.8, 3.0–3.3; L/W of apical flagellomere 2.7–3.7; MOD 0.75–0.90× as long as POD; POD 0.95–1.14× as long as LOL, and 0.75–1.00× as long as POL (Fig. 75); ocelli with fine pits medially (Fig. 75); OOL 2.00–2.33× as long as POL (Fig. 76); head length 0.61–0.66× width in dorsal view; occiput slightly evenly curved (Fig. 76); head L/H 0.79–0.89 in lateral view; eye L/H 0.71–0.82, eyeH/headH 0.61–0.67, eye width/gena width 2.0–2.17; gena uniformly wide over most of eye height to slightly widened ventrally (Fig. 77); face completely covered by granular microsculpture, setae as long as clypeus height, clypeus W/H 1.8–3.00, clypeus width 1.13–1.28× as long as malar space (Fig. 78). *Wings:* Forewing with RS vein straighter near apex than base, slightly decurved at point of attachment to R; RS+Ma with basal ⅓ to entire vein unpigmented, basal ⅓ thinner than remainder, point of attachment to M almost obsolete in some specimens, distance between attachment of RS+Ma to M and parastigma



Figs. 65–69. *Pseudognaptodon striatus*. 65, Head in dorsal view. 66, Head in lateral view. 67, Head in anterior view. 68, Mesosoma in dorsal view. 69, Wings.



Figs. 70–74. *Pseudognaptodon striatus*. 70, Head in dorsal view. 71, Head in lateral view. 72, Head in anterior view. 73, Mesosoma in dorsal view. 74, Wings.

0.50–0.75× as long as RS+Mb; 2M spur 1.60–2.25× as long as RS+Mb; 2–1A vein present as a crease to present but obsolete and very faintly pigmented on basal ⅔, first subdiscal cell open (Fig. 79). Hind wing with r-m 0.5–1.0× as long as R; angle of M and r-m without spur or thickened area; apex of R slightly to moderately knobbed (Fig. 79). *Mesosoma:* Notauli shallow, indistinct on posterior half (Fig. 80); propodeum smooth, medioapical carinae slightly arcuate and convergent, medioapical cell open (Fig. 81). *Metasoma:* T1 length 0.85–0.96× as long as apical width, lateral margins straight to slightly concave posterior to spiracle, lateral carinae 0.5–0.8 of tergum length, weakly striate lateral to carinae and smooth to weakly striate at apex between carinae (Figs. 82, 83); basal raised area of T2 0.33–0.41 of total T2 length, posterior margin of basal raised area evenly curved, rarely slightly irregular and somewhat obsolete; T2 sculpture obsolete granulostriate to weakly striate near basal raised area to basal half; T3 0.60–0.73× as long as T2, smooth, with anterior and lateral grooves smooth to slightly crenulate (Fig. 84). *Legs:* Hind femur length 3.13–3.88 maximum width, ventral hairs shorter than femur width at point of attachment (Fig. 85).

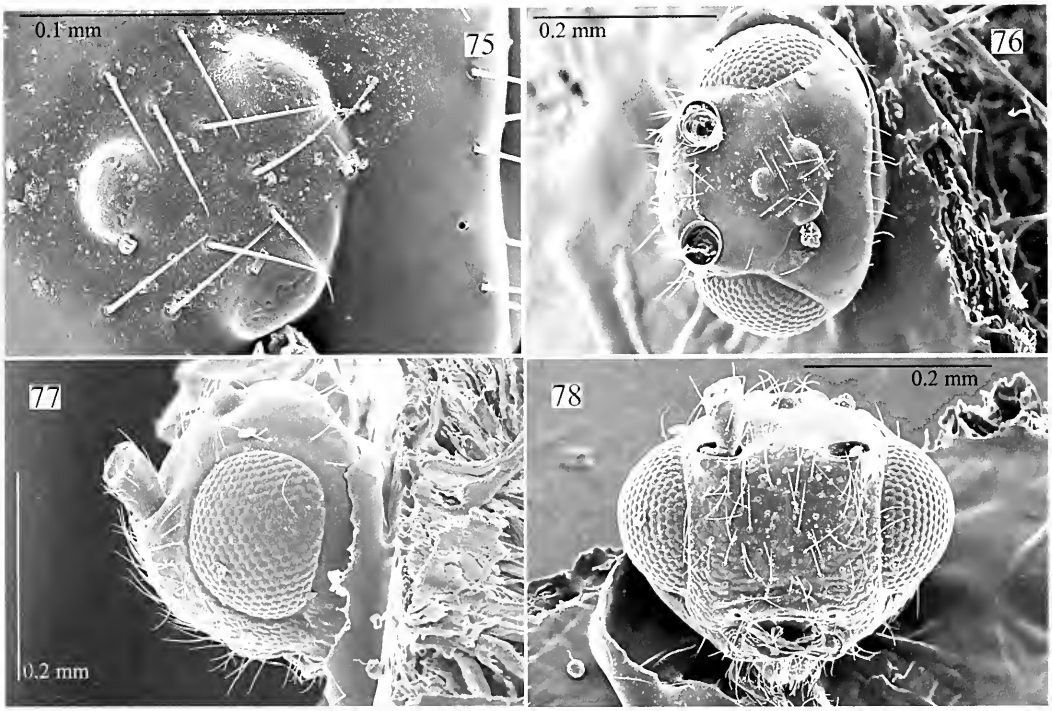
Material examined.—7♂, 22♀. HOLOTYPE FEMALE (CNCI), labelled as follows: "U.S.A Georgia 15 km. W. Fargo Okefenokee Swamp Nov. 1979 D. Williams coll.". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon xanthus* Williams Holotype det. D. Williams 2003". PARATYPES: **U.S.A. Georgia:** 15 km W. Fargo, Okefenokee Swamp, XI-1979, D. Williams, 1♂, 1♀ (DJMW), 9♀ (CNCI). 15 km W. Fargo, Okefenokee Swamp, 82° 20'W: 40° 30'N, slash pine stand, 13-XI-1979, D. Williams 3♀ (RNHL). **Florida: Sarasota Co.:** Myakka, 16-18-I-1984, R. Wharton 1♂, 2♀ (TAMU). **Florida:** Lake Dorr Rec. Area, Ocala Net. Forest, 20-XI-1979, D. Williams 1♀ (gold coated for S.E.M.) (DJMW). **Texas: San Jacinto Co.:** Big Creek Scenic Area, 7-III-1987, R. Wharton J. Heraty, 1♂ (TAMU). **Tyler Co.:** Kirby State Forest, 3miS. Warren, 22-V-1984, J. Woolley 2♂, 4♀ (TAMU). **Montgomery Co.:** Jones State Forest, 8miS. Conroe, 4-18-X-1987, R. Wharton, 1♀ (TAMU). **Costa Rica: Guanacaste:** Santa Rosa Nat. Park, 300m, ex. Malaise trap, Site# H-2-C, (H) open regenerating woodland <10 years old, (C) more or less fully shaded as possible, 24-V-14VI-1986, I. Gauld D. Janzen 2♂ (UWYO).

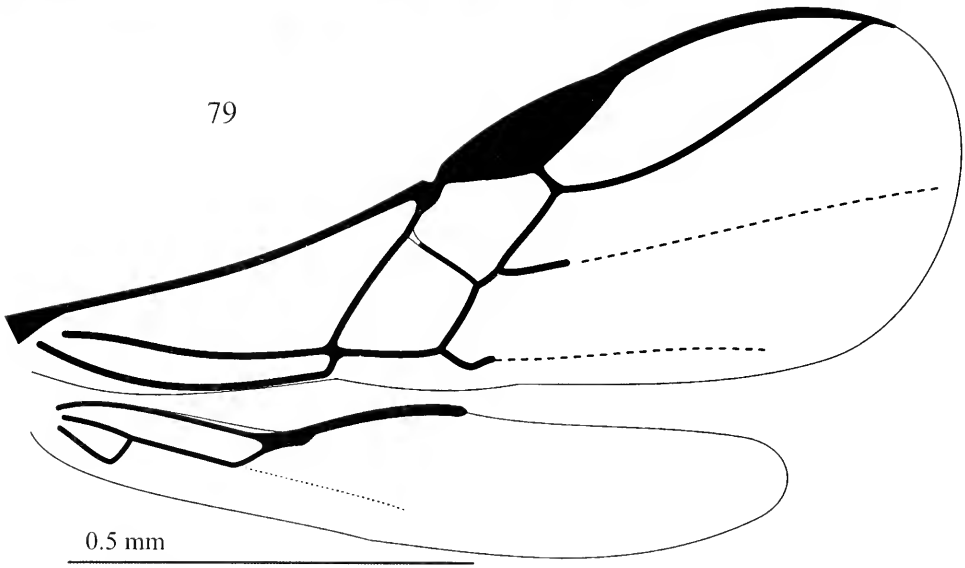
Remarks.—Specimens from Florida are generally pale, and those from Texas generally darker. One of the two male specimens from Costa Rica has distinctively medium-brown abdominal terga, but resembles other specimens in most other characters.

Etymology.—The name *xanthus* refers to the almost entirely yellow body color.

CURTICAUDA GROUP

Included species.—This species group includes *Pseudognaptodon curticauda* Fischer,

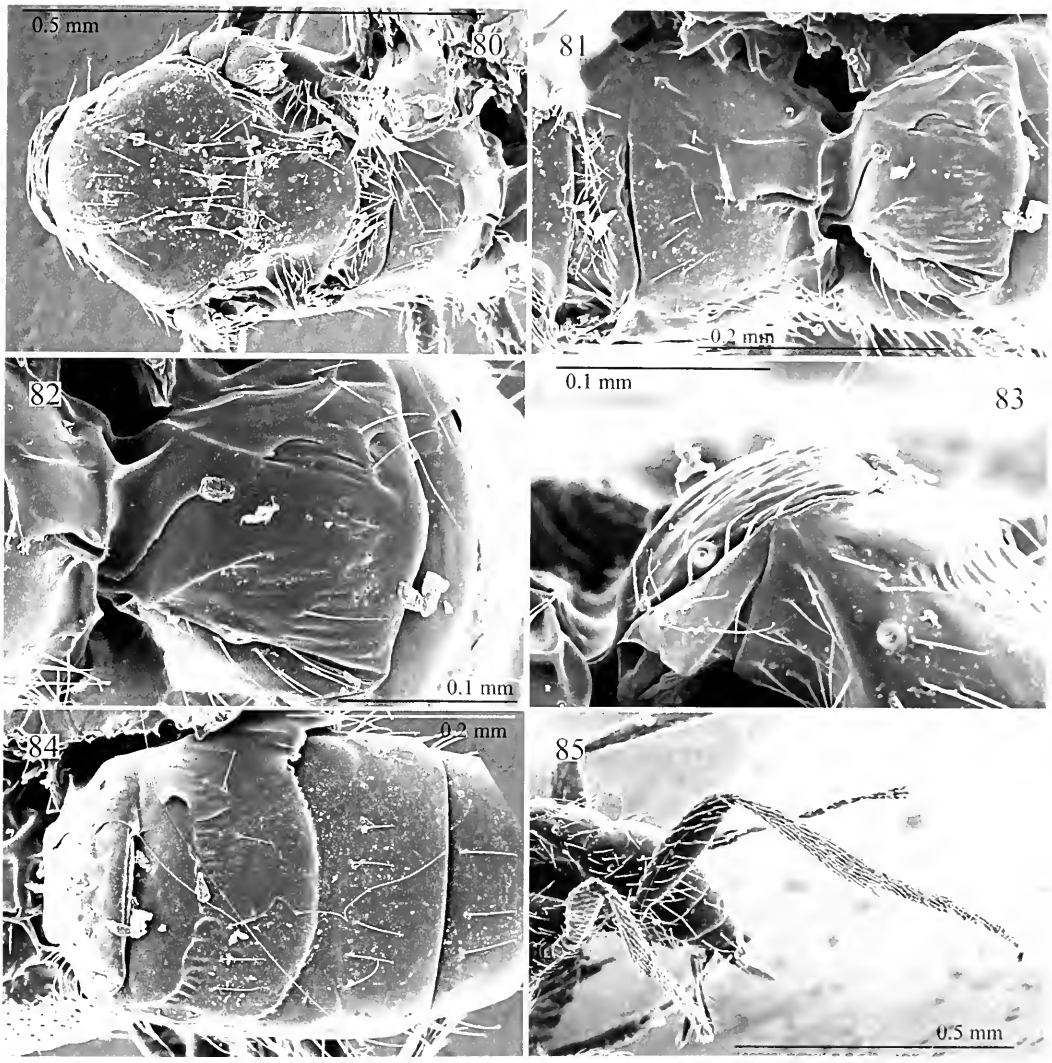




Figs. 75–79. *Pseudognaptodon xanthus*. 75, Ocelli in dorsal view. 76, Head in dorsal view. 77, Head in lateral view. 78, Head in anterior view. 79, Wings.

P. minutus (Ashmead), and the following new species: *P. brevis*, *P. carinatus*, *P. gibsoni*, *P. hemicolor*, *P. lab us*, *P. minimus*, *P. nitidus*, *P. shawi*, *P. whart i*, and *P. whitfieldi*.

Remarks.—The species of this group are separated from the *omissus*-group by the following combination of characters: Most species with frons, including ocellar trian-



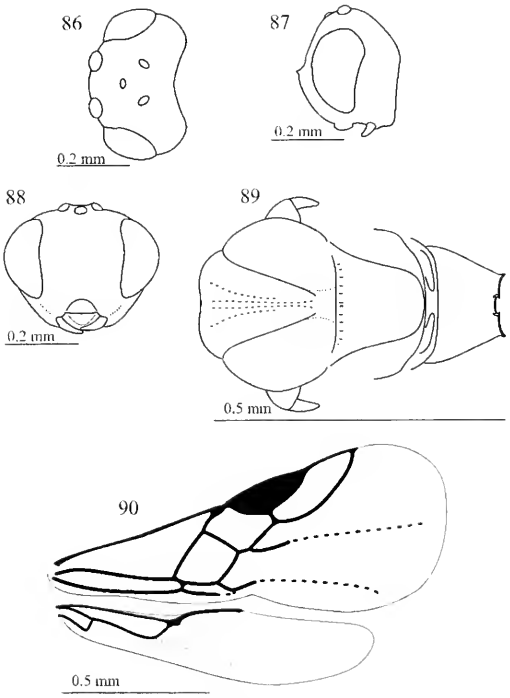
Figs. 80–85. *Pseudognaptodon xanthus*. 80, Mesosoma in dorsal view. 81, Propodeum in dorsal view. 82, T1 of metasoma in dorsal view. 83, T1 of metasoma in lateral view. 84, Anterior end of metasoma in dorsal view. 85, Hind leg.

gle, with fine but distinct granulate sculpture between posterior ocelli and antennal sockets (Figs. 86, 87). Episternal scrobe present as a faint depression or absent (Figs. 2, 3). Propodeum without small depression and/or area of fine wrinkles mediobasally (Figs. 111, 132). T3 of metasoma with anterolateral grooves lacking, or with grooves smooth and faintly impressed near lateral margins of tergite, or with anterolateral areas defined by microsculpture (Figs. 104, 114). Ovipositor barely exserted, setose portion of sheath less than half as long as hind basitarsus (Fig. 115).

Pseudognaptodon brevis Williams, new species

(Figs. 86–95)

Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Sculpture of frons obsolete except in ocel-



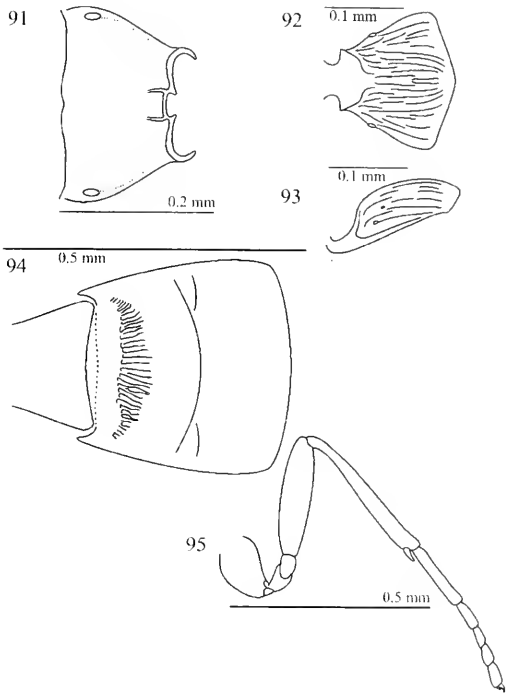
Figs. 86–90. *Pseudognaptodon brevis*. 86, Head in dorsal view. 87, Head in lateral view. 88, Head in anterior view. 89, Mesosoma in dorsal view. 90, Wings.

lar triangle; MOD and POD half as long as interocellar distances or less; vein R of forewing shorter than length of stigma on anterior wing margin (Fig. 90).

Holotype female.—Color: Body dark brown except for the following: Pedical and first two flagellomeres orange-brown; legs light orange-brown with brown hind coxa. *Head:* Length of antennal scape 1.5× width; flagellum with 16 flagellomeres: L/W of first three flagellomeres 4.3, 3.9, 3.2; L/W of apical flagellomere 3.0; MOD 0.9× as long as POD; POD 0.5× as long as LOL, and 0.4× as long as POL (Fig. 86); OOL as long as POL (Fig. 86); vertex without granular microsculpture except in ocellar triangle; head length 0.6× width in dorsal view; occiput narrowly indented (Fig. 86); head L/H 0.7 in lateral view; eye L/H 0.7, eyeH/headH 0.6, eye width/gena width 1.8 (Fig. 87); gena wider ventrally than dorsally (Fig. 87); face smooth on medial ⅓, with granular microsculpture laterally, setae as long as clypeus height, clypeus W/H 1.8, clypeus width 1.5× as long as malar space (Fig. 88). *Wings:* Forewing with RS vein evenly sharply curved, with R vein shorter than length of stigma on anterior margin; RS+Ma slightly pigmented and evenly sclerotized throughout length; 2M spur 3.0× as long as RS+Mb; 2-A1 present as a sclerotized vein on basal ⅔ and a pigmented crease on remainder; spur of m-cu present, subdiscal cell closed (Fig. 90). Hind wing with r-m 1.5× as long as R; Rs 5.4× as long as R; apex of R with moderately developed knob (Fig. 90). *Mesosoma:* Mesoscutum with median groove distinct, merged with notauli near posterior margin of mesoscutum, posteromedial depression small (Fig. 89); propodeum with medioapical carinae straight, convergent, basal cell open (Fig. 91). *Metasoma:* T1 0.9× as long as apical width, lateral margins convex posterior to spiracle, spiracle moderately protuberant, lateral carinae indistinct, merged with other striae; T1 evenly convex and finely striate throughout, except for basal area which is separated from remaider by a transverse ridge (Figs. 92, 93); basal raised area of T2 0.25 of total T2 length, posterior margin of basal raised area irregular; basal raised area margin obscured by coarse striae, T2 otherwise smooth; T3 0.75× as long as T2, smooth, with anterior groove crenulate (Fig. 94). *Legs:* Hind femur length 4.3× maximum width (Fig. 95).

Material examined.—HOLOTYPE ♀ (CNCI), labelled as follows: "Chile: Malleco: Princessa 20 km W Curacautin, 12.XII.1984–16.II.1985, S&J Peck, 300m, Notho. for.". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon brevis* Williams Holotype det. D. Williams 2003".

Etymology.—The name *brevis* refers to the very short R vein of the forewing, unique to this species within the genus.



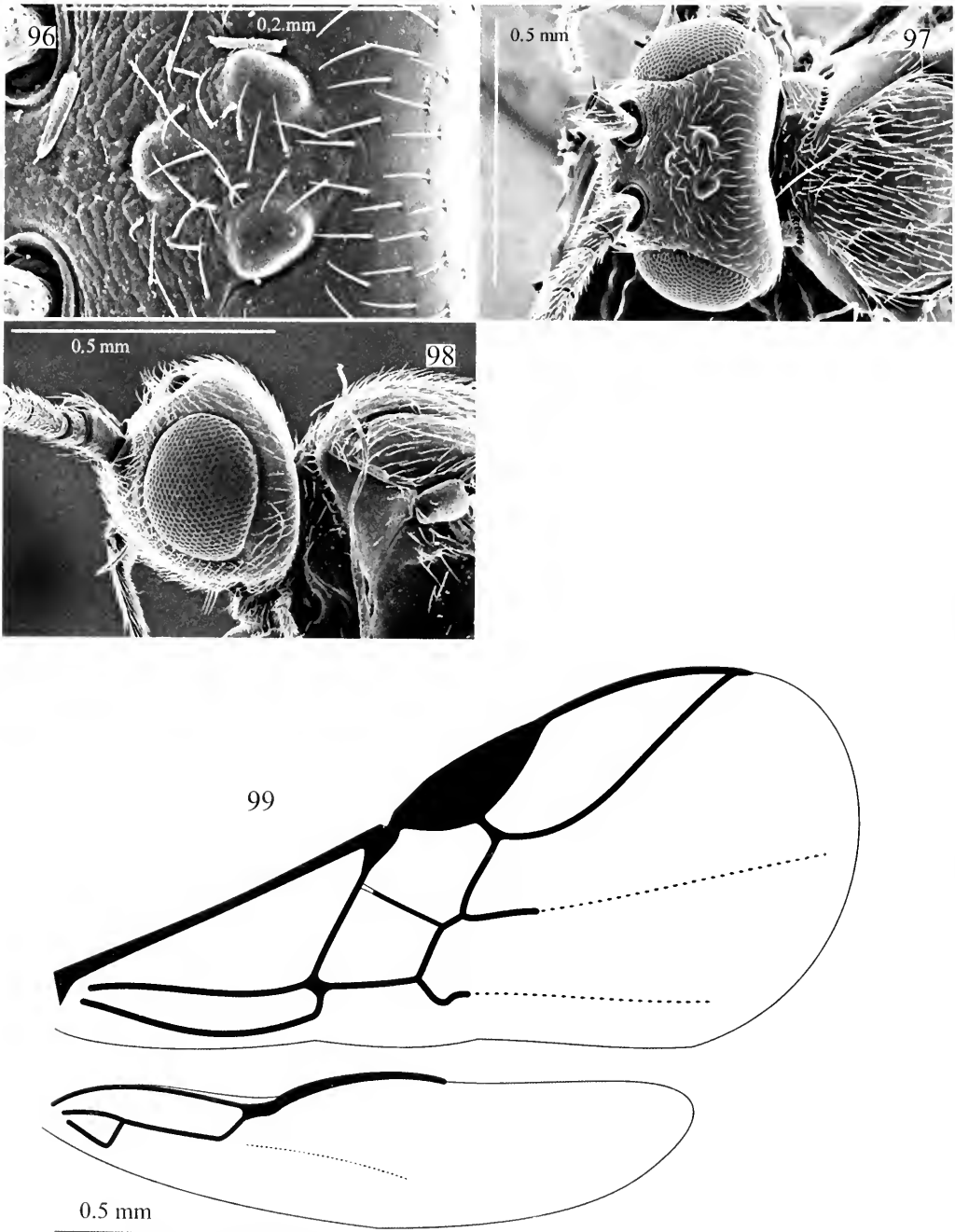
Figs. 91–95. *Pseudognaptodon brevis*. 91, Propodeum in dorsal view. 92, T1 of metasoma in dorsal view. 93, T1 of metasoma in lateral view. 94, Anterior end of metasoma in dorsal view. 95, Hind leg.

Pseudognaptodon carinatus Williams, new species
(Figs. 96–105)

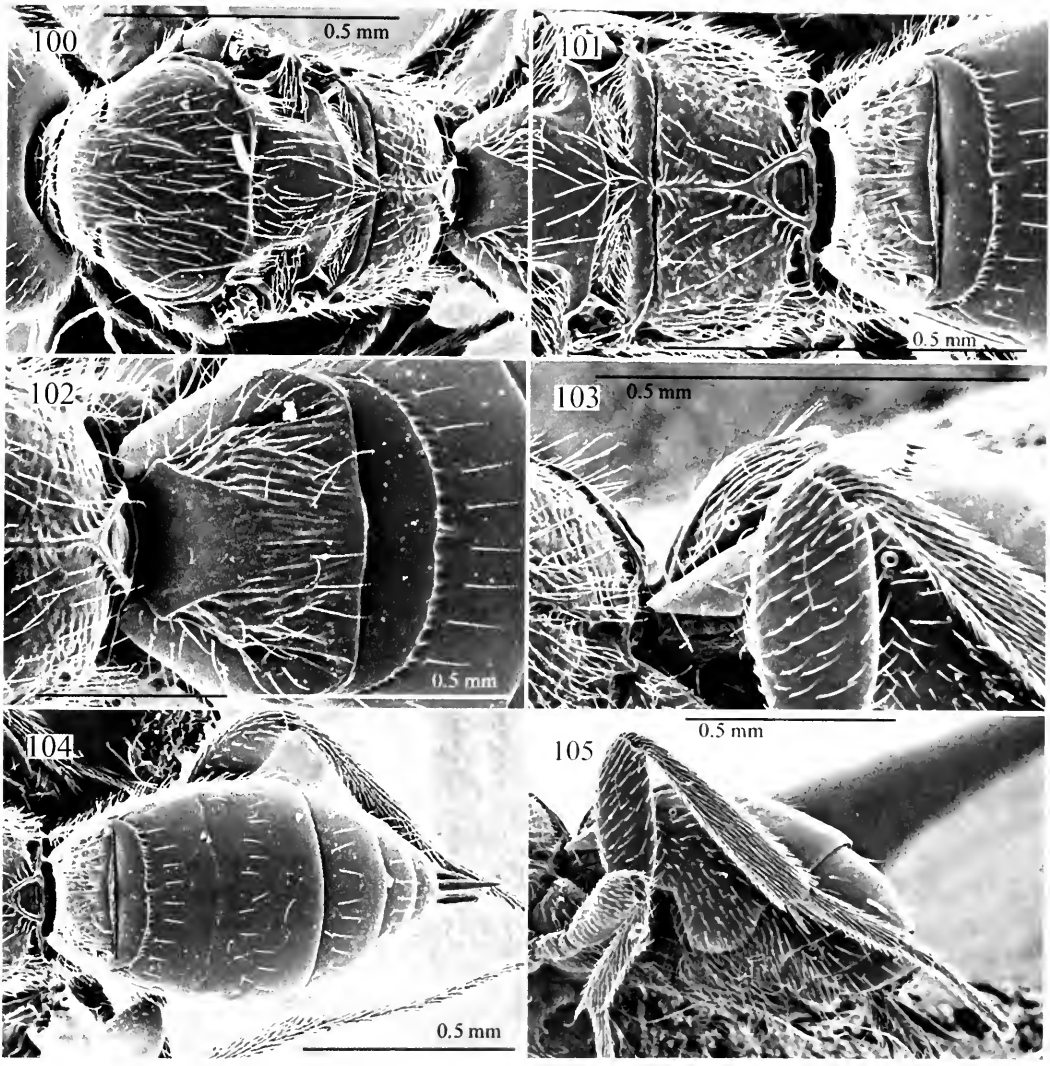
Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Propodeum with triangular basal cell and complete median carina (Fig. 101).

Female.—Color: Body dark brown except for the following: Scape light orange-brown; Pronotal collar and part of mesopleuron with light orange-brown area; legs yellow, except hind tarsus light brown. *Head:* Length of antennal scape 1.5–1.6× width; flagellum with 20–21 flagellomeres: L/W of first three flagellomeres 2.2, 2, 2.2–2.4; L/W of apical flagellomere 2.3; MOD as long as POD; POD as long as LOL, and 0.8–0.9× as long as POL (Fig. 96); OOL 2.0× as long as POL (Fig. 97); vertex with well developed granular microsculpture and fine wrinkles between lateral ocelli and dorsal margin of eye; head length 0.6× width in dorsal view; occiput narrowly indented (Fig. 97); head L/H 0.7 in lateral view; eye L/H 0.7, eyeH/headH 0.6, eye width/gena width 1.8 (Fig. 98); gena wider ventrally than dorsally (Fig. 98); face granulate with a polished area dorsal to clypeus and a polished stripe that is narrow dorsally, setae as long as clypeus height, clypeus W/H 2.2, clypeus width as long as malar space. *Wings:* Forewing with RS vein apically decurved; RS+Ma pigmented and tubular, slightly thinner basally than apically; 2M spur 3.0× as long as RS+Mb; 2-A1 absent; spur of m-cu absent, first subdiscal cell open (Fig. 99). Hind wing with r-m 1.6× as long as R; Rs 6.0× as long as R and thickened basally; apex of R with poorly to moderately developed knob (Fig. 99). *Mesosoma:* Mesoscutum with median groove present near posteromedial depression, notauli merged with one another on anterior margin of posteromedial depression (Fig. 100); propodeum with basal cell complete, triangular, median carina complete to anterior propodeal margin (Fig. 101). *Metasoma:* T1 length as long as apical width, lateral margins slightly concave posterior to spiracle, spiracle moderately protuberant, lateral carinae present on basal half and present but merged with coarse striae on apical half; T1 striate on apical half and lateral to carinae (Figs. 102, 103); basal raised area of T2 0.3× of total T2 length, posterior margin of basal raised area evenly curved but slightly sinuate medially; basal raised area margin crenulate, with a few obsolete striae near midline; T3 as long as T2, smooth, with anterior groove smooth, sinuate, and somewhat obsolete laterally (Fig. 104). *Legs:* Hind femur length 2.9× maximum width (Fig. 105).

Material examined.—3♀, 1♂. HOLOTYPE ♀ (TAMU), labelled as follows: "Mexico: Guerrero 6.2 mi SW Xochipala VII-6-1987 5670 ft R. Wharton". Also red



Figs. 96–99. *Pseudognaptodon carinatus*. 96, Ocelli in dorsal view. 97, Head in dorsal view. 98, Head in lateral view. 99, Wings.



Figs. 100–105. *Pseudognaptodon carinatus*. 100, Mesosoma in dorsal view. 101, Propodeum in dorsal view. 102, T1 of metasoma in dorsal view. 103, T1 of metasoma in lateral view. 104, Anterior end of metasoma in dorsal view. 105, Hind leg.

label "HOLOTYPE" and bordered label "*Pseudognaptodon carinatus* Williams Holotype det. D. Williams 2003". PARATYPES: **Chiapas:** Tapachula, 22-24-IX-1987, R. Wharton, 1♂ (TAMU). **Costa Rica: Guanacaste:** Santa Rosa Nat. Park, ex. Malaise, 300m, site 27.IX, (H) open regenerating woodland <10 years old, (O) in clearing, fully isolated part of day, 18-IX-1986, I. Gauld D. Janzen, 2♀ (UWYO).

Etymology.—The name *carinatus* refers to the complete median carina of the propodeum.

Pseudognaptodon curticauda Fischer 1967

(Figs. 106–115)

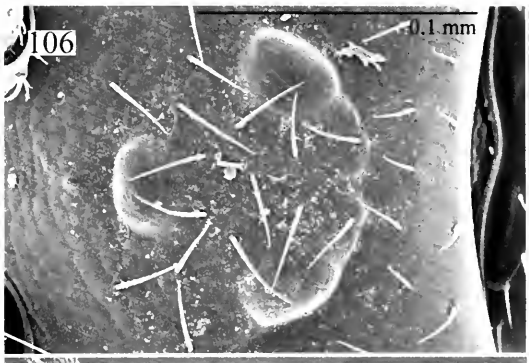
Holotype female.—Mexico, on Mesquite leaf, Brownsville no. 34069, 12-X-1943 (USNM). Examined.

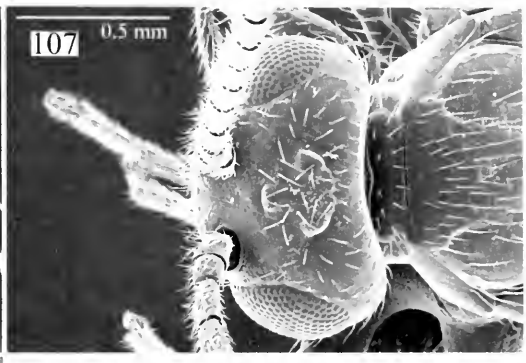
Diagnosis.—This species is separated from other *curticauda*-group species by the

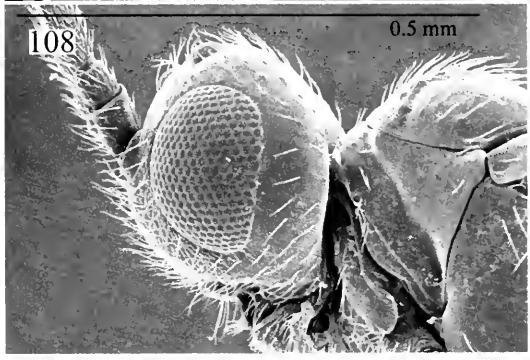
following combination of characters: Head, mesosoma, and most or all of metasoma uniformly dark brown or black in color, rarely with lighter clypeus or pronotal collar; metasoma with T1 about as wide as long (Fig. 112), and T2 finely granulate near apex of basal raised area to most of center of tergum in a semicircular pattern (Fig. 114).

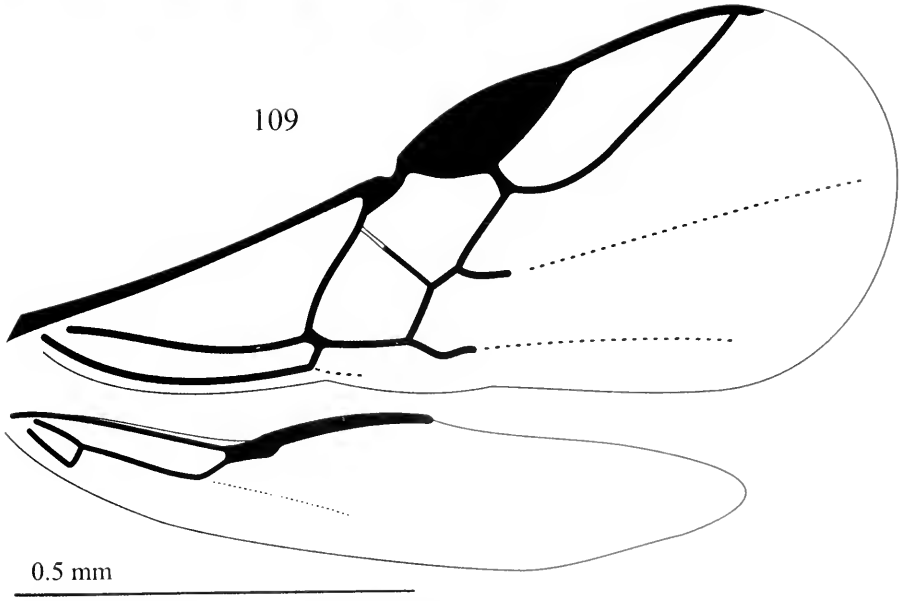
Female.—Color: Body dark red-brown to black except as follows: Scape and pedicel yellow to light brown; rarely with clypeus light brown; pronotal collar light orange-brown in some specimens; legs yellow to light orange-brown, rarely with light brown apical tarsomeres and hind tarsus, or hind tibia darker apically, or femora with darker area on dorsal surface. *Head:* Length of antennal scape 1.4–1.8× width; flagellum with 13–17 flagellomeres: L/W of first three flagellomeres 2.5–3.9, 2.2–3.3, 2.3–3.2, rarely with flagellomeres shorter apically; L/W of apical flagellomere 2.3–3.3; MOD 0.6–1.0× as long as POD; POD 0.8–1.0× as long as LOL, and 0.6–1.0× as long as POL (Fig. 106); OOL 1.4–2.1× as long as POL (Fig. 107); vertex with well developed granular sculpture anterior to ocelli to entire vertex granular, with very fine, incomplete suture or fine wrinkles present between lateral ocelli and dorsal eye margin; head length 0.6–0.7× width in dorsal view; occiput shallowly, narrowly to widely indented, head somewhat C-shaped in dorsal view (Fig. 107); head L/H 0.7–0.8 in lateral view; eye L/H 0.6–0.7, eyeH/headH 0.6–0.7, eye width/gena width 1.2–1.9 (Fig. 108); gena parallel sided (Fig. 108); face granulate, rarely with a small polished area dorsal of clypeus and a narrow median polished strip, setae shorter than or as long as clypeus height, clypeus W/H 1.8–3.0, clypeus width 0.8–1.3× as long as malar space. *Wings:* Forewing with RS vein curved but straighter apically than basally, decurved, or decurved and sinuate at midlength; RS+Ma unpigmented on basal ⅓ and tubular throughout length, rarely thinned on basal half; 2M spur 1.6–3.3× as long as RS+Mb; 2-A1 absent to present as an unpigmented crease on basal half; spur of m-cu absent or present as a very small lobe, first subdiscal cell open (Fig. 109). Hind wing with r-m 0.8–1.3× as long as R; Rs 3.6–5.6× as long as R; apex of R moderately to well developed knob (Fig. 109). *Mesosoma:* Mesoscutum with median groove absent, notauli merged with one another on anterior margin of posteromedial depression (Fig. 110); propodeum with medioapical carinae straight, parallel, and widely separated to cell closed by complete carina, rarely with irregular very fine wrinkles, or with other irregular small carinae (Fig. 111). *Metasoma:* T1 length 0.9–1.2× as long as apical width, lateral margins slightly concave to straight posterior to spiracle, spiracle not to strongly protuberant, lateral carinae present on basal half to complete to apex or nearly so, rarely merged with coarse striae or continuous with lateral margins of a medial raised area; T1 striate throughout except for small area at base of tergum to striate on apical half, (Figs. 112, 113); basal raised area of T2 0.2–0.4 of total T2 length, posterior margin of basal raised area broadly concave with lateral lunules to evenly curved, irregular, slightly medially produced, or rarely toothed; basal raised area margin smooth or weakly crenulate, smooth to granulate on most of tergum posterior to basal raised area in a semicircular pattern; T3 0.8–1.0× as long as T2, smooth to granulate on basal ⅓ of disc, with anterior groove smooth to weakly crenulate, rarely with groove widened or decurved medially (Fig. 114). *Legs:* Hind femur length 2.7–3.6× maximum width (Fig. 115).

Material examined.—**Costa Rica: Guanacaste:** P.N. Santa Rosa, 200m, I-1991, P. Hanson, 2♀ (UWYO). Guanacaste Conservation Area, Santa Rosa hdq., 200m, light trap, 7-VII-1997, L. van der Ent, 1♀ (UWYO). Santa Rosa Natl. Park, 300m, ex. Malaise trap, (H) open regenerating woodland <10 years old, (C) more or less

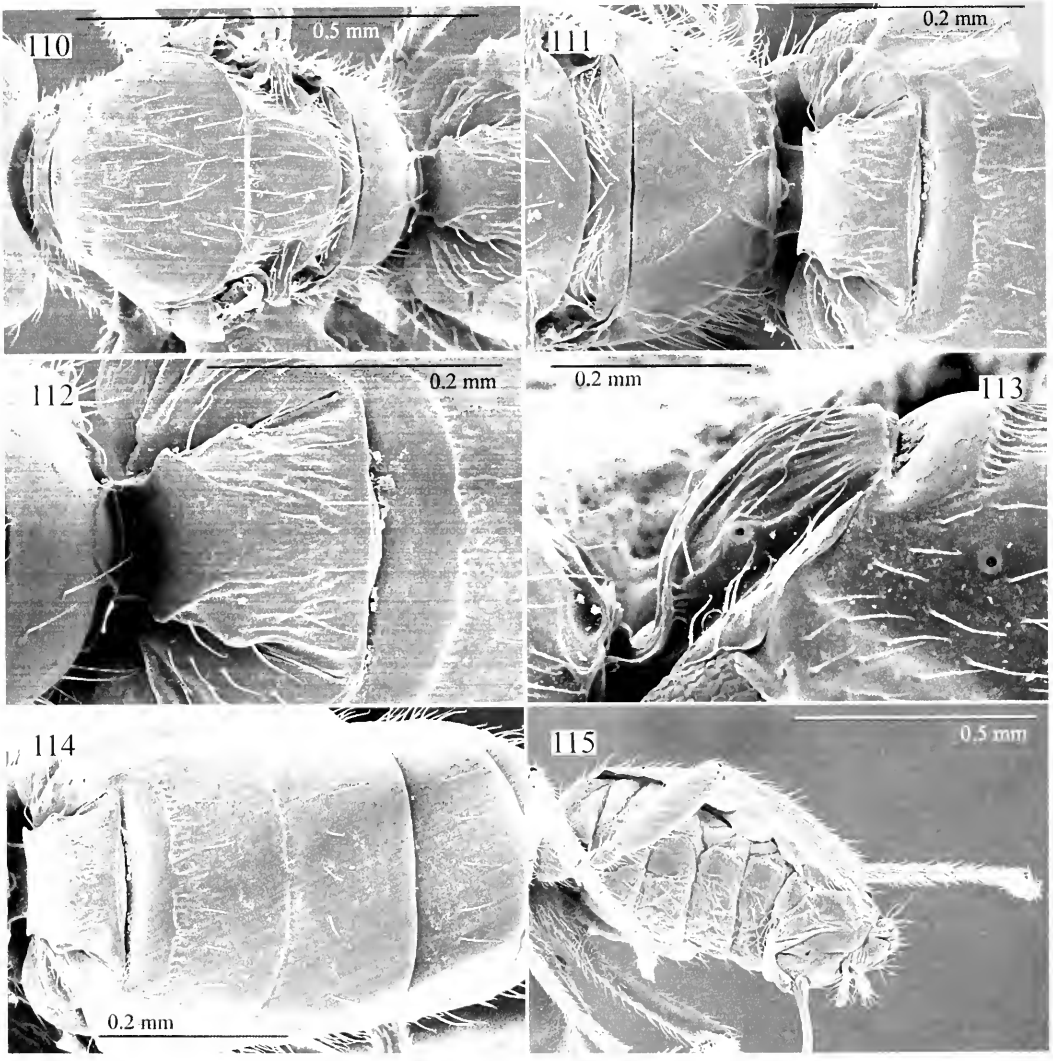








Figs. 106–109. *Pseudognaptodon curticauda* Fischer. 106, Ocelli in dorsal view. 107, Head in dorsal view. 108, Head in lateral view. 109, Wings.



Figs. 110–115. *Pseudognaptodon curticauda* Fischer. 110, Mesosoma in dorsal view. 111, Propodeum in dorsal view. 112, T1 of metasoma in dorsal view. 113, T1 of metasoma in lateral view. 114, Anterior end of metasoma in dorsal view. 115, Hind leg.

fully shaded as possible, 14-VIII-6-IX-1986 (1♂), 8-II-2-III-1986 (1♀), 23-III-13-IV-1986 (1♀), 21-II-14-III-1986 (1♀), 26-II-14-III-1987 (3♀, 1♂), 23-III-1986 (1♂), I. Gauld D. Janzen, (UWYO). Santa Rosa Natl. Park, 300m, ex. Malaise trap, (H) open regenerating woodland <10 years old, (O) in clearing fully isolated part of the day, 28-XII-1985-18-I-1986, I. Gauld D. Janzen, 1♀ (UWYO). Estac. Pitilla, 9 km S. Santa Cecilia, 700m, V-1989, I. Gauld, 1♀ (UWYO). Cerro el Hacha, N.W. Volcan Orosi, 300m 1988, 2♀, 1♂ (UWYO). **Puntarenas:** R.F. Golfo Dulce, 3 km S.W. Rincon, 10m, XII-1992, P. Hanson, 1♀ (UWYO). San Vito, Estac. Biol. Las Alturas, 1500m, III-1992, P. Hanson, 1♀ (UWYO). **Mexico: Guerrero:** 6.2miS.W. Xochipala, 13-VII-1985, Woolley & Zolnerowich, 3♀ (TAMU). 6miE. Xochipala, 13-VII-1985, Woolley & Zolnerowich, 3♂, 2♀ (TAMU). 6miE. Xochipala, 18-VII-1985, Woolley & Zolnerowich, 2♀,

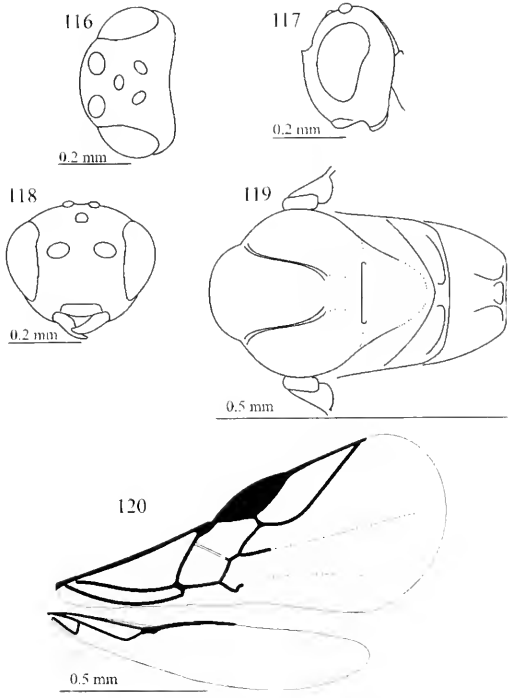
1♂ (TAMU). 15miW. Chichihualco, elev. approx. 1500', 15-VII-1984, J. Woolley, 1♀ (TAMU). 2miN. Cacahuamilpa, 19-VII-1984, J. Woolley, 1♂ (TAMU). 17miE. Tixtla, 11-VII-1985, J. Woolley G. Zolnerowich, 1♀, 1♂ (TAMU). 7miW. Chilapa, 16-VII-1984, J. Woolley, 3♀, 1♂ (TAMU). 32miS.E. Petalan, 10-VII-1985, Woolley & Zolnerowich, 2♀ (TAMU). **Michoacan:** 49miS.E. Aguila, 13-VII-1984, J. Woolley, 1♀ (TAMU). 2miS. Carapan, 6-VII-1985, Woolley & Zolnerowich, 1♂ (TAMU). **Oaxaca:** 8miN.E. El Punto, 18-VII-1985, Woolley & Zolnerowich, 1♀ (TAMU). 10.8miS. El Punto, 6100', 9-VII-1987, R. Wharton, 1♀ (TAMU). Puerto Escondido, 15-VII-1985, Woolley & Zolnerowich, 1♀ (TAMU). 6miN.E. Mitla, 20-VII-1985, J. Woolley G. Zolnerowich, 5♀, 4♂ (TAMU). 19miS. San Miguel Suchixtepec, 17-VII-1985, Woolley & Zolnerowich 2♀ (TAMU). 17miN.W. Tehuantepec, 15-VII-1987, R. Wharton, 1♀ (TAMU). 10miS.E. Totolapam, 4000', 20-VII-1987, R. Wharton, 1♀ (TAMU). 3.2miS.W. La Cumbre, 18-VII-1985, Wooley & Zolnerowich, 1♂ (TAMU). **Puebla:** 5miS.E. Izucar de Matamoras, 20-VII-1984, J. Woolley, 3♀, 1♂ (TAMU). **U.S.A.: Arizona: Santa Cruz Co.:** 1.0miS. Pena Blanca Lk., 4100', 6-VIII-1982, G. Gibson, 1♀ (DJMW). **California: S.L.O. Co.:** S.L.O. reservoir, 21-V-1975, R. Wharton, 1♀ (TAMU). **New Mexico: Otero Co.:** Cloudcroft, 8600', 24-VII-1982, G. Gibson, 2♂ (DJMW). **Texas: Brewster Co.:** Big Bend National Park, Oak Cyn, Window Trail, 5400', 24-27-VI-1982, G. Gibson, 2♀ (DJMW). Big Bend National Park, Cottonwood Campsite, 2300', 13-14-VII-1982, G. Gibson, 2♂ (DJMW). **Culberson Co.:** 3.6miS. Pine Springs, old Guadalupe Pass Road nr. Guadalupe Springs, 5200', sweeping flowering *Acacia constricta*, 20-22-VII-1982, G. Gibson, 1♀, 1♂ (DJMW). Guadalupe Nat'l Park, Choza Springs, 5100', 22-VII-1982, 1♀, 2♂ (DJMW). **Hidalgo Co.:** Bensten Rio Grande State Park, 15-XII-1983, J. Woolley H. Browning, 1♀, 1♂ (TAMU). **Kerr Co.:** Stumbergs Patio Ranch, 5.6miW. Hunt, 2000', 1-2-VII-1982, G. Gibson, 2♂ (DJMW). **Presidio Co:** Big Bend Ranch SNA, Agua Adentro, 29° 40'N, 104° 06''W, 14-V-1990, R. Wharton, 1♂ (TAMU).

Remarks.—This species shows the most character variation of any *Pseudognaptodon* in this study. There is much more variation in *P. curticauda* than *P. minutus* (Ashmead) and *P. whartoni* new species for example, which are described here from similar numbers of specimens. Specimens assigned to this species are united primarily by overall uniform dark body color and granulate sculpture of T2+T3 of the metasoma, which are common characters in the genus and may represent the plesiomorphic states. These specimens may represent several very similar species with overlapping ranges of characters. The majority of specimens are from the adjacent Mexican states Guerrero and Oaxaca. These specimens are the most uniform in appearance, and the most similar to the holotype. Short series or single specimens from Costa Rica and the United States vary in color, wing venation, shape and sculpture of metasomal T1, and other characters that are usually important in species diagnosis. These differences are consistent, but less in magnitude than difference among other species in the genus. It cannot be determined from the specimens available if this represents geographic variation or separate species.

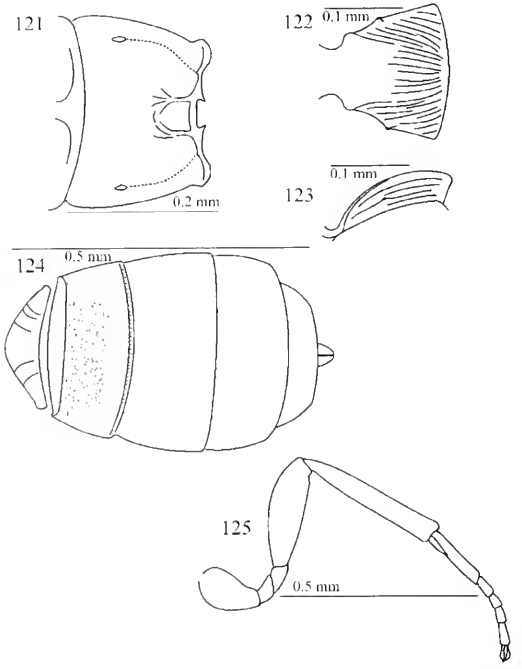
Pseudognaptodon gibsoni Williams, new species

(Figs. 116–125)

Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Metasoma yellow, with slight brown tint on middle of dorsal surface of terga from T3 to end of metasoma; T1 of metasoma slightly wider apically than long (Fig. 122); T2 of metasoma finely granulate, near apex of basal raised area to most of center of tergum (Fig. 124).



Figs. 116–120. *Pseudognaptodon gibsoni.* 116, Head in dorsal view. 117, Head in lateral view. 118, Head in anterior view. 119, Mesosoma in dorsal view. 120, Wings.



Figs. 121–125. *Pseudognaptodon gibsoni.* 121, Propodeum in dorsal view. 122, T1 of metasoma in dorsal view. 123, T1 of metasoma in lateral view. 124, Anterior end of metasoma in dorsal view. 125, Hind leg.

Female.—Color: Head and mesosoma dark brown except for the following: Scape yellow; clypeus light orange-brown; pronotal collar light to medium orange-brown; metasoma yellow, with light brown tint on dorsal surface of T3 to end of metasoma. *Head:* Length of antennal scape 1.6–1.8× width; flagellum with 18 flagellomeres: L♀W of first three flagellomeres 2.7–2.8, 2.3, 2.2–2.3; L♀W of apical flagellomere 2.3; MOD 0.8–0.9× as long as POD; POD 0.8–0.9× as long as LOL, and 0.7× as long as POL; OOL 1.2–1.4× as long as POL (Fig. 116); vertex with well developed granular sculpture anterior to ocelli; head length 0.6–0.6× width in dorsal view; occiput narrowly indented (Fig. 116); head L/H 0.6–0.7 in lateral view; eye L/H 0.5–0.6, eyeH/headH 0.6, eye width/gena width 0.9–1.2 (Fig. 117), gena wider ventrally than dorsally (Fig. 117); face granulate with a narrow median polished strip, setae much shorter than clypeus height, clypeus W/H 2.4–2.6, clypeus width 1.4× as long as malar space (Fig. 118). *Wings:* Forewing with RS vein straight on apical half; RS+Ma unpigmented, thinned on basal half to obsolete near base; 2M spur 1.8–2.2× as long as RS+Mb; 2-A1 present as an unpigmented crease on basal half; spur of m-cu absent, first subdiscal cell open (Fig. 120). Hind wing with r-m 1.3–1.5× as long as R; Rs 4.4–5.8× as long as R; apex of R with well developed knob (Fig. 120). *Mesosoma:* Mesoscutum with median groove absent, notauli merged with one another on anterior margin of posteromedial depression (Fig. 119); propodeum with medioapical carinae slightly converging, widely separated, irregular very fine wrinkles inside basal cell nearly closing cell apex (Fig. 121). *Metasoma:* T1 length 1.1–1.3× as long as apical width, lateral margins straight posterior to spiracle, spiracle slightly protuber-

ant, lateral carinae present on basal half; T1 striate on apical half and lateral to carinae (Figs. 122, 123); basal raised area of T2 0.3 of total T2 length, posterior margin of basal raised area evenly curved; basal raised area margin smooth to slightly crenulate, granulate on most of tergum posterior to basal raised area in a semicircular pattern; T3 0.8–0.9× as long as T2, smooth, with anterior groove weakly crenulate and evenly curved (Fig. 124). *Legs:* Hind femur length 3.5–3.7× maximum width (Fig. 125).

Material examined.—HOLOTYPE ♀ (CNCI), laballed as follows: "USA Texas Ward Co.: Monahans St. Pk., 6.0 mi N.E. Monahans 3000' 22.VI.82 G.A.P. Gibson, sweeping *Quercus havardi*". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon gibsoni* Williams Holotype det. D. williams 2003". PARATYPE: 1♀ with same data as holotype (CNCI).

Etymology.—This species is named for Gary Gibson, whose collection of specimens of several undescribed species (including the above) started me on this project.

Pseudognaptodon hemicolor Williams, new species
(Figs. 126–135)

Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Ocellar triangle darker in color than vertex, face lighter laterally than medially; propodeum with basal cell closed (Fig. 132); metasoma medium to dark brown apically, yellow to light orange-brown on lateral margins or most of first two or three terga; junction of RS+Ma and 1M apical of midlength of discal cell (Fig. 130); T1 of metasoma slightly wider apically than long (Fig. 133); T2 of metasoma finely granulate, near apex of basal raised area to most of tergum disc in a semicircular pattern (Fig. 135).

Female.—Color: Body medium red-brown except as follows: Scape yellow; clypeus yellow to light orange-brown in some specimens, face lighter brown near eye margins than medially; light orange-brown laterally on first two or three metasomal terga; legs yellow with light brown first hind tarsomere. *Head:* Length of antennal scape 1.5–1.8× width; flagellum with 16–19 flagellomeres: L/W of first three flagellomeres 2.3–3.0, 2.1–2.7, 2.1–2.5; L/W of apical flagellomere 2.7–2.9; MOD 0.9–1.0× as long as POD; POD 0.8–1.0× as long as LOL, and 0.6–0.8× as long as POL (Fig. 126); OOL 1.5–2.0× as long as POL (Fig. 127); vertex with well developed granular sculpture anterior to ocelli, very fine suture or fine wrinkles present between lateral ocelli and dorsal eye margin; head length 0.6× width in dorsal view; occiput narrowly, medially indented (Fig. 127); head L/H 0.7–0.8 in lateral view; eye L/H 0.6–0.7, eyeH/headH 0.6, eye width/gena width 1.2–1.5 (Fig. 128); gena parallel sided (Fig. 128); face completely granulate to a small polished area dorsal of clypeus and a narrow median polished strip, setae shorter than or as long as clypeus height, clypeus W/H 2.0–2.3, clypeus width 1.1× as long as malar space (Fig. 129). *Wings:* Forewing with RS vein decurved apically; RS+Ma unpigmented, tubular throughout length, rarely thinned on basal half and obsolete at extreme base, about as long as 1M; 2M spur 2.0–3.3× as long as RS+Mb; 2-A1 absent; spur of m-cu absent, first subdiscal cell open (Fig. 130). Hind wing with r-m 1.0–1.3× as long as R; Rs 4.2–5.2× as long as R; apex of R with well developed knob (Fig. 130). *Mesosoma:* Mesoscutum with median groove absent to faint, notauli merged with lateral margins of posteromedial depression (Fig. 131); propodeum with medioapical carinae enclosing a basal cell (Fig. 132). *Metasoma:* T1 length 0.9–1.1× as long as apical width, lateral margins straight posterior to spiracle, spiracle slightly protuberant, lateral carinae present on basal ⅓ to ⅔, poorly developed in some specimens; T1 weakly granulostriate

on apical half and lateral to carinae, rarely nearly smooth (Figs. 133, 134); basal raised area of T2 0.2–0.4 of total T2 length, posterior margin of basal raised area evenly curved, rarely obsolete; basal raised area margin smooth to slightly crenulate, granulate on most of tergum posterior to basal raised area in a semicircular pattern; T3 0.9–1.1× as long as T2, smooth, with anterior groove crenulate (Fig. 135). *Legs:* Hind femur length 2.9–3.7× maximum width.

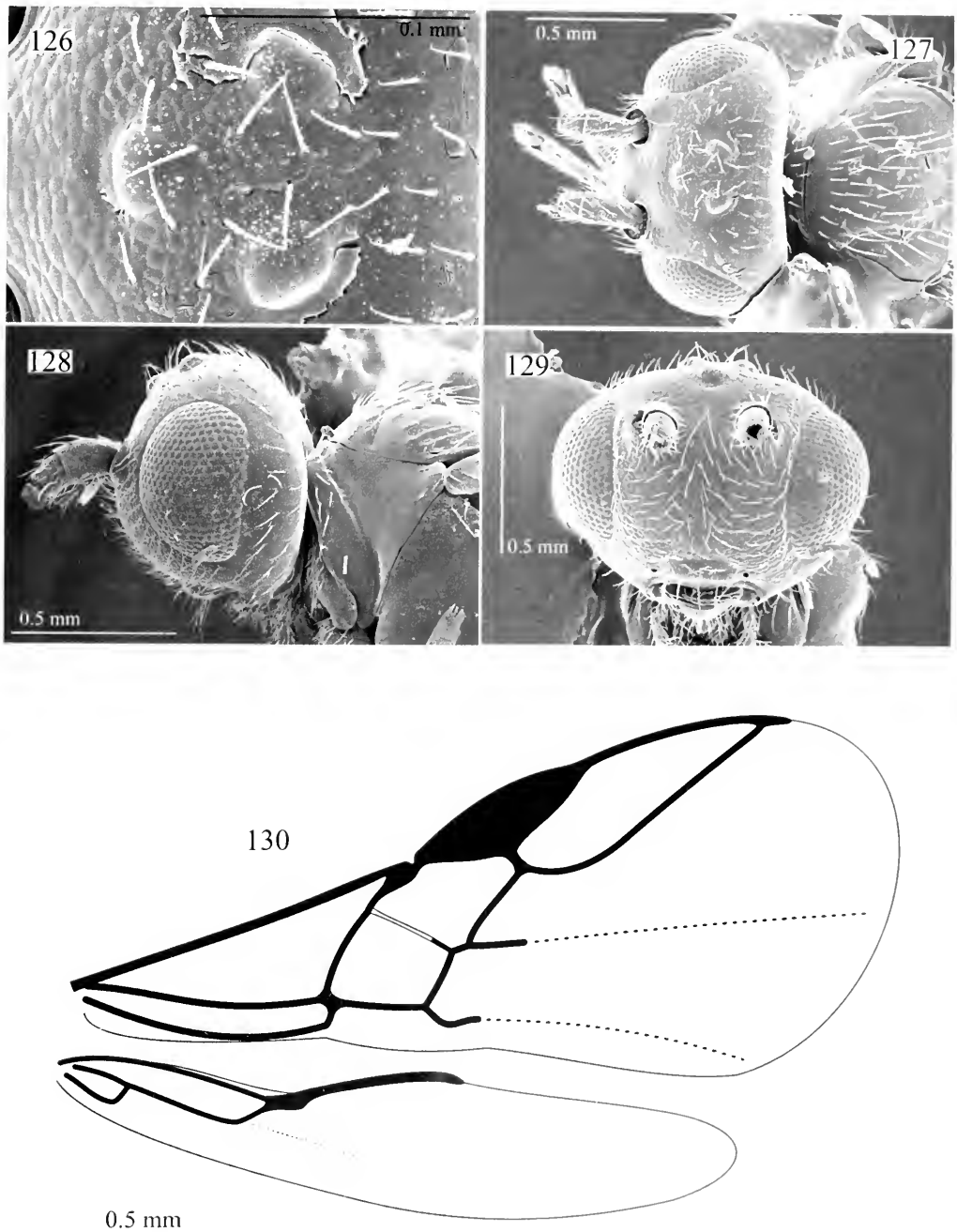
Material examined.—HOLOTYPE ♀ (FSCA), labelled as follows: upper label "Florida: Alachua Co., Gainesville Doyle Connor Building", and lower label "H.V. Weems Jr. and C.R. Artaud 12-XI-1971 Malaise trap". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon hemicolor* Williams Holotype det. D. Williams 2003". PARATYPES: **U.S.A.: Florida: Alachua Co.:** Gainesville, Doyle Connor Building, Malaise trap, 12-XI-1971, H Weems C. Artaud, 1♀ (FSCA). S9-T10S-R18E, Pierce's Homestead, Malaise trap, 1-XI-1973 (1♀), 19-XI-1973 (1♀), 10-V-1974 (1♂), W. Pierce (FSCA). **Wakulla Co.:** F.W. Mead Sta. 20-IV-1955, C. Muesebeck 1♀ (FSCA). **North Carolina: Wake Co.:** Raleigh, 9-VIII-1983, J. Whitfield 1♀ (JWCI).

Etymology.—The name *hemicolor* refers to coloration of the metasoma.

Pseudognaptodon labrus Williams, new species
(Figs. 136–145)

Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Body dark brown; labrum apically truncate, as large as clypeus, dark brown (Fig. 138); Forewing vein 2M markedly longer than RS+Ma (Fig. 140); Forewing vein 2-A1 pigmented for most of length, first subdiscal cell closed (Fig. 140).

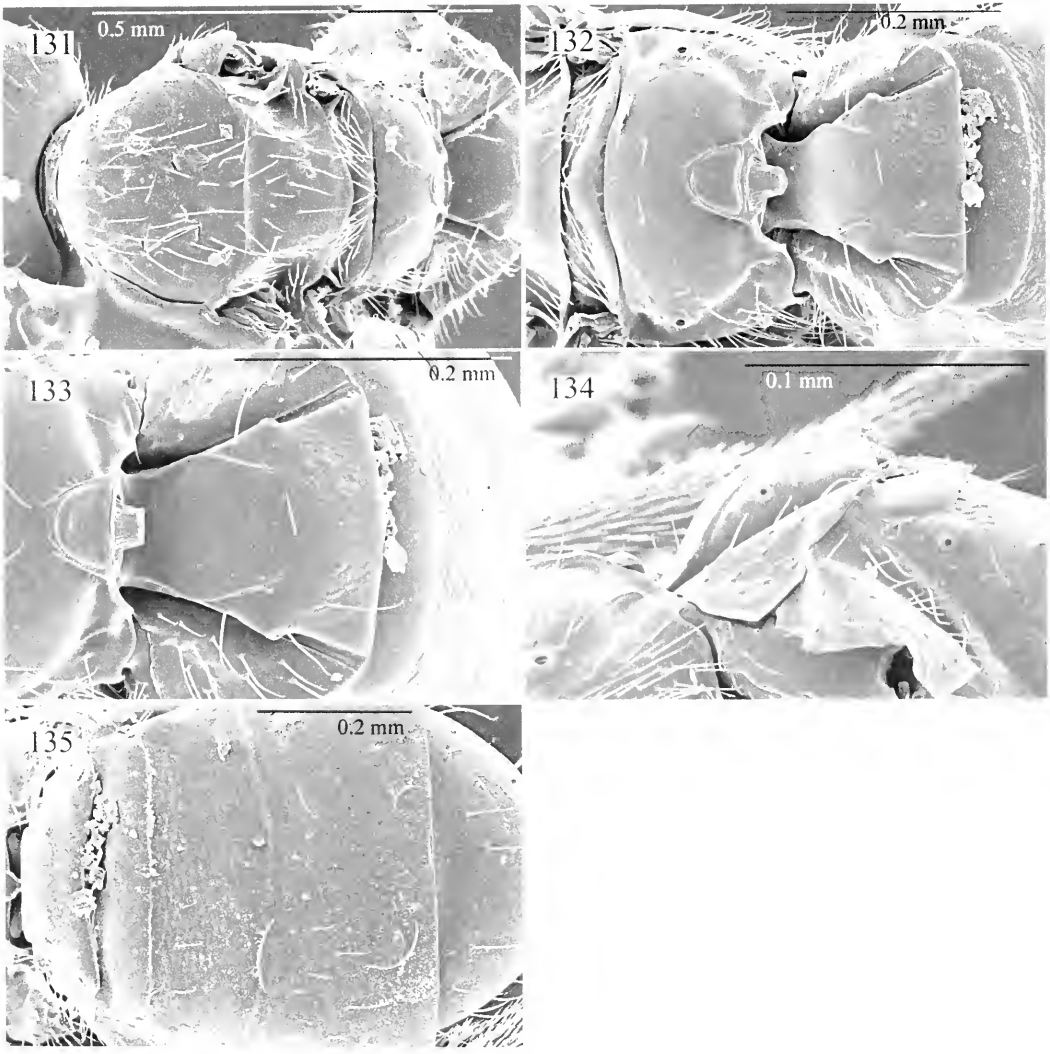
Holotype female.—Color: Body dark brown to black except for the following: legs orange-brown, with apical tarsomeres, base of hind coxa, apical half of hind tibia and hind tarsus light brown. *Head:* Length of antennal scape 1.7× width; flagellum with 19 flagellomeres: L/W of first three flagellomeres 3.3, 2.8, 2.8; L/W of apical flagellomere 2.5; MOD as long as POD; POD long as LOL, and 0.67× as long as POL (Fig. 136); OOL 1.8× as long as POL (Fig. 136); head length 0.64× width in dorsal view; occiput evenly deeply indented, head somewhat 'c-shaped' in dorsal view (Fig. 136); head L/H 0.7 in lateral view; eye L/H 0.58, eyeH/headH 0.58, eye width/gena width 1.1 (Fig. 137); gena wider ventrally than dorsally (Fig. 137); face granulate with median polished stripe, setae as long as clypeus height, clypeus W/H 1.7, clypeus width 0.8× as long as malar space (Fig. 138); labrum as large as clypeus, with truncate apex (Fig. 138). *Wings:* Forewing with RS vein straighter apically than basally; RS+Ma pigmented and tubular; 2M spur 6.4× as long as RS+Mb and markedly longer than RS+Ma; 2-A1 present as a tapering tubular vein over most of length and pigmented crease over remainder; spur of m-cu present, subdiscal cell closed (Fig. 140). Hind wing. r-m as long as R; Rs 3.6× as long as R; angle of M and r-m with posteriorly directed faintly pigmented spur; apex of R with moderately developed knob (Fig. 140). *Mesosoma:* Mesoscutum with median groove absent, notauli deeply impressed, joining in a U posteriorly, posteromedial depression small (Fig. 139); propodeum with basal carinae short, paralell (Fig. 141). *Metasoma:* T1 length 1.4× as long as apical width, lateral margins concave posterior to spiracle, spiracle slightly protuberant, lateral carinae present on basal half, convergent, merged with striae on apical half; T1 finely striate on apical ⅔ (Figs. 142, 143); basal raised area of T2 0.2 of total T2 length, posterior margin of basal raised area evenly curved; T2 finely granulostriate on most of tergum posterior to basal raised area, striae longer medially than laterally; T3 0.7× as long as T2, smooth, with anterior groove slightly



Figs. 126–130. *Pseudognaptodon hemicolor*. 126, ocelli in dorsal view. 127, Head in dorsal view. 128, Head in lateral view. 129, Head in anterior view. 130, Wings.

crenulate, deeply impressed, slightly procurved medially (Fig. 144). *Legs:* Hind femur length 4.8× maximum width (Fig. 145).

Material examined.—HOLOTYPE ♀ (CNCI), labelled as follows: "COLOMBIA, 2900 m. Putumayo 2.XII.72 1°10'N, 77°15'W. J. Helava". Also red label "HO-



Figs. 131–135. *Pseudognaptodon hemicolor*. 131, Mesosoma in dorsal view. 132, Propodeum in dorsal view. 133, T1 of metasoma in dorsal view. 134, T1 of metasoma in lateral view. 135, Anterior end of metasoma in dorsal view.

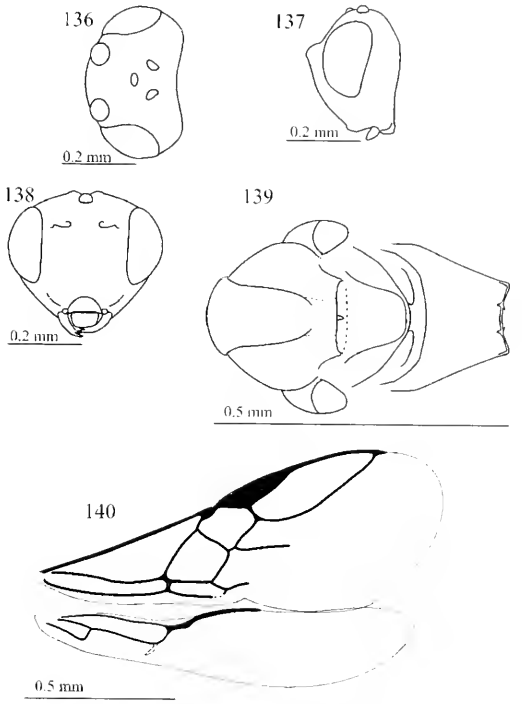
LOTYPE'' and bordered label ''*Pseudognaptodon labrus* Williams Holotype det. D. Williams 2003''. PARATYPES: **Colombia:** Quindio, 11 km E Calarca, 7000', 5-III-1974, S&J Peck 1♂ (CNCI). **Peru: Amazonas:** 6°50'S, 77°38'W, 3200', 13-II-1973, J. Helava, 2♂ (CNCI). **Peru: Amazonas:** 6°48'S, 77°38'W, 2800', 13-II-1973, J. Helava, 1♂ (CNCI).

Etymology.—The name *labrus* refers to the labrum, whose size shape, and color is unique within the genus.

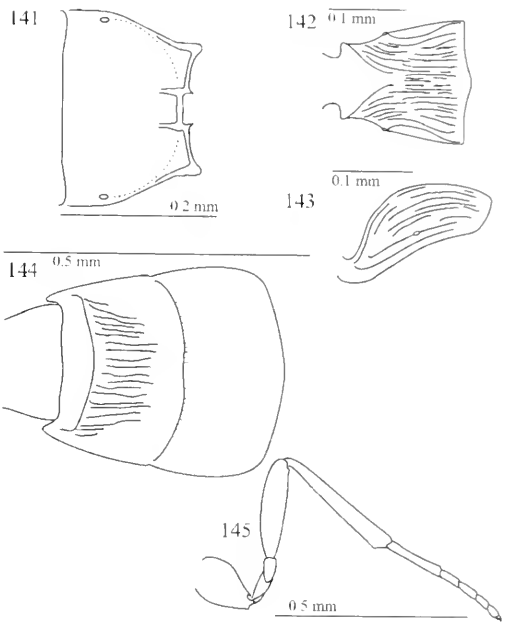
Pseudognaptodon minimus Williams, new species

(Figs. 146–155)

Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Body dark brown with light brown metasomal T1 and basal raised area and lateral margins of T2; metasomal T1 distinctly wider at apex than long, with basal carinae and striae obsolete (Fig. 152), somewhat flat in



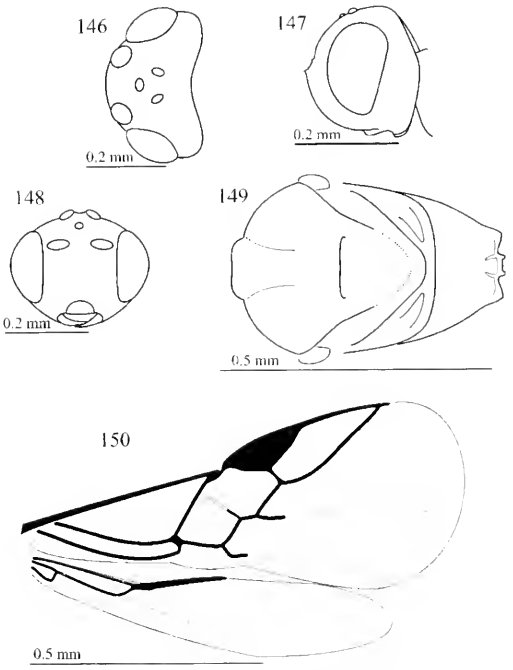
Figs. 136–140. *Pseudognaptodon labrus*. 136, Head in dorsal view. 137, Head in lateral view. 138, Head in anterior view. 139, Mesosoma in dorsal view. 140, Wings.



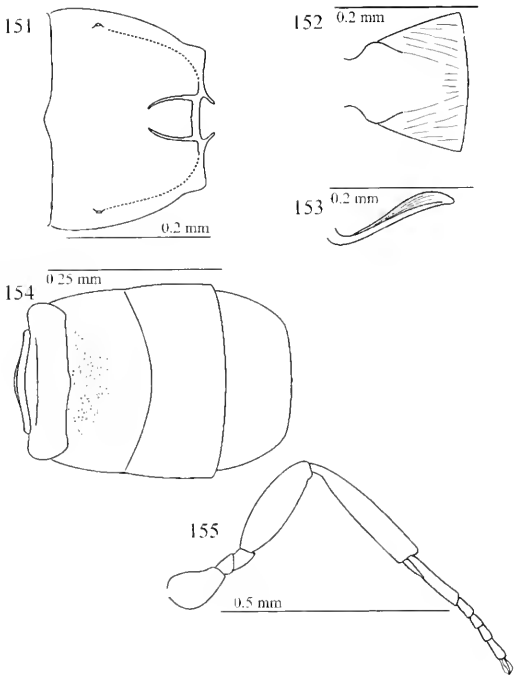
Figs. 141–145. *Pseudognaptodon labrus*. 141, Propodeum in dorsal view. 142, T1 of metasoma in dorsal view. 143, T1 of metasoma in lateral view. 144, Anterior end of metasoma in dorsal view. 145, Hind leg.

lateral view (Fig. 153); very minute, total body length less than 1.5 mm.

Female.—Color: Body dark brown except for the following: Scape, metasomal T1, and T2 basal raised area and lateral margins light brown; legs yellow to light brown, apex of hind tibia and hind tarsus light brown. *Head:* Length of antennal scape 1.6× width; flagellum with 13 flagellomeres: L/W of first three flagellomeres 3.6, 2.8, 2.6–2.7; L/W of apical flagellomere 2.5; MOD 0.9× as long as POD; POD 0.9× as long as LOL, and 0.8× as long as POL (Fig. 146); OOL 1.5× as long as POL (Fig. 146); head length 0.7× width in dorsal view; occiput evenly shallowly indented (Fig. 146); head L/H 0.8 in lateral view; eye L/H 0.6, eyeH/headH 0.7, eye width/gena width 1.2 (Fig. 147); gena wider ventrally than dorsally (Fig. 147); face granulate on lateral margins and smooth medially, most setae shorter than clypeus height, clypeus W/H 2.0, clypeus width 1.2× as long as malar space (Fig. 148). *Wings:* Forewing with RS vein sinuate on apical half; RS+Ma unpigmented, tubular but slender, obsolete at base; 2M spur 2.0× as long as RS+Mb; 2-A1 present as a faint crease on basal ⅓; spur of m-cu absent, first subdiscal cell open (Fig. 150). Hind wing. r-m 0.9× as long as R; Rs 3.6× as long as R; apex of R with poorly developed knob (Fig. 150). *Mesosoma:* Somewhat dorsoventrally compressed; mesoscutum with median groove absent, notauli obsolete on posterior half (Fig. 149); propodeum with basal carinae curved, convergent, basal cell narrowly open at apex (Fig. 151). *Metasoma:* T1 length 0.8× as long as apical width, nearly flat dorsoventrally, lateral margins straight posterior to spiracle, spiracle not protuberant, lateral carinae present only on base; T1 with a few poorly developed striae on apical and lateral ⅓ (Figs. 152, 153); basal raised area



Figs. 146–150. *Pseudognaptodon minimus*. 146, Head in dorsal view. 147, Head in lateral view. 148, Head in anterior view. 149, Mesosoma in dorsal view. 150, Wings.



Figs. 151–155. *Pseudognaptodon minimus*. 151, Propodeum in dorsal view. 152, T1 of metasoma in dorsal view. 153, T1 of metasoma in lateral view. 154, Anterior end of metasoma in dorsal view. 155, Hind leg.

of T2 0.4 of total T2 length, posterior margin of basal raised area evenly curved, poorly impressed; T2 granulate on basal half of tergum posterior to basal raised area; T3 0.9× as long as T2, smooth, with anterior groove crenulate, poorly developed grooves defining anterolateral corners present near lateral margins (Fig. 154). *Legs:* Hind femur length 3.8× maximum width (Fig. 155).

Material examined.—HOLOTYPE ♀ (CNCI), labelled as follows: "USA Texas Brewster Co. Big Bend National Park Oak Cyn.–Window Trail 5400' 24–27.VI.82 G.A.P. Gibson". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon minimus* Williams Holotype det. D. Williams 2003". PARATYPES: **Pima Co.:** Brawley Wash, Mile Wide Rd., 1.5 mi E. Sandaro Blvd., 2500', sweeping *Bacharis glutinosa*, 3-VIII-1982, G. Gibson, 2♀ (CNCI).

Etymology.—The name *minimus* refers to the very small size (<1.5 mm) of specimens of this species. It is the smallest species examined in this study.

Pseudognaptodon minutus (Ashmead) 1894

(Figs. 156–166)

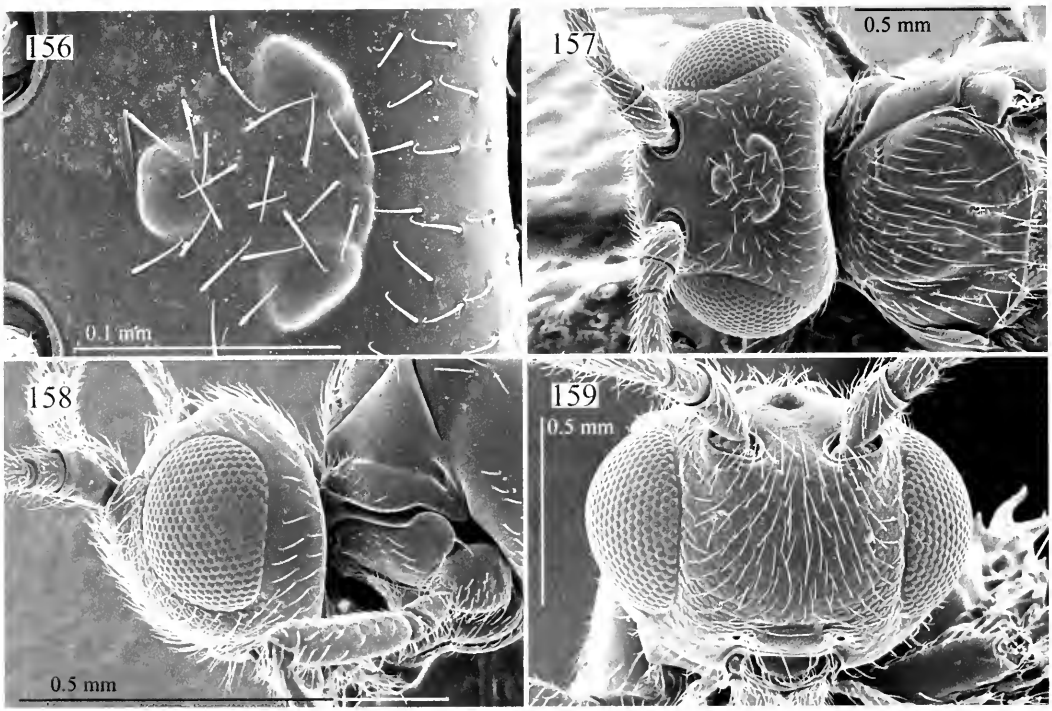
Holoytpe male.—**St. Vincent:** W. Indies 93–331, *Leiophron minutus* Type Ash., B.M. TYPE 3:659, Type H.T., H.H. Smith (BMNH). Examined.

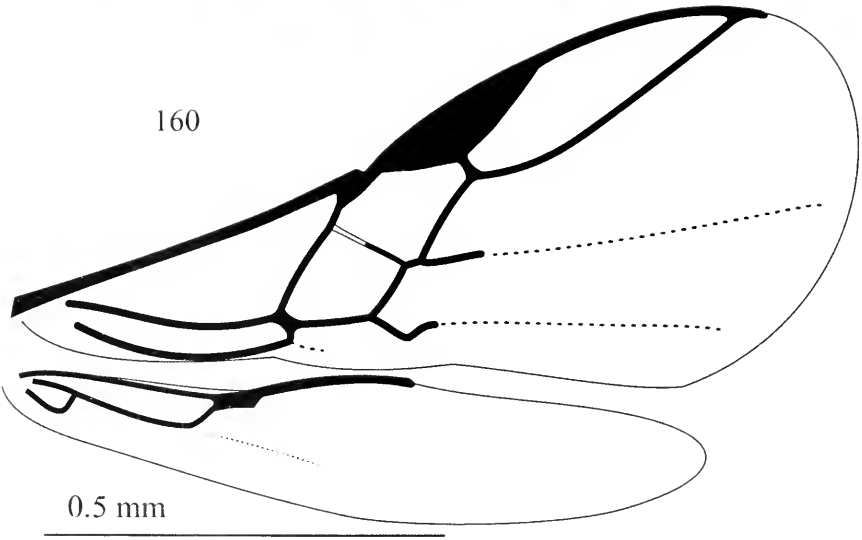
Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Body uniformly light to dark brown in color; T1 of metasoma length markedly greater than apical width (Fig. 163); T2 of metasoma finely striate or granulostriate near basal raised area margin, rarely with striae extending to posterior margin of tergum (Fig. 165); T3 of metasoma smooth, with

slightly crenulate anterior groove (Fig. 165).

Female.—Color: Body light honey-brown to dark red-brown except as follows: Scape yellow to light brown; legs yellow with darker hind tarsus, rarely with light brown area on dorsal surface of hind femur. *Head:* Length of antennal scape 1.3–1.7× width; flagellum with 14–16 flagellomeres: L/W of first three flagellomeres 2.7–3.3, 2.3–3.0, 2.1–2.8; L/W of apical flagellomere 2.3–3.6; MOD 0.8–1.0× as long as POD; POD 0.9–1.2× as long as LOL, and 0.7–1.2× as long as POL (Fig. 156); OOL 1.7–2.5× as long as POL (Fig. 157); vertex with obsolete granular sculpture anterior to ocelli; head length 0.6–0.7× width in dorsal view; occiput evenly moderately indented (Fig. 157); head L/H 0.8–0.9 in lateral view; eye L/H 0.7–0.8, eyeH/headH 0.6–0.7, eye width/gena width 1.8–2.6 (Fig. 158); gena as wide ventrally as dorsally (Fig. 158); face granulate, setae as long as clypeus height, clypeus W/H 1.8–2.3, clypeus width 0.8–1.0× as long as malar space (Fig. 159). *Wings:* Forewing with middle of RS vein slightly decurved beyond midlength, vein slightly sinuate, rarely nearly straight; RS+Ma unpigmented on basal half and tubular throughout length to unpigmented and thinned on entire length with basal section obsolete; 2M spur 1.8–3.2× as long as RS+Mb; 2-A1 absent, to present as an unpigmented crease on basal half; spur of m-cu absent, first subdiscal cell open (Fig. 160). Hind wing with r-m 0.8–1.1× as long as R; Rs 3.1–5.0× as long as R; apex of R with moderately to slightly developed knob (Fig. 160). *Mesosoma:* Mesoscutum with median groove faint, notauli merged with posteromedial depression on posterior ⅓ (Fig. 161); propodeum with medioapical carinae enclosing a cell, or carinae curved toward each other but with small gap at the apex of the cell (Fig. 162). *Metasoma:* T1 length 1.1–1.6× as long as apical width, lateral margins straight or slightly concave posterior to spiracle, spiracle moderately to strongly protuberant, lateral carinae present on basal half and merged in some specimens with striae or ridges originating at spiracles, to complete to tergum apex, T1 raised between carinae and somewhat distinct from flatter posterolateral corners, striate laterally and apically, (Figs. 163, 164); basal raised area of T2 0.2–0.4 of total T2 length, posterior margin of basal raised area irregular, rarely slightly medially produced; T2 with coarse striae at basal raised area margin to striate or granulostriate on middle half of tergum about 0.8 of distance to posterior margin, rarely smooth with weakly crenulate basal raised area margin, striae longer medially than laterally; T3 0.9–1.1× as long as T2, smooth, with anterior groove partially or entirely crenulate (Fig. 165). *Legs:* Hind femur length 3.1–3.5× maximum width (Fig. 166).

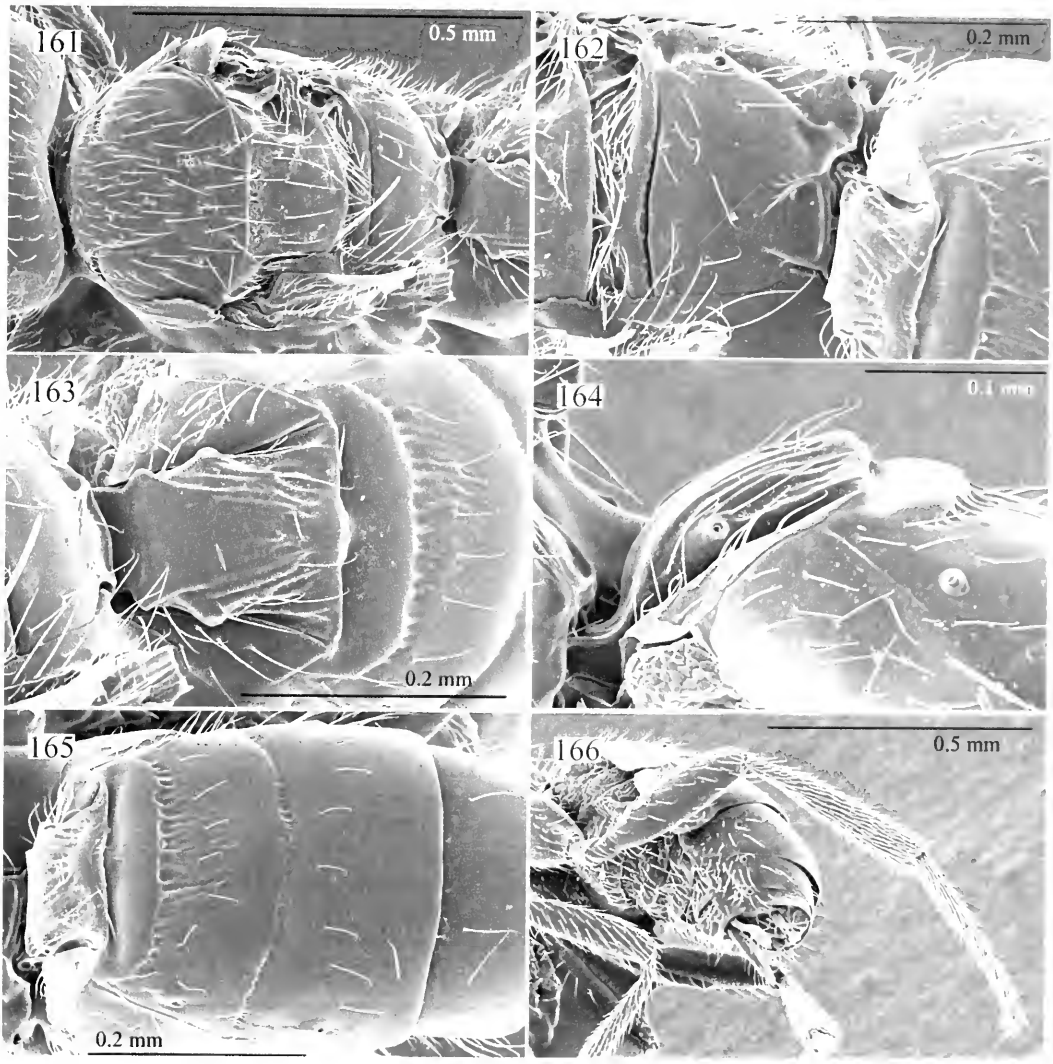
Material examined.—**Bolivia:** Yungas, 50 km N. La Paz, 27-I-1973, 2200m, J. Helava, 1♂ (CNCI). **Brazil: Caruaru:** Pernambuco, VII-1972, M Alvarenga, 1♀ (CNCI). Pernambuco, IV-1972, M Alvarenga, 1♀, 1♂ (CNCI). **Bahia:** Encruzilhada, XI-1974, M. Alvarenga, 2♀, 1♂ (CNCI). **Represa Rio Grande:** Guanabara, VII-1972, F.H. Oliviera, 1♀ (CNCI). **Vila Vera:** M. Grosso, 12° 46′ S, 55° 30′W, X-1973, 500M, M. Alvarenga, 1♀ (CNCI). Para Jacareacanga, XII-1968, M. Alvarenga, 1♀ (CNCI). **Costa Rica: Guanacaste:** Santa Rosa Natl. Park, regenerating woodland <10 years old, direct sun daily, wet, 300m, Malaise trap, 6-27-IX-1986, I. Gauld, 7♀, 10♂ (UWYO). Santa Rosa Natl. Park, (H) open regenerating woodland <10 years old, (O) in clearing, fully isolated part of day, 300m, Malaise trap, 27-IX-18-X-1986 (3♀, 6♂), 26-X-16-XI-1986 (2♂), 14-VIII-6-IX-1986 (2♂), 8-29-XI-1986 (1♂), 29-XI-20-IX-1986 (1♂), 26-X-16-XI-1986 (1♀), I. Gauld D. Janzen, (UWYO). Santa Rosa National Park, regenerating woodland <10 years old, clearing, 300m, Malaise trap, 5-26-VII-1986, I. Gauld, 1♀, 1♂ (UWYO). Santa Rosa Natl. Park, (H) open regenerating woodland





Figs. 156–160. *Pseudognaptodon minutus* (Ashmead). 156, Ocelli in dorsal view. 157, Head in dorsal view. 158, Head in lateral view. 159, Head in anterior view. 160, Wings.

<10 years old, (C) more or less fully shaded as possible, 300m, Malaise trap, 14-VIII-6-IX-1986 (3♀, 3♂), 8-II-2-III-1986 (1♀, 2♂), 2-23-III-1986 (1♀, 1♂), 8-18-III-1986 (2♂), 21-II-14-III-1986 (1♂), I. Gauld D. Janzen, (UWYO). Santa Rosa Natl. Park, (SE) Bosque San Emilio 30yr old deciduous forest, (O) in clearing, fully isolated part of day, 300m, Malaise trap, 26-VII-14-VIII-1986, I. Gauld D. Janzen, 1♂



Figs. 161–166. *Pseudognaptodon minutus* (Ashmead). 161, Mesosoma in dorsal view. 162, Propodeum in dorsal view. 163, T1 of metasoma in dorsal view. 164, T1 of metasoma in lateral view. 165, Anterior end of metasoma in dorsal view. 166, Hind leg.

(UWYO). Santa Rosa Natl. Park, (SE) Bosque San Emilio 30yr old deciduous forest, (C) more or less fully shaded as possible, 300m, Malaise trap, 13-IV-4VI-1986, I. Gauld D. Janzen, 1♂ (UWYO). P.N. Santa Rosa, 200m, I-1991, P. Hanson, 1♂ (UWYO). P.N. Guanacaste, below Pitilla, 500m, 7-8-III-1990, J. Noyes, 2♀ (UWYO). Estac. Pitilla, 9 km S. Santa Cecillia, 700m, V-1989, I Gauld, 6♀, 1♂ (UWYO). **Limon:** 7 km S.W. Bribri, 50m, 1-II-1990, P. Hanson, 2♂ (UWYO). 7 km S.W. Bribri, 50m, 4-VI-1990, P. Hanson, 1♂ (UWYO). 7 km S.W. Bribri, 50m, XI-1989, P. Hanson, 1♂ (UWYO). 16 km W. Guapiles, 400m, 1-IV-1991, P. Hanson, 1♂ (UWYO). **Puntarenas:** Peninsula Osa, Puerto Jimenez, grassy weedy site, 10m, 1-II-1992, P. Hanson, 2♂ (UWYO). Peninsula Osa, Puerto Jimenez, grassy disturbed site, 10m, 10-XI-1991, P. Hanson, 1♀, 1♂ (UWYO). Golfo Dulce, 3 km S.W. Rincon, 10m, XII-1989-I-1990, P.

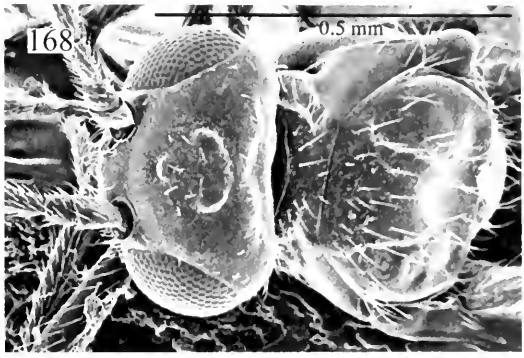
Hanson 1♂ (UWYO). R.F. Golfo Dulce, 24 km W. Piedras Blancas, 200m, III.1993, P. Hanson 2♀ (UWYO). Monteverde, seasonal forest, II-1980, 1400m, W. Mason, 1♀ (CNCI). **Alajuela:** 5 km W. San Ramon, 1200m, X-1997, O. Castro & P. Hanson, 1♀, 1♂ (UWYO). 5 km W. San Ramon, 1200m, II-1997, O. Castro & P. Hanson, 1♂ (UWYO). San Pedro de la Tigra Cacao, 200m, 1-II-1990, R. Cespedes, 1♀ (UWYO). **San Jose:** San Antonio de Escazu, 1300m, IV-1999, W. Eberhard, 1♀, 3♂ (UWYO). Cuidad Colon, 800m, III-IV-1990, L. Fournier, 1♂ (UWYO). Cuidad Colon, 800m, XII-1989-I-1990, L. Fournier, 1♀ (UWYO). Zurqui de Moravia, 1600m, X-1995, P. Hanson, 1♂ (UWYO). Zurqui de Moravia, 1600m, 24-XII-1988, P. Hanson, 1♂ (UWYO). Zurqui de Moravia, 1600m, Malaise, II-1996, P. Hanson, 1♀ (UWYO). **Heredia:** 3 km S. Puerto Viejo, OTS-La Selva, 100m, V-VI-1993, P. Hanson, 1♀, 3♂ (UWYO). 3 km S. Puerto Viejo, OTS-La Selva, 100m, IV-1991, P. Hanson, 1♂ (UWYO). **Carthago:** Dulce Nombre, Vivero Linda Vista, 1300m, VII-IX-1994, P. Hanson, 1♀ (UWYO). La Cangreja, 1950m, VII-1991, P. Hanson, 1♀ (UWYO). **Ecuador: Napo:** Limoncocha, 15-28-VI-1976, S&J Peck, 1♂ (CNCI). 5 km S. Baeza, 13-II-1983, 1700m, Masner & Sharkey, 1♀ (CNCI). **Pich.:** S. Domingo, 16 km S. Tinalandia, 15-30-VI-1975, 680m, S. Peck, 1♀ (CNCI). Rio Palenque R.S., 4-II-1983, 200m, Masner & Sharkey 1♀ (CNCI). **Mexico: Guerrero:** 32 mi S.E. Petalan, 10-VII-1985, Woolley & Zolnerowich, 2♀, 1♂ (TAMU). 2 mi N. Cacahuamilpa, 19-VII-1984, J. Woolley, 1♂ (TAMU). 2 mi N. Cacahuamilpa, 5300', 4-VII-1987, R. Wharton, 1♂ (TAMU). **Jalisco:** 16 mi S. Autlan on Hwy. 80, 8-VII-1984, J. Woolley, 1♀ (TAMU). 5.4 mi N. Autlan 7-VII-1984, Schaffner Woolley Carroll Friedlander, 1♂ (TAMU). **Oaxaca:** 4.4 mi N.E. San Pedro Mixtepec, 16-VII-1985, Woolley & Zolnerowich, 3♀, 3♂ (TAMU). 2 mi N. Candelaria Loxicha, 17-VII-1985, J. Woolley G. Zolnerowich, 4♂ (TAMU). **Sinaloa:** 20 mi E. Concordia, 12-VIII-1964, 3000m, W. Mason, 1♂ (CNCI). **Peru:** Cuzco, 13° 40'S, 70° 40'W, 18-I-1973, J.Helava, 1♀ (CNCI). **Suriname:** Kobo forest Reserve, S.W. of line 391, Malaise trap, 1-5-IX-1978, E. Nee... (hand written label, collector name illegible), 1♀ (RNHL).

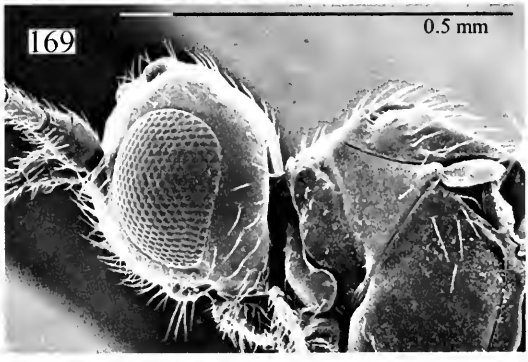
Pseudognaptodon nitidus Williams, new species

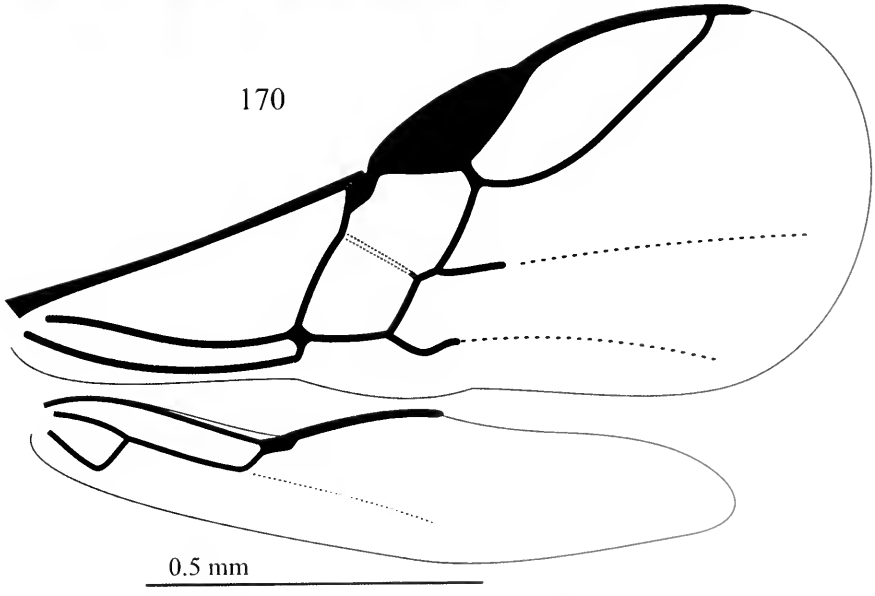
(Figs. 167–176)

Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Vertex of head smooth, or with obsolete granulate microsculpture (Figs. 167, 188); ocellar triangle large, interocellar distances longer than POD (Fig. 167); base of T1 of metasoma separated from remainder by a transverse ridge or sharp convexity, apex irregularly rugose (Fig. 173); T2 of metasoma with coarse striae on basal half or more posterior to basal raised area; T3 of metasoma medially striate on base, with anterolateral corners defined by bands of sculpture (Fig. 175).

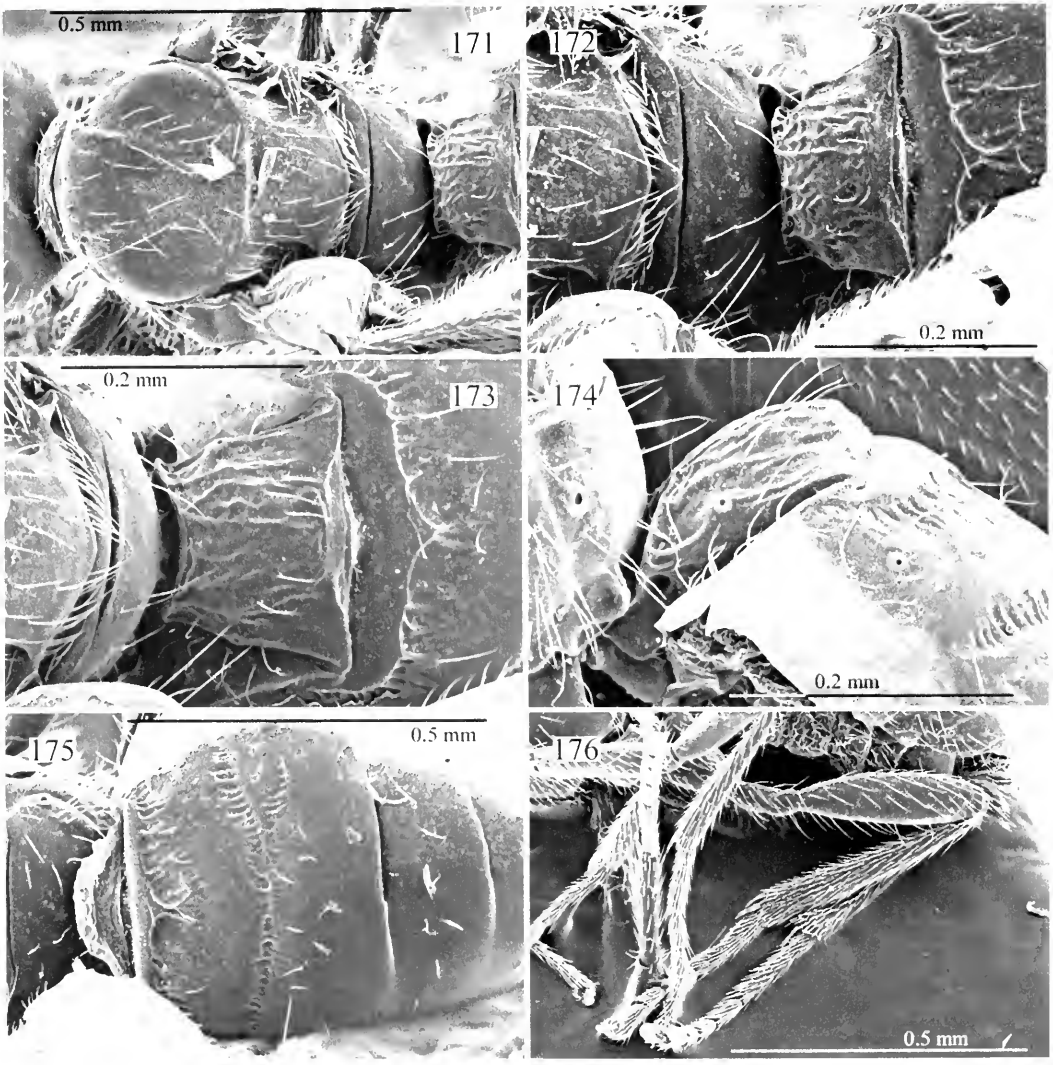
Female.—*Color:* Body medium to dark brown except for the following: Scape and pedicel yellow; mesosoma with lighter brown area on pronotal collar and ventral portion of mesopleuron in some specimens; legs yellow, except hind tarsus light brown. *Head:* Length of antennal scape 1.6× width; flagellum with 14–16 flagellomeres: L/W of first three flagellomeres 2.9–3.0, 2.8–2.9, 2.7; L/W of apical flagellomere 3.3; MOD 0.8× as long as POD; POD 0.8–0.9× as long as LOL, and 0.7× as long as POL (Fig. 137); OOL 1.6–1.8× as long as POL (Fig. 168); vertex smooth or with very faint granular microsculpture; head length 0.7× width in dorsal view; occiput broadly but unevenly indented (Fig. 168); head L/H 0.9 in lateral view; eye L/H 0.6–0.7, eyeH/headH 0.7, eye width/gena width 1.9 (Fig. 169); gena wider ventrally than dorsally (Fig. 169); face granulate with a narrow median polished ridge on dorsal half, setae shorter







Figs. 167–170. *Pseudognaptodon nitidus*. 167, Ocelli in dorsal view. 168, Head in dorsal view. 169, Head in lateral view. 170, Wings.



Figs. 171–176. *Pseudognaptodon nitidus*. 171, Mesosoma in dorsal view. 172, Propodeum in dorsal view. 173, T1 of metasoma in dorsal view. 174, T1 of metasoma in lateral view. 175, Anterior end of metasoma in dorsal view. 176, Hind leg.

than clypeus height, clypeus W/H 2.3, clypeus width 1.1× as long as malar space. *Wings:* Forewing with RS vein slightly sinuate on apical half; RS+Ma unpigmented, tubular except extreme base, obsolete; 2M spur 2.0–2.5× as long as RS+Mb; 2-A1 present as a crease on basal ⅓; spur of m-cu absent, first subdiscal cell open (Fig. 170). Hind wing with r-m 0.9–1.0× as long as R; Rs 3.5–4.5× as long as R; apex of R with well developed knob (Fig. 170). *Mesosoma:* Mesoscutum with median groove absent, notauli merged with one another on anterior margin of posteromedial depression (Fig. 171); propodeum with basal cell complete, somewhat transverse and slightly raised, carinae more developed laterally than at cell apex (Fig. 172). *Metasoma:* T1 length 1.1× as long as apical width, lateral margins slightly concave posterior to spiracle, spiracle slightly protuberant, lateral carinae

present on basal ⅓, joined medially by a transverse ridge that defines a semicircular basal smooth area; T1 coarsely irregularly striate throughout and very convex, except for basal area, (Figs. 173, 174); anterior basal raised area of T2 0.3 of length, posterior margin of basal raised area evenly curved to slightly irregular, crenulate, and medially produced, T2 striate on basal half most of tergum posterior to basal raised area except for a narrow apical band; T3 0.9× as long as T2, striate medially on basal ⅓, with anterior groove crenulate, and anterolateral areas delimited by narrow bands of sculpture (Fig. 175). *Legs:* Hind femur length 2.9× maximum width (Fig. 176).

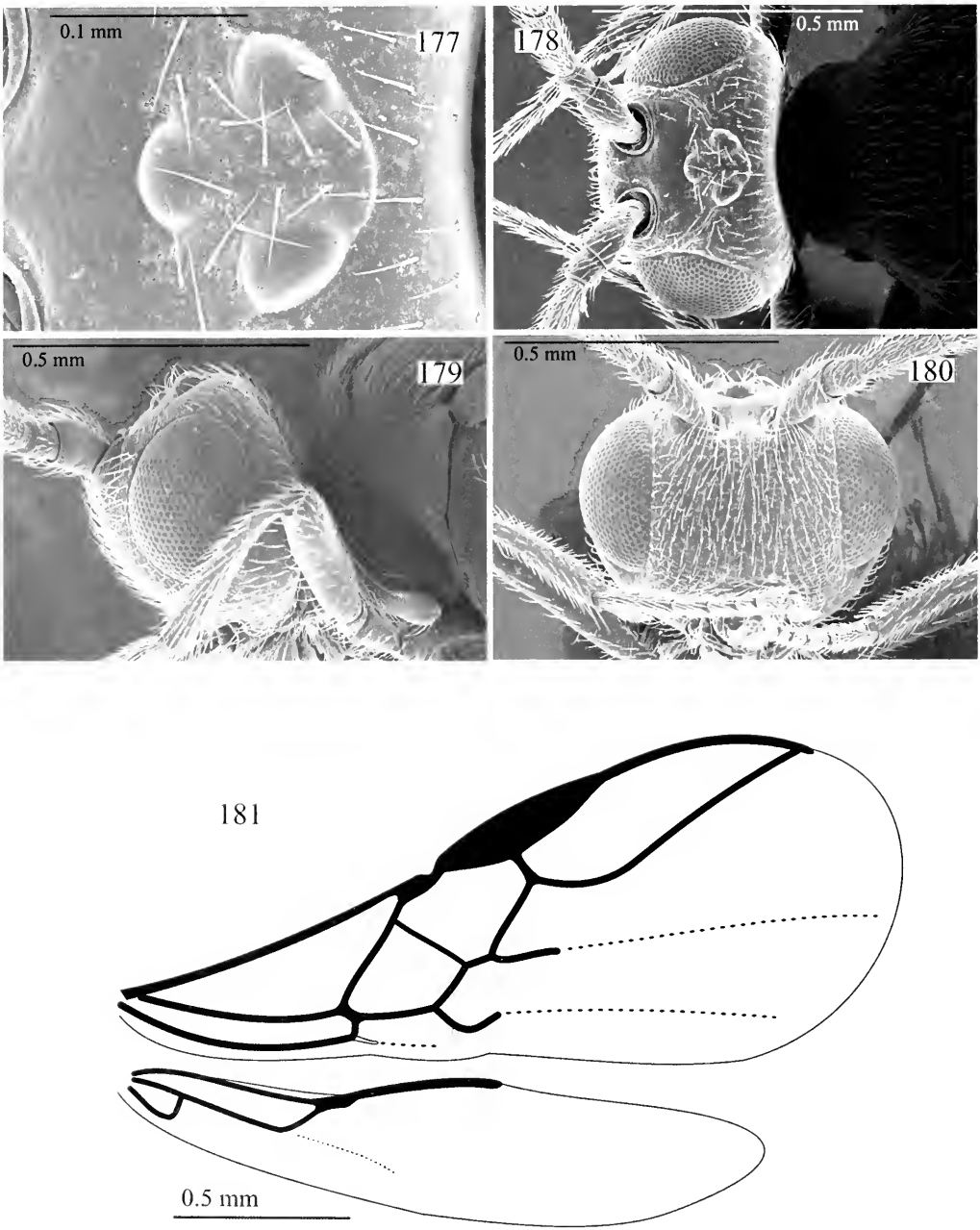
Material examined.—HOLOTYPE ♀ (UWYO), labelled as follows: upper label "Costa Rica: Guanacaste Santa Rosa Natl. Park 300m ex. Malaise trap site#: 1 Dates: 18-i.8-ii 1986 I.D. Gauld & D. Janzen" lower label "(H) open regenerating woodland <10 years old, (O) in clearing, fully isolated part of the day". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon nitidus* Williams Holotype det. D. Williams 2003". PARATYPES: **Costa Rica: Guanacaste:** Santa Rosa Natl. Park, 300m, (H) open regenerating woodland <10 years old, (C) more or less fully shaded as possible, Malaise trap, 26-VII-14-VIII-1986, I. Gauld D. Janzen, 1♀ (UWYO). **San Jose:** San Antonio de Escazu, 1300m, IV-1999, W. Eberhard, 1♀, 1♂ (UWYO).

Etymology.—The name *nitidus* refers to the smooth appearance of the vertex in this species, which resembles the state in *omissus*-group species but is rare in the *curticauda*-group.

Pseudognaptodon shawi Williams, new species
(Figs. 177–187)

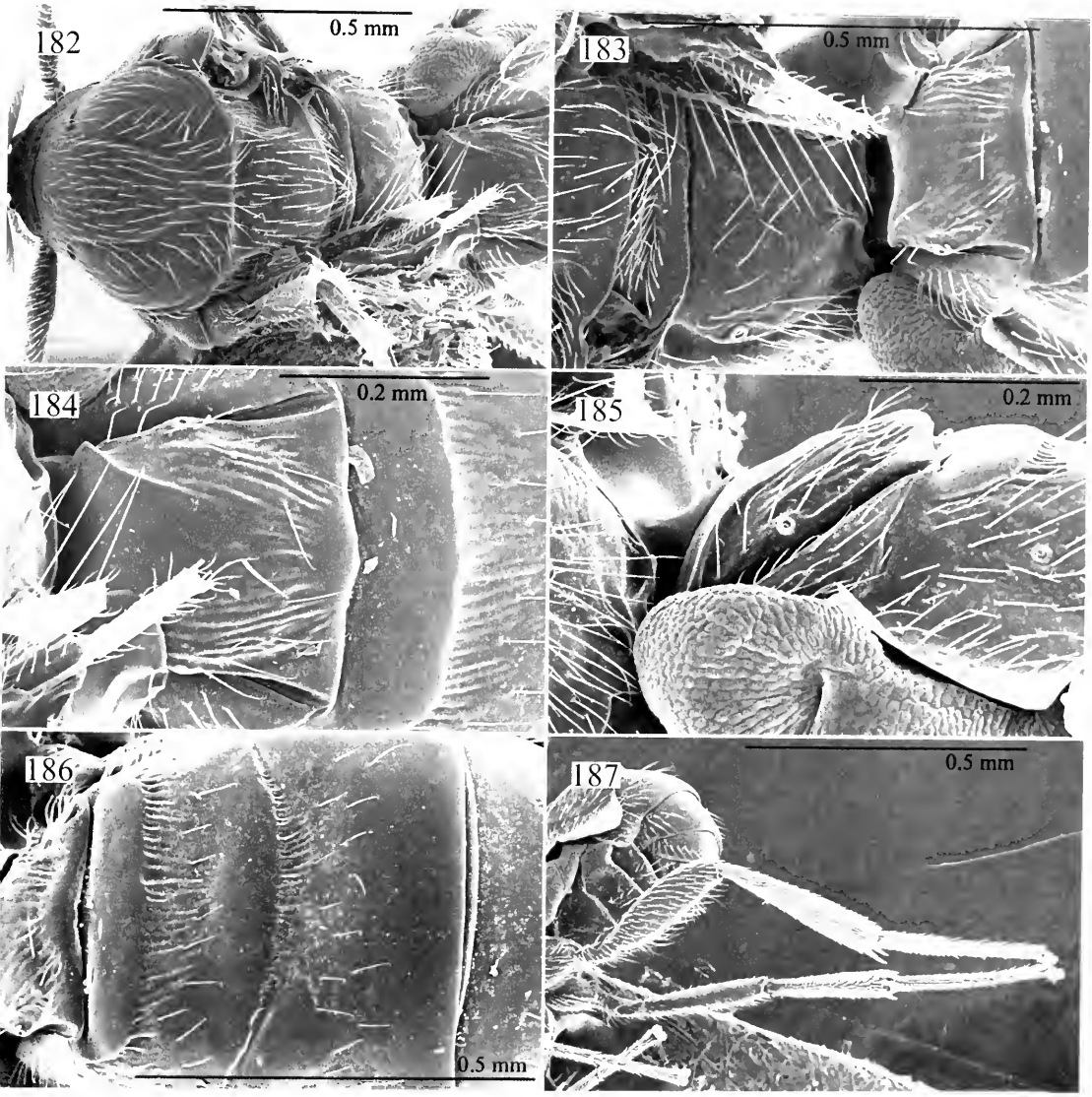
Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Ocelli as long as or longer than inter-ocellar distances (Fig. 177); T3 of metasoma with deeply impressed, crenulate, laterally decurved anterior groove, widened medially with a narrow band of striae extending posteriorly (Fig. 186); forewing 2-A1 vein pigmented for most of length, first subdical cell closed by veins and pigmented creases (Fig. 181).

Female.—Color: Body black except for the following: Scape yellow, pedicel light brown; pronotal collar light orange-brown; legs yellow, apical tarsomeres, base of hind coxa, and entire hind tarsus light brown, rarely with dorsal surface of femur and apex of tibia light brown. *Head:* Length of antennal scape 1.7–1.9× width; flagellum with 17–19 flagellomeres: L/W of first three flagellomeres 2.7–2.8, 2.4–2.5, 2.4–2.5; L/W of apical flagellomere 2.8–3.3; MOD 0.8–0.9× as long as POD and longer than LOL and POL; POD 1.3–1.7× as long as LOL, and 1.0–1.3× as long as POL (Fig. 177); OOL 2.0–2.5× as long as POL (Fig. 178); vertex with obsolete granular microsculpture and well developed grooves or wrinkles between lateral ocelli and dorsal margin of eye (Fig 178); head length 0.6–0.7× width in dorsal view; occiput narrowly indented (Fig. 178); head L/H 0.6–0.8 in lateral view; eye L/H 0.6–0.7, eyeH/headH 0.6–0.7, eye width/gena width 1.5–1.8 (Fig. 179); gena wider ventrally than dorsally (Fig. 179); face granulate with median polished stripe, setae shorter than clypeus height; clypeus W/H 2.6, clypeus width 1.2× as long as malar space (Fig 180). *Wings:* Forewing with RS vein decurved beyond midlength, slightly sinuate; RS+Ma pigmented and tubular, slightly thinner at base; 2M spur 2.5–3.0× as long as RS+Mb; 2-A1 present as a tubular spur at base and faintly pigmented crease over most of length; spur of m-cu present as a faintly pigmented line, first subdiscal cell closed (Fig. 181). Hind wing with r-m 1.1–1.3× as long as R; Rs 3.5–4.2× as long as R; apex of R with well developed knob (Fig. 181). *Mesosoma:* Mesoscutum with median groove absent, notauli deeply impressed, joining in a U pos-



Figs. 177–181. *Pseudognaptodon shawi*. 177, Ocelli in dorsal view. 178, Head in dorsal view. 179, Head in lateral view. 180, Head in anterior view. 181, Wings.

teriorly in some specimens, posteromedial depression small (Fig. 852); propodeum with basal carinae convergent, ending in several fine wrinkles, cell broadly open (Fig. 183). *Metasoma:* T1 length 1.1× as long as apical width, lateral margins slightly concave posterior to spiracle, spiracle slightly protuberant, lateral carinae present on basal half, rarely merged with coarse striae on apical half; T1 striate on



Figs. 182–187. *Pseudognaptodon shawi*. 182, Mesosoma in dorsal view. 183, Propodeum in dorsal view. 184, T1 of metasoma in dorsal view. 185, T1 of metasoma in lateral view. 186, Anterior end of metasoma in dorsal view. 187, Hind leg.

apical half and lateral to carinae, (Figs. 184, 185); basal raised area of T2 0.2–0.× of total T2 length, posterior margin of basal raised area irregular, slightly sinuate or evenly curved; basal raised area margin crenulate, coarsely striae on basal half to most of tergum posterior to basal raised area, striae longer medially than laterally; T3 0.9–1.0× as long as T2, with anterior groove crenulate, deeply impressed, decurved laterally, and merged with a narrow band of coarse striae medially, striae extending onto disc of T3 (Fig. 186). *Legs*: Hind femur length 3.4–3.6 maximum width (Fig. 187).

Material examined.—HOLOTYPE ♂ (UWYO), labelled as follows: "Costa Rica: San Jose:Zurqui de Moravia 1600m vii-1992 Col. Paul Hanson". Also red label "HOLOTYPE" and bordered label "*Pseu-*

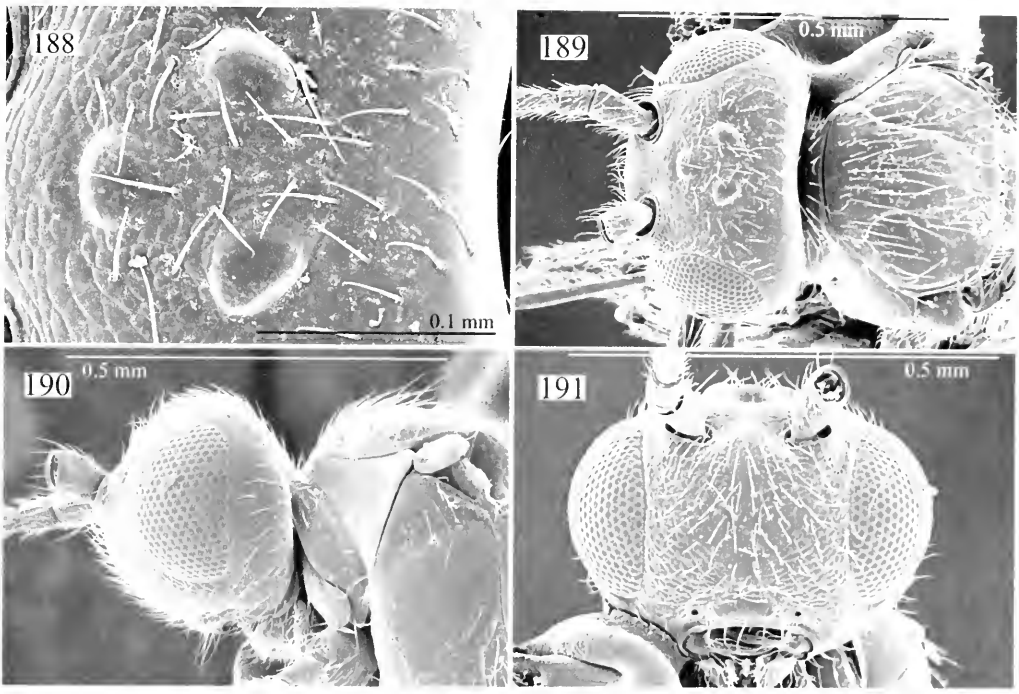
dognaptodon shawi Williams Holotype det. D. Williams 2003". PARATYPES: **Alajuela:** 5 km W. San Ramon, 1200m, X-1996 (1♂), XII-1996 (1♂), II-1997 (1♂), IV-1997 (3♂), X-1997 (1♀, 3♂), VII-1997 (3♂), O. Castro, P. Hanson, (UWYO). **Guanacaste:** ACT Bagaces, P.N. Palo Verde Sec. P Verde, 200 N.E. Est., Extremo E. de Cameo de Atterizaje, Malaise, 0–50m, 8-XI-9-XII-1999, I. Jiminez, 1♂ (UWYO). Guanacaste Conservation Area, Santa Rosa Hdq., Malaise, 200m, 3-7-VII-1997, L. van der Ent, 1♂ (UWYO). **San Jose:** P.N. Braulio Carillo, 9.5 km E. Tunel, 1000m, 1-III-1990, P. Hanson, 1♀ (UWYO). **Ecuador: Napo:** Baeza, 9-12-II-1983, L. Huggert, 1♀ (RNHL).

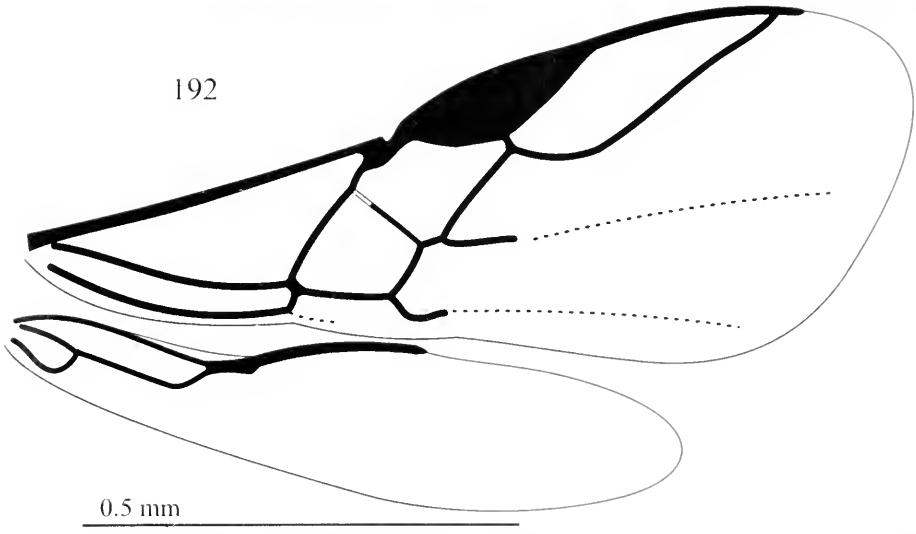
Etymology.—This species is named for Scott Shaw, who has been one of the major contributors of specimens to this study.

Pseudognaptodon whartoni Williams, new species
(Figs. 188–198)

Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Metasoma medium to dark brown apically, yellow to light brown on lateral margins or most of first two or three terga; T1 of metasoma slightly wider apically than long, granulostriate (Fig. 195); T2 of metasoma finely granulate, near apex of basal raised area to most of tergum disc in a semicircular pattern (Fig. 197).

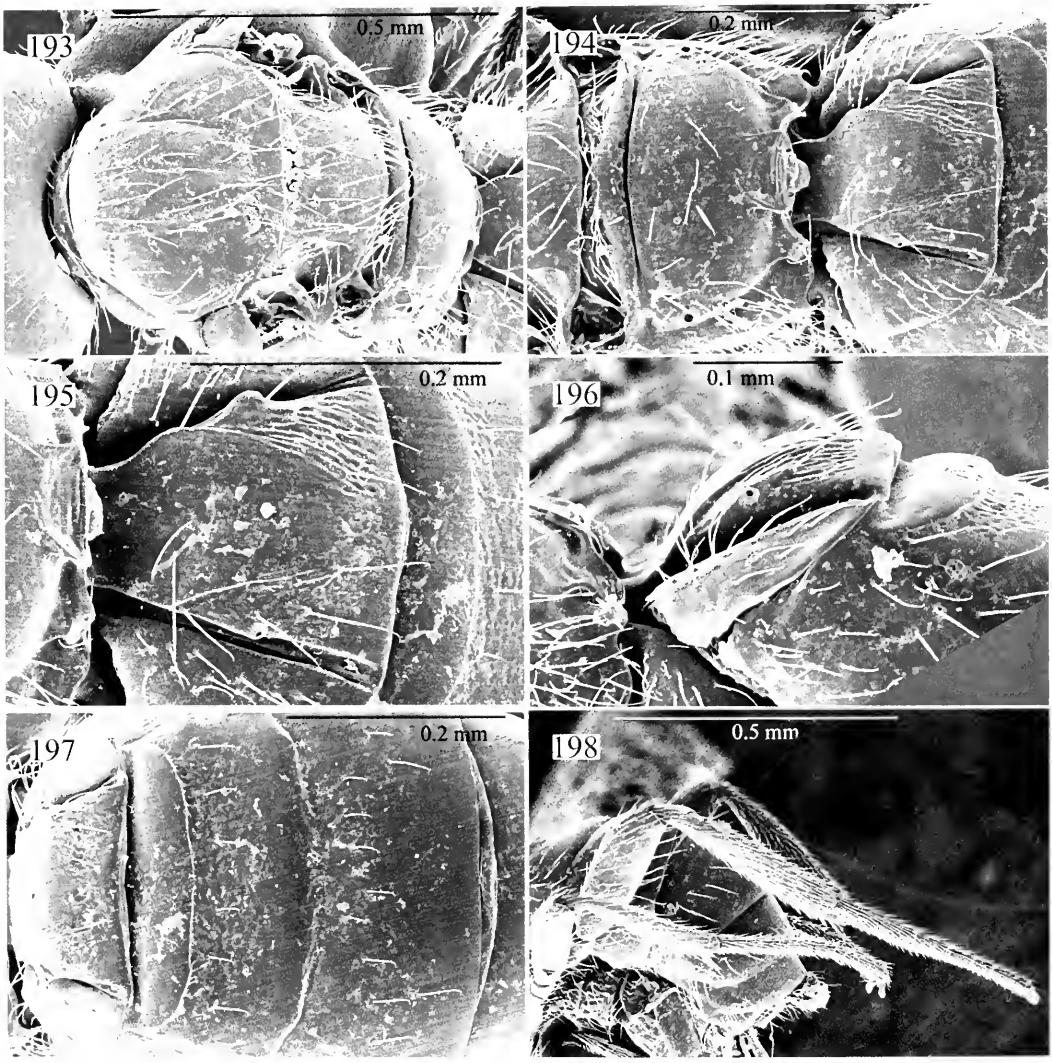
Female.—Color: Body dark brown to black except as follows: Scape yellow; clypeus yellow to light orange-brown in some specimens; pronotal collar light orange-brown in some specimens; mesopleuron with lighter bands in some specimens; T1 and T2 of metasoma light brown laterally to entirely yellow on first three metasomal terga; legs yellow with light brown hind tarsus, apical tarsomeres and apex of hind tibia darker in some specimens. *Head:* Length of antennal scape 1.5–1.9× width; flagellum with 15–19 flagellomeres; L/W of first three flagellomeres 2.1–3.7, 2.1–2.8, 1.9–2.7; L/W of apical flagellomere 2.3–2.8; MOD 0.8–0.9 POD; POD 0.8–1.0× as long as LOL, and 0.7–0.9× as long as POL (Fig. 188); OOL 1.3–2.0× as long as POL (Fig. 189); vertex with well developed granular sculpture anterior to ocelli, very fine, incomplete suture or fine wrinkles present between lateral ocelli and dorsal eye margin (Fig 189); head length 0.6–0.7× width in dorsal view; occiput shallowly, evenly indented, head somewhat C-shaped in dorsal view (Fig. 189); head L/H 0.6–0.8 in lateral view; eye L/H 0.6–0.7, eyeH/headH 0.6–0.7, eye width/gena width 1.5–1.9 (Fig. 190); gena parallel sided (Fig. 190); face completely granulate to a small polished area dorsal of clypeus and a narrow median polished strip, setae shorter than or as long as clypeus height, clypeus W/H 1.8–2.2, clypeus width 0.9–1.2× as long as malar space (Fig. 191). *Wings:* Forewing with RS vein decurved apically; RS+Ma unpigmented on basal ⅓ to entire length and tubular throughout length, rarely thinned on basal ½, longer than 1M; 2M spur 2.5–5.3× as long as RS+Mb; 2-A1 absent to present as an unpigmented crease on basal half; spur of m-cu absent, first subdiscal cell open (Fig. 192). Hind wing with r-m 0.9–1.3× as long as R; Rs 3.4–4.6× as long as R; apex of R moderately to well developed knob (Fig. 192). *Mesosoma:* Mesoscutum with median groove absent to faint, notauli merged with one another on anterior margin of posteromedial depression (Fig. 193); propodeum with medioapical carinae straight, parallel, and widely separated, rarely with irregular very fine wrinkles or transverse obsolete carina enclosing a compressed cell (Fig. 194). *Metasoma:* T1 length 0.9–1.1× as long as apical width, lateral margins slightly concave to straight posterior to spiracle, spiracle not protuberant, lateral carinae present on basal ⅓ to complete to apex or nearly so, in some specimens continuous with lateral margins of a weakly raised medial area; T1 granulos-





Figs. 188–192. *Pseudognaptodon whartoni*. 188, Ocelli in dorsal view. 189, Head in dorsal view. 190, Head in lateral view. 191, Head in anterior view. 192, Wings.

triate on apical half and lateral to carinae, rarely somewhat more granulate between carinae and striate laterally (Figs. 195, 196); basal raised area of T2 0.3–0.4 of total T2 length, posterior margin of basal raised area evenly curved, slightly medially produced or toothed in some specimens; basal raised area margin smooth to slightly



Figs. 193–198. *Pseudognaptodon whartoni*. 193, Mesosoma in dorsal view. 194, Propodeum in dorsal view. 195, T1 of metasoma in dorsal view. 196, T1 of metasoma in lateral view. 197, Anterior end of metasoma in dorsal view. 198, Hind leg.

crenulate, granulate on most of tergum posterior to basal raised area in a semicircular pattern; T3 0.8–1.0× as long as T2, smooth, with anterior groove smooth to weakly crenulate, rarely with groove wider medially (Fig. 197). *Legs:* Hind femur length 3.0–3.8× maximum width (198).

Hosts: Reared from *Nepticula sp.* and *Coptodisca sp.* (Lepidoptera: Nepticulidae) on *Myrica certifera* (Fagales: Myricaceae).

Material examined.—HOLOTYPE ♀ (TAMU), labelled as follows: "Texas: Brazos Co. College Station Lick Creek Park November 1–14, 1987 R. Wharton Malaise". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon whartoni* Williams Holotype det. D. Williams 2003". PARATYPES: **USA: Texas: Brazos Co.:** College Station, Lick Creek Park, Malaise, 1-14-XI-1987 (4♀, 4♂), 20-IX-4-X-1987 (3♀,

7♂), 4-18-X-1987 (3♀, 1♂), R. Wharton, (TAMU). College Station, Lick Creek Park, 16-III-9-IV-1988 (1♂), 16-31-V-1988 (2♀), 22-XI-6-XII-1987 (2♀), 2-16-V-1988 (1♀), 13-18-V-1988 (1♂), Wharton, Praetorius, (TAMU). College Station, Lick Creek Park, 3-9-X-1988 (2♂), 11-18-IX-1988 (2♀, 1♂), 11-18-X-1988 (2♀, 2♂), 18-30-X-1987 (2♀, 3♂), 23-X-6-XI-1988 (3♀, 1♂), 7-20-XI-1988 (2♀), R. Wharton, (TAMU). College Station, Lick Creek Park, dissected, 14-IX-1990, R. Wharton, 1♀, 1♂ (TAMU). Lick Creek Park, 22-30-VI-1987, J Heraty J. Woolley, 1♂ (TAMU). **Harris Co:** Bear Cr. Pk., ex. *Nepticula* on *Myrica certifera*, JAP No. 82M13, 28-XII-1982, D. Wagner, 1♀, 1♂ (JWCI). Bear Cr. Pk., ex. *Coptodisca* on *Myrica certifera*, JAP No. 82M14, 28-XII-1982, D. Wagner, 1♀ (JWCI). **Montgomery Co.:** Jones State Forest, 8 mi S. Conroe, 8-19-IX-1987, Wharton, Carroll, Praetorius, 1♀, 2♂ (TAMU); 18-31-X-1987, Wharton, Praetorius, 2♀, 1♂ (TAMU); 1-6-IX-1987, Wharton, Steck Carroll, 2♀ (TAMU); 20-26-IV-1987, Wharton, Praetorius, Wang, 1♀ (TAMU); 13-19-IV-1987, Wharton, Praetorius, Wang, 2♂ (TAMU); 1-7-VI-1987, Wharton, Steck, Carroll Wang, 1♂ (TAMU); 9-16-VIII-1987, Wharton, Steck, Carroll, 1♀ (TAMU). **Bandera Co.:** Lost Maples State Park, 18-VIII-1988, G. Zolnerowich, 2♀, 1♂ (TAMU). Lost Maples State Park, 22-VIII-1987, R. Wharton, 1♂ (TAMU). **Travis Co.:** Austin, 8-X-1983, R. Wharton, 1♂ (TAMU). **Bosque Co.:** 3 mi W. Laguna Park, 13-IV-1984, R. Wharton J. Woolley, 1♀, 1♂ (TAMU). **Tyler Co.:** Kirby State Forest, 3 mi S. Warren, 22-V-1984, J. Woolley, 1♀ (TAMU). **Walker Co.:** Stubblefield Lake, 7-VI-1985, R. Wharton 1♀ (TAMU). **Kerr Co.:** Center Point, Mal[illegible]ise trap, 26-VII-2-VIII-1987, Wharton, [illegible]raetorius, 2♀ (TAMU). **Gonzales Co.:** [illegible]lmetto State Pk., 1-IV-1984, J. Woolley, [illegible] 1♂ (TAMU). **Harrison Co.:** 9 mi S. [illegible]rshall, [illegible]7-VII-1982, R. Wharton, 1♀ [illegible]AMU). OTHER SPECIMENS EXAM[illegible]D: **Bra[illegible]**: **Ceará:** Barbalha, V-1969, 1♀ [illegible]CI). B[illegible]a: Encruzilhada, IX-1974, M. Alvarenga, 2♀ (CNCI). **Jatai:** Goias, XI-1972, F.M. Oliviera, 1♀, 1♂ (CNCI). **Canada: Ontario:** Aylmer West, 23-27-VII-1972, Malaise Trap, 1♂ (CNCI). **Dominican Republic:** El Rio (La Vega), 17-III-1978, 1000m, L. Masner, 1♀ (CNCI). **USA: Arkansas: Mountain Pine:** L. Ouachita State Park, V-1972, G. Heinrich, Malaise Trap, 1♀ (CNCI). **Florida: Alachua:** Gainesville, DPI, 1-23-VI-1987, J. Wiley, Malaise Trap, 2♀ (CNCI). **Georgia:** Forsyth, 1-8-X-1970 (3♀), 25-VII-1970 (1♀), 25-X-1970 (1♀), 20-XI-1970 (1♀, 1♂), VII-1970 (1♀), 7-IX-1970 (1♀, 1♂), 23-30-VIII-1970 (3♀), F.T. Naumann, Malaise trap, (CNCI). **Louisiana: Evangeline Co.:** Bayou Chicot, 15-V-4-VI-1971, D. Shanek, 2♀ (CNCI). **Nachitoches:** 20 mi W. Gorum, 3-18-V-1989, R. Wharton, 1♀ (TAMU). **County?:** Lake Bistineau State Park, 15-18-IV-1972, G. Heinrich, Malaise Trap, 1♀ (CNCI). Lake Bistineau State Park, 22-27-IV-1972, G. Heinrich, Malaise Trap, 1♂ (CNCI). **Maryland:** Laurel, 11-V-1965, Malaise Trap, 1♂ (CNCI). **Missouri:** Williamsville, 10-IX-5-X-1969, J.T. Becker, 1♂ (CNCI). Williamsville, 15-VII-10IX-1969, J.T. Becker, 1♀ (CNCI). Williamsville, X-VII?-1969, E.C. Becker, 1♂ (CNCI). **North Carolina:** Highlands, 3-VI-1957, 3800', J.R. Vockeroth, 1♂ (CNCI). **Oklahoma: Lati. Co.:** 4 mi W. Red Oak, sweep, 1-4-VII-1987, D. Chandler, 1♀ (UWYO). **Tennessee: Lexington:** Natchez Trace State Park, 11-15-VI-1972 (1♀, 1♂), 15-19-VI-1972 (1♀), VI-1972 (1♂), G. Heinrich, Malaise Trap, (CNCI). **Mexico: Michoacan:** 10 mi S. Urupan, 7-VII-1985, J. Woolley, G. Zolnerowich, 3♀ (TAMU). **Nuevo Leon:** 29 mi W. Linares, S. Rosa Cyn, 730m, 3-VI-1983, M. Kaulbars, 1♀ (CNCI). **Sinaloa:** 20 mi E. Concordia, 3000', 8-VIII-1964, W.R.M. Mason, 1♂ (CNCI). **Costa Rica: San Jose:** Cuidad Colon, 800m, VI-VII-1990, Luis Fournier, 1♀ (UWYO). **Guanacaste:** Guanacaste Conservation Area, Santa Rosa Hdq., Malaise, 200m, 373-VII-1997, L. van der Ent, 1♀ (UWYO). Santa Rosa Natl. Park, Malaise trap, (H) open regen-

erating woodland <10 years old, (O) in clearing, fully isolated part of day, 14-VI-5-VII-1986, I. Gauld, D. Janzen, 1♀ (UWYO). Santa Rosa Natl. Park, Malaise trap, (H) open regenerating woodland <10 years old, (C) more or less fully shaded as possible, 10-31-I-1987, I. Gauld, D. Janzen, 2♂ (UWYO). P.N. Santa Rosa, 200m, I-1991, P. Hanson, 1♀ (UWYO).

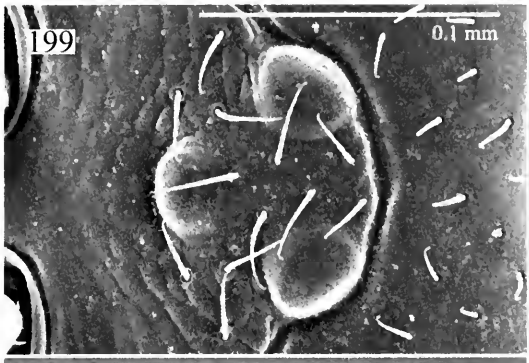
Remarks.—This species is distributed from Canada to Brazil. Specimens are realativel uniform in appearance, although there is variation in color, the size of ocelli, and the shape and sculpture of the first metasomal tergum in specimens from the northern and southern extremes. Because if this I have selected the type series only from the central part of the range in Texas and Mexico.

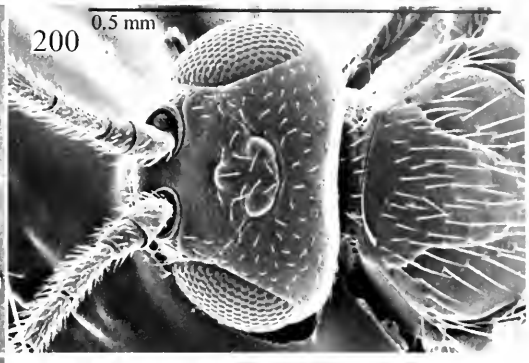
Etymology.—This species is named for Robert Wharton, who collected the holotype and most of the specimens of this species, who has been one of the major contributors of specimens to this study, and who has been patient while I retained specimens needed for his work on other Gnamptodontinae.

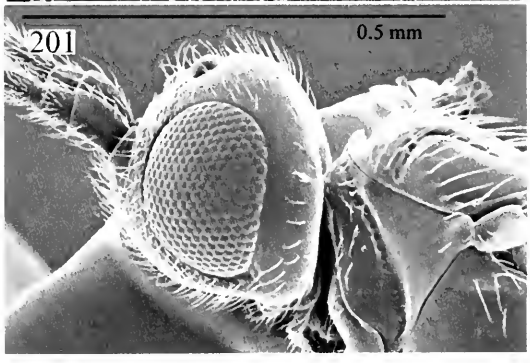
Pseudognaptodon whitfieldi Williams, new species
(Figs. 199–208)

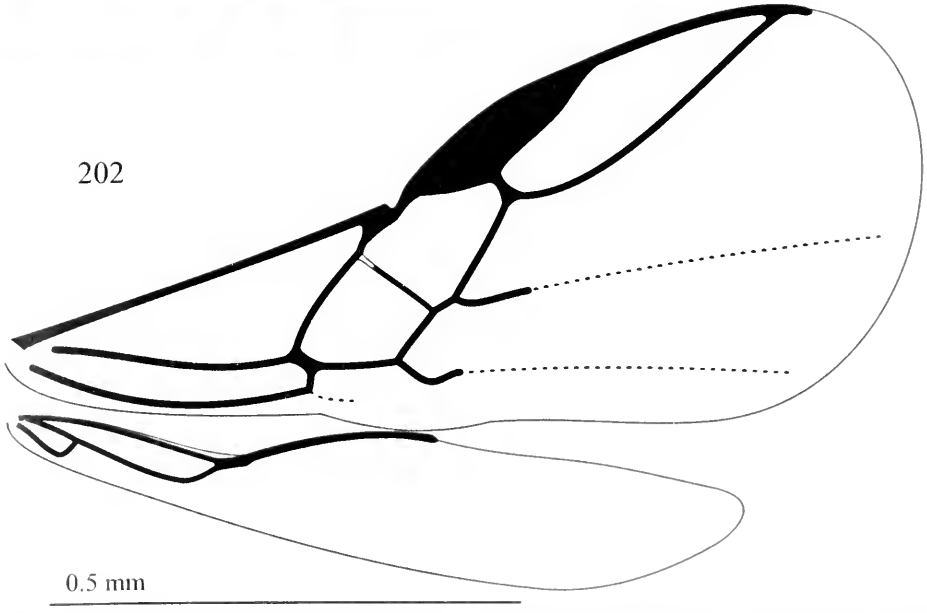
Diagnosis.—This species is separated from other *curticauda*-group species by the following combination of characters: Vertex of head with weak granular microsculpture; LOL as long as or shorter than LOD (Fig. 200); T2 of metasoma almost entirely covered by coarse striae except for narrow apical band; T3 of metasoma medially striate on basal ⅓, with polished anterolateral corners defined by bands of sculpture (Fig. 207).

Female.—Color: Body medium to dark brown except for the following: Scape and pedicel yellow; legs yellow, except hind tarsus light brown. *Head:* Length of antennal scape 1.8× width; flagellum with 14–16 flagellomeres: L/W of first three flagellomeres 2.9–3.0, 2.8–2.9, 2.7; L/W of apical flagellomere 3.3; MOD 0.8× as long as POD; POD 1.0–1.3× as long as LOL, and 1.0–1.1× as long as POL (Fig. 199); OOL 2.0–2.3× as long as POL; vertex with well developed granular microsculpture (Fig. 200); head length 0.7× width in dorsal view; occiput broadly evenly indented (Fig. 200); head L/H 0.8–0.9 in lateral view; eye L/H 0.6–0.7, eyeH/headH 0.7, eye width/gena width 1.7–1.8 (Fig. 201); gena wider ventrally than dorsally (Fig. 201); face granulate with a narrow median polished ridge on dorsal half, setae shorter than clypeus height, clypeus W/H 2.3, clypeus width 1.1× as long as malar space. *Wings:* Forewing with RS vein straight or slightly sinuate on apical half; RS+Ma pigmented and tubular except extreme base obsolete; 2M spur 3.0–3.3× as long as RS+Mb; 2-A1 present as a crease on basal ⅓; spur of m-cu absent, first subdiscal cell open (Fig. 202). Hind wing with r-m 1.3× as long as R; Rs 4.5–5.0× as long as R; apex of R with poorly developed knob (Fig. 202). *Mesosoma:* Mesoscutum with median groove present but faint near posteromedial depression, notauli merged with one another on anterior margin of posteromedial depression (Fig. 203); propodeum with basal cell complete, somewhat transverse, carinae more developed laterally than at cell apex (Fig. 204). *Metasoma:* T1 length 1.1–1.3× as long as apical width, lateral margins slightly concave posterior to spiracle, spiracle slightly protuberant, lateral carinae complete to apex but merged with coarse striae and ridges originating from spiracles on very convex medioapical area; T1 coarsely striate throughout except for basal area between carinae (Figs. 205, 206); basal raised area of T2 0.3 of total T2 length, posterior margin of basal raised area evenly curved or slightly irregular and medially concave; basal raised area margin crenulate, striate on most of tergum posterior to basal raised area except for a narrow apical band; T3 0.9–1.1× as long as T2, striate medially on basal ⅓, with anterior groove crenulate, and anterolateral smooth areas delimited

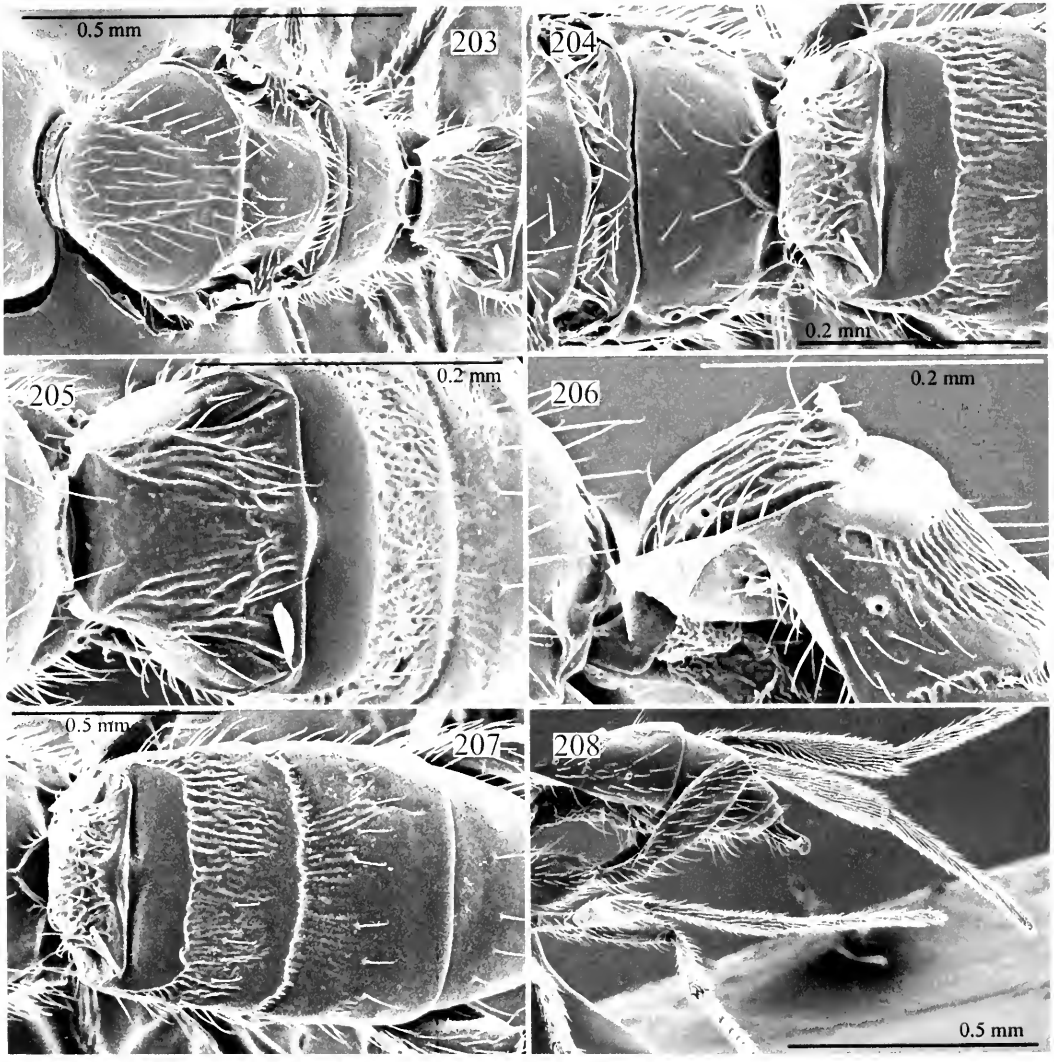








199–202. *Pseudognaptodon whitfieldi*. 199, Ocelli in dorsal view. 200, Head in dorsal view. 201, Head in ıl view. 202, Wings.



Figs. 203–208. *Pseudognaptodon whitfieldi*. 203, Mesosoma in dorsal view. 204, Propodeum in dorsal view. 205, T1 of metasoma in dorsal view. 206, T1 of metasoma in lateral view. 207, Anterior end of metasoma in dorsal view. 208, Hind leg.

by narrow bands of sculpture (Fig. 207). *Legs:* Hind femur length 3.1× maximum width (208).

Material examined.—HOLOTYPE ♀ (UWYO), labelled as follows: "Costa Rica: Puntarenas Golfo Dulce, 24 km W. Piedras Blancas, 200m xii-1991. Paul Hanson". Also red label "HOLOTYPE" and bordered label "*Pseudognaptodon whitfieldi* Williams Holotype det. D. Williams 2003". PARTYPES: **Costa Rica: Puntarenas:** R.F. Golfo Dulce, 24 km W. Piedras Blancas, 200m, II-1993 (1♀), III-1993 (1♀), P. Hanson, (UWYO). **U.S.A.: Texas: Erath Co.:** Stephenville, suction trap, 25-31-III-1982, C. Agnew, 1♀ (TAMU).

Etymology.—This species is named for James Whitfield, who has provided the only specimens in this study for which there are confirmed host data.

REMARKS ON OTHER SPECIMENS EXAMINED

I have examined three problematic *Pseudognaptodon* specimens from CNCI that have not been included in the species treatments above. Two are single males that probably each represent new species but are not described here because females are unknown. Their label data is as follows: "Constance Bay Carleton Co., ONT VIII-24–1983 M. Sanbourne" (CNCI), and "USA: FL: Alachua Co. Gainesville, DPI 1–23.VI.1987, MT J Wiley" (CNCI). Both specimens have also been labelled "*Pseudognaptodon* n. sp. det. D.J.M. Williams 2003". The third specimen is a teneral female with pale color and incompletely sclerotized legs and wing veins, whose identity cannot be determined with certainty. It is labelled as follows: "9 mi. N. Forrest, Man. 29.VIII.1958 R.L. Hurley" (CNCI). I have also added a label "*Pseudognaptodon omissus* prob, teneral det. D.J.M. Williams 2003". I have not included it in the treatment of *P. omissus* above because it does not possess all of the diagnostic characters of that species. Determination of whether this specimen is a geographical variant of *P. omissus* or represents a new species cannot be made with this specimen.

ACKNOWLEDGEMENTS

I thank David Langor, John Huber, and Henri Goulet for providing a critical review of the manuscript. Scott Shaw, Robert Wharton, and James Whitfield provided numerous specimens and waited patiently while this manuscript was produced on a very part-time basis. This study was supported by David Langor, who allowed me time that should have been devoted to other projects.

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EDITOR'S NOTE

With this issue of the Journal I regretfully step down as editor. It has been a pleasure (in most cases) to work with the many fine hymenopterists who have contributed papers over the past seven years. It is time to infuse the journal with new blood and new ideas, and I am confident that your new editor, Gavin Broad, will do so. Dr. Broad may be contacted by email at gabro@ceh.ac.uk; his office phone number is 01487 772406 and his fax number is 01487 773467.

Beginning at this moment, if not before, all manuscripts should be sent to the following address:

Dr. Gavin Broad
Coordinator of Zoological Data & Research
Biological Records Centre
Centre for Ecology & Hydrology
Monks Wood
Abbots Tipton, Huntingdon PE28 2LS UK

I am extremely grateful to the subject editors for their noble assistance throughout the editorial process. There was definitely a sharing of duties without much recognition on their behalf, but they reduced my efforts considerably. They should all receive medals for their conscientious and largely unheralded duties to our society. Our many reviewers should also be recognized for devoting much time and attention to their reviews and the health of our journal.

In bowing out, let me simply say: Keep those manuscripts coming—to Gavin's address, that is—and may the journal live long and prosper!

—Eric Grissell

INSTRUCTIONS FOR AUTHORS

General Policy. The *Journal of Hymenoptera Research* invites papers of high scientific quality reporting comprehensive research on all aspects of Hymenoptera, including biology, behavior, ecology, systematics, taxonomy, genetics, and morphology. Taxonomic papers describing single species are unlikely to be accepted unless a strong case is evident, such as importance in economic entomology or with concurrent biology or ecology. Manuscript length generally should not exceed 50 typed pages; however, no upper limit on length has been set for papers of exceptional quality and importance, including taxonomic monographs at generic or higher level. All papers will be reviewed by at least two referees. The referees will be chosen by the appropriate subject editor. However, it would be helpful if authors would submit the names of two persons who are competent to review the manuscript. The language of publication is English. Summaries in other languages are acceptable.

The deadline for receipt of manuscripts is 1 September (for the April issue) and 1 March (for the October issue).

Format and Preparation. Three copies of each manuscript, including copies of illustrations, should be submitted on letter size or A4 paper, double spaced, with at least 25 mm margins on all sides. On the upper left of the title page give name, address, telephone and fax numbers, and e-mail address of the author to whom all correspondence is to be sent. The paper should have a concise and informative title, followed by the names and addresses of all authors. The sequence of material should be: title, author(s), abstract, text, acknowledgments, literature cited, appendix, figure legends, figure copies (each numbered and identified), tables (each numbered and with heading). Each of the following should start a new page: (1) title page, (2) abstract, (3) text, (4) literature cited, (5) figure legends, (6) footnotes.

Upon **final acceptance** of a manuscript, the author should provide the editor with one copy accompanied by either an IBM or Macintosh formatted electronic version. ZIP discs, CD-ROMS, or 3.5 inch floppy discs are acceptable. Final manuscripts and figures may also be sent via email, but because symbols and tables are not always correctly translated it is still best to send a printed copy of the manuscript. Preferred word processing programs are Microsoft Word, WordPerfect, and MacWrite Pro. If possible, all words that must be italicized should be done so, not underscored. Tables may be formatted in a spread sheet program such as MS Works or MS Excel. Text should be double-spaced typing, with 25 mm left and right margins. Tables should be put in a separate file. Diskettes should be accompanied by the name of the software program used (e.g., WordPerfect, Microsoft Word). Authors should keep backup copies of all material sent to the Editor. The Society cannot be responsible for diskettes or text mislaid or destroyed in transit or during editing.

Illustrations should be planned for reduction to the dimension of the printed page (14 × 20.5 cm, column width 6.7 cm) and allow room for legends at the top and bottom. Do not make plates larger than 14 × 18 in. (35.5 × 46 cm). Individual figures should be mounted on a suitable drawing board or similar heavy stock. Photographs should be trimmed, grouped together and abutted when mounted. Figure numbers should be on the plate. Include title, author(s) and address(es), and illustration numbers on back of each plate. Original figures need not be sent until requested by the editor, usually after the manuscript has been accepted. Reference to figures/tables in the text should be in the style "(Fig. 1)" "(Table 1)". Measurements should be in the metric system.

Electronic plates may be submitted on disc or via email. They must be fully composited, labeled, and sized to fit the proportions of the journal page. Line art should be scanned at 1200 dpi (minimum input resolution is 600 dpi). Color or grayscale (halftone) images should have a dpi of 300–350. Color files should be in CMYK and not RGB. Graphics should be submitted as TIFF or EPS files. No PowerPoint or Word/Word Perfect files with images embedded in them are acceptable.

All papers must conform to the *International Code of Zoological Nomenclature*. The first mention of a plant or animal should include the full scientific name including the authority. Genus names should not be abbreviated at the beginning of a sentence. In taxonomic papers type specimens must be clearly designated, type depositories must be clearly indicated, and new taxa must be clearly differentiated from existing taxa by means of keys or differential diagnoses. Authors are required to deposit all type material in internationally recognized institutions (not private collections). Voucher specimens should be designated for specimens used in behavioral or autecological studies, and they should be deposited similarly.

Acceptance of taxonomic papers will not require use of cladistic methods; however, authors using them will be expected to specify the phylogenetic program used (if any), including discussion of program options used. A data matrix should be provided if the subject is complex. Cladograms must be hung with characters and these should include descriptors (not numbers alone) when feasible. The number of parsimonious cladograms generated should be stated and reasons given for the one adopted. Lengths and consistency indices should be provided. Adequate discussions should be given for characters, plesiomorphic conditions, and distributions of characters among outgroups when problematical.

References in the text should be (Smith 1999), without a comma, or Smith (1999). Two articles by a single author should be (Smith 1999a, 1999b) or Smith (1999a, 1999b). For multiple authors, use the word "and," not the symbol "&" (Smith and Jones 1999). For papers in press, use "in press," not the expected publication date. The Literature Cited section should include all papers referred to in the paper. Journal names should be spelled out completely and in italics.

Charges. Publication charges are $10.00 per printed page. At least one author of the paper must be a member of the International Society of Hymenopterists. Reprints are charged to the author and must be ordered when returning the proofs; there are no free reprints. Author's corrections and changes in proof are also charged to the author. Color plates will be billed at full cost to the author.

Beginning 1 April 2004, all manuscripts and correspondence should be addressed to:

Dr. Gavin Broad
Coordinator of Zoological Data & Research
Biological Records Centre
Centre for Ecology & Hydrology

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