

THE GENUS *DILOCANTHA* (HYMENOPTERA: EUCHARITIDAE)

JOHN M. HERATY

Department of Entomology, University of California, Riverside, CA 92521, U.S.A.
(e-mail: john.heraty@ucr.edu).

Abstract.—Five species of *Dilocantha* are described from South and Central America: *D. albicoma*, *n. sp.*, *D. bennetti*, *n. sp.*, *D. flavicornis* (Walker), *D. lachaudii*, *n. sp.*, and *D. serrata*, *n. sp.* *Dilocantha* are unique within Eucharitidae for having extreme sexual dimorphism and a patch of specialized setae filling a deep depression of the scutellum at the scutoscuteellar sulcus. The patch of scutellar setae is associated with external secretions that may act as an ant appeasement structure similar to trichomes of ant-associated Staphylinidae. The first-instar of *D. serrata* is described.

Key Words: Eucharitidae, taxonomy, Neotropical, *Dilocantha*

All members of the Eucharitidae (Hymenoptera: Chalcidoidea) are specialized parasitoids of ants (Clausen 1940ab, Heraty 1994). Adults deposit their eggs into or on plant tissue, and the active first-instar larva is responsible for gaining access to the ant host, often by phoretic attachment to foraging ants (Clausen 1940a, 1941). One species is newly recorded as a parasite of *Ectatomma tuberculatum* (Olivier) (Formicidae: Ponerinae). *Dilocantha* are nested within a monophyletic group of New World Eucharitini (Eucharitinae) with *Kapala* Cameron and *Isomerala* Ashmead, species of which are known to attack larger ponerine ants of the genera *Pachycondyla*, *Ectatomma* and *Odontomachus* (Heraty 1994).

Dilocantha was first recognized for the species *Thoracantha flavicornis* Walker by Shipp (1894). Only the female of this one species from Brazil has been described, and its characteristic features do not readily apply to females of the other species or to the distinctive sexually dimorphic males. The sexes of Eucharitidae are readily separated by features of the antennae and metasoma, but usually the mesosoma does not exhibit

much dimorphism. Males of *Dilocantha* have a much narrower and more highly vaulted mesosoma than females, and the postscutellar spines are more typical of the genus *Kapala* (thin and cylindrical) than the flattened and carapace-like spines of the female. Within Eucharitidae, similar postscutellar spines are known only for *Dicoelothorax* Ashmead and *Galearia* Brullé, both belonging to the same monophyletic group but not considered as sister taxa by current analyses of relationships (Heraty, unpublished).

All species of *Dilocantha* possess a unique patch of setae filling a deep lateral depression of the scutellum at the scuto-scuteellar sulcus (Figs. 1–4); the depressions on each side are completely separated medially. The setae within the depression are long and hooked or bent apically, resembling the hooks found in velcro® fabric. Each hair has minute longitudinal striations along most of its length, no externally visible pores, and is gold-brown basally and white or clear apically. The base of each hair is seated in a pronounced socket, which are interspersed by minute pores in the cu-

ticle (Fig. 3). In museum specimens, the depression and hairs are often associated with a silvery exudate covering the cuticle within the cavity and enveloping the base of the hairs (Figs. 3, 4). The structure and associated secretion are unique to Eucharitidae. The shape of the hairs and distribution of pores is similar to the trichomes of the staphylinid *Xenodusa reflexa* (Walker) (Kistner 1979, his fig. 2b), which are used for appeasement and adoption by the host ants. In staphylinids, the pores are associated with flask-like glandular cells and are characteristic of the ant-associated Aleocharinae (Jordan 1913, Kistner 1979). The secretory pores of Aleocharinae open into a cribriform plate (Pasteels 1968, Kistner 1979), which in *Dilocantha* are not apparent on either slide-mounts or SEMs of the cuticle. Dissections did not reveal glandular cells associated with the pores or setae; however all of the material dissected was preserved in alcohol and either critical-point-dried or chemically dried with hexamethydisilazane, which preserves muscles and nerve tissue but possibly not glandular tissue. Minute pores associated with the scutoscutellar sulcus occur in the closely related genus *Kapala* but without an associated depression, setal patch or exudate.

In all Eucharitinae, larvae develop on the host pupa and emerge from the host cocoon within the ant nest; Oraseminae have similar habits but usually attack Myrmicinae, which lack a pupal cocoon (Heraty 1994). Adults obviously must encounter the ant hosts before leaving the nest to mate and deposit eggs. In the few cases observed, the interaction is usually favorable, with the ants fondling or feeding the adult wasp and often protecting them when the nest is disturbed (Wheeler 1907, Clausen 1941, Ayre 1962, Vander Meer et al. 1989, personal observations). In *Kapala*, a genus closely related to *Dilocantha*, worker ants within nest colonies of *Ectatomma* have been observed carrying adults by their elongate postscutellar spines (Lachaud and Pérez-Lachaud, pers. comm.), again treating the adults am-

icably. In *Orasema xanthopus* (Cameron) (Oraseminae) parasitic on *Solenopsis invicta* Buren, immatures and newly emerged adults possess a cuticular hydrocarbon profile similar to the host, allowing them to go undetected within the nest (Vander Meer et al. 1989). Acquisition of the similar cuticular hydrocarbon profile was presumed to be from social interactions and contact with the host brood. The protection is not permanent, and a few days after emerging in laboratory cultures the adults of *Orasema* are recognized and destroyed (personal observations). Under some conditions it may be advantageous for adult eucharitids to remain in the nest beyond a period considered acceptable to the ant hosts. Various behaviors for remaining with hosts which can include structural or chemical defences have been documented in other myrmecophilous insects. The morphology of some eucharitid genera, such as *Galearia* (cf. Guérin-Ménéville 1845, fig. 8), which have a fusiform body shape and can withdraw the gaster under the carapace-like scutellar spines, appear as if they would be protected from the ants. The patch of hairs and exudate found in *Dilocantha* could function as an appeasement structure similar to the trichomes of staphylinids, but no biological observations exist to support this idea.

TERMS AND METHODS

Important terms are indicated in Figs. 1 and 5, but generally follow Heraty (1985, 1989, 1994). The first antennal flagellomere is labelled as F2 to reflect the loss of F1 (anellus) in Eucharitini. MPS refer to the multiporous plate sensillae. Mt refers to the metasomal tergites (Mt1 = petiole); Ms refers to the metasomal sternites. Material was borrowed from the following: CNCI, Canadian National Collection, Ottawa (G. Gibson); BMNH, Museum of Natural History, London (J. Noyes); FLA, Florida State Collection of Arthropods, Gainesville (R. Stange); HOND, Departamento de Protección Vegetal, Tegucigalpa, Honduras (R. Cave); IZW, Institut Zoologique, Academie

Polonaise des Sciences, Warsaw, Poland (E. Kierych); LACM, Los Angeles County Museum of Natural History, Los Angeles (B. Brown); MADR, Museo Nacional de Ciencias Naturales, Madrid, Spain (J. Nieves-Aldrey); MCZ, Museum of Comparative Zoology, Cambridge (D. Furth); UCD, University of California, Davis (S. Heydon); UCLA, University of California, Los Angeles (H. Hesperheide); UCR, University of California, Riverside (S. Triapitsyn); USNM, National Museum of Natural History, Smithsonian Institution, Washington (E. Grissell).

Dilocantha Shipp

Dilocantha Shipp, 1894: 188. Type species: *Thoracantha flavicornis* Walker, by monotypy and original designation.

Dilocantha; Ashmead, 1904: 268, 270, 471 (in key). Schmeideknecht 1909: 68, 70, 77–78 (key and description).

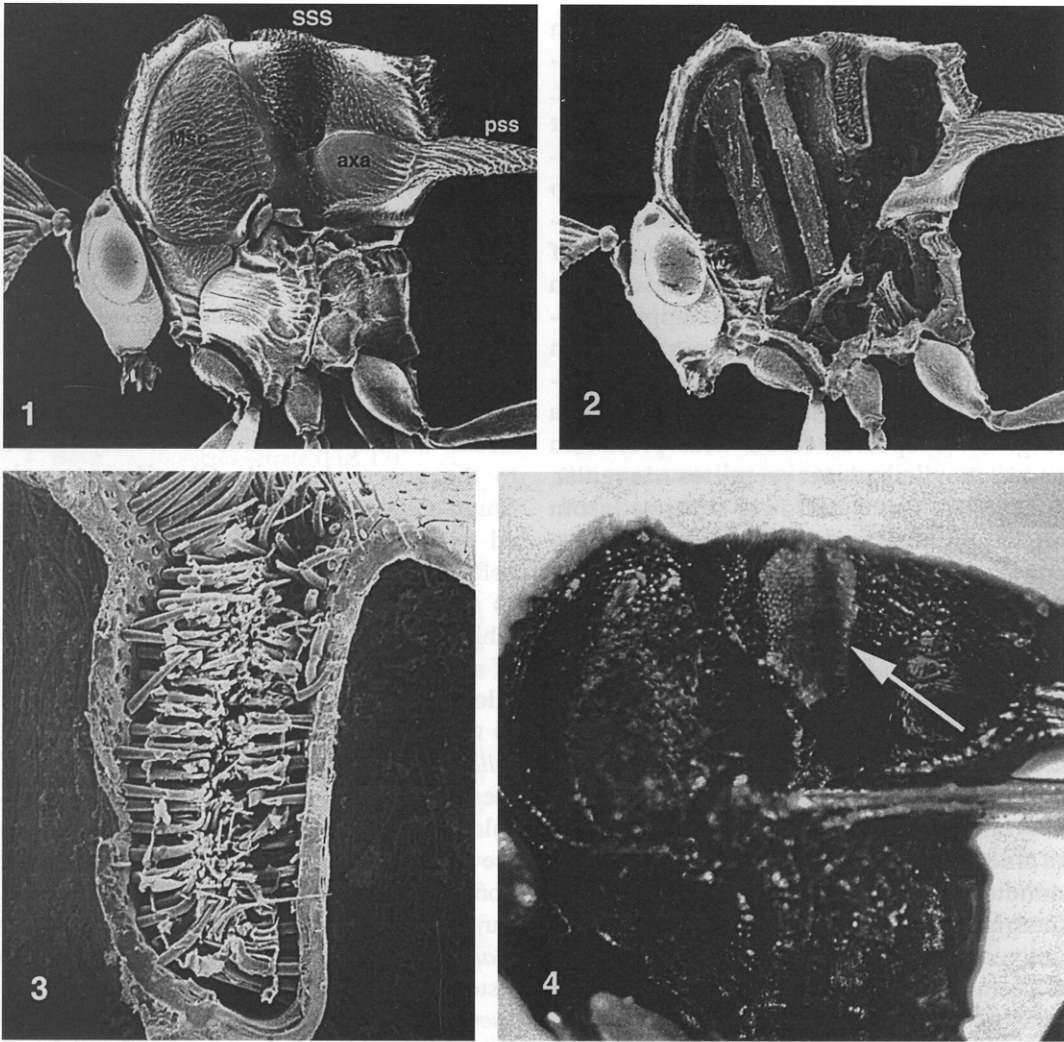
Diagnosis.—Recognized by having a dense patch of long hook-tipped hairs filling the scutoscuteellar sulcus (Figs. 1–4, 5, 8–9, 14, 18, 19). The scutellar spines of females are usually broad and flat (Figs. 6, 13, 19) but can be narrow and cylindrical (Fig. 14). In males the spines are always cylindrical and thin (Figs. 10, 15, 21). In both sexes the mesoscutum is vaulted (Figs. 1, 4, 5, 8–9, 24) with strong transverse carinae on the midlobe. Both sexes are presented in the key to genera by Ashmead (1904) that includes New World genera (duplicated by Schmeideknecht 1909). Males do not key adequately as Ashmead appears to have made the assumption that males would have scutellar spines similar to the female (broad, contiguous and flat) rather than long and slender (his couplet 32).

Description.—Length 3.2–4.8 mm. General body color black; female antenna yellowish brown, male antenna darker; legs beyond coxa light yellow; wings hyaline or infuscate, forewing venation brown, postmarginal vein transparent.

Head: In frontal view subquadrate, eyes

rounded and bare; median ocellus in line with lateral ocelli and included within scrobes, frons extending slightly above ventral margin of lateral ocelli. Occiput vertical and weakly aciculate to smooth, dorsal margin with prominent carina. Frons reticulate or granulate, usually with fine oblique carinae lateral to scrobes, lower face similarly sculptured; scrobal depression shallow and broadly impressed. Clypeus with distinct anteclypeus, clypeal margin transverse or only slightly rounded; supraclypeal area present, lateral margins vague. Genal depression absent; hypostomal lobes broadly separated. Mandibles falcate. Labrum with six digits. Antenna of female with 10 segments (Figs. 7, 8, 11, 16, 17), male with 12 segments (Figs. 9, 24); anellus absent; funicle of female with 7 segments, F2L:F2W less than 3 times as long as broad, funicular segments simple or serrate; funicular segments of male each with an elongate dorsal ramus, rami progressively slightly shorter and alternating in origin on each side of midline. MPS of female small and recessed into depressions, MPS of male minute and restricted to outer lateral margin of ramus.

Mesosoma: Pronotum abutting mesoscutum, no overlap of sclerites. Mesosoma robust and strongly vaulted above head (Figs. 5, 8, 9, 24), height of mesoscutum 1.4–1.5 times height of head, anterior margin of mesoscutum reflected behind head; posterolaterally with large plate-like flange extending over tegula; dorsum pilose; notauli deeply impressed and broadly separated posteriorly; posterodorsal margin of midlobe bilobed in frontal view. In male, midlobe of mesoscutum with median carinae bordered laterally by a strong vertical carina extending dorsally 0.8 times the distance up the vertical face of the midlobe to a strong transverse shelf dorsally, carinae never extending more than 0.2 times height of mesoscutum in female. Scutoscuteellar sulcus (SSS) transverse, strongly impressed laterally (nearly to midline) and filled with dense patch of long bent-tipped



Figs. 1-4. 1-3, *Dilocantha bennetti*, male. 1, Head and mesosoma, lateral view. 2, Mesosoma, sagittal section, longitudinal flight muscles removed. 3, Cross section of invagination of scutoscutellar sulcus, left side of specimen midline. 4, *D. serrata*, mesosoma of female, lateral view. Abbreviations: axa = axillula, Msc = mesoscutum, pss = postscutellar spine, SSS = scutoscutellar sulcus. Arrow points to exudate.

hairs (Figs. 1-4, 5, 8, 9, 14, 18); lateral axillar lobe small; axillular sulcus present as distinct channel. Frenal groove distinct laterally but absent medially; posterior margin of scutellum broadly rounded or flat anterior to frenal line, or elevated and abrupt posteriorly; frenum with pair of long spines reaching to or beyond apex of gaster and separated to base; scutellar spines of female broad and dorsoventrally flattened (Figs. 6, 13, 19) or narrow and

cylindrical (Fig. 14), spines longitudinally carinate, carinae much finer and sculpture more rugose medially, ventral surface of spines obliquely carinate; scutellar spines of male cylindrical and broadly separated basally (Figs. 10, 15, 21). Propodeum, petiole, coxae and most of mesepimeron colliculate to very finely reticulate or shagreened; propodeal disc flat and bordered by a strong carina (Fig. 23); metapleuron strongly areolate-rugose; callus

with dense, fine, white setae; spiracle with elongate and narrow emargination of ventral margin; metepimeral groove absent. Femoral groove absent, mesepimeron flat or only slightly impressed (Fig. 1); mesepimeron evenly sculptured, finely striate to granulate, transepimeral sulcus absent; acropleuron deeply grooved for reception of upper corner of prepectus; mesepisternum with anteromedial margin overlapping posterior margin of prepectus; ventral margin of mesepisternum wedge-shaped and extending vertically anterior to the midcoxa (Fig. 1). Prepectus fused with pronotum and in the same plane; prepectus triangular, apex of prepectus narrowly separated from tegula; pronotal spine present; spiracle narrowly enclosed dorsally. Coxae bare except for few minute ventral setae, mesocoxa without lateral groove or carina; calcar bifid and slightly bent apically; hind tibia with 1 spur, tibiae and tarsi with sparse reclinate setae. Forewing of female 2.6–2.9 times as long as broad (Fig. 25), costal cell with moderate covering of fine ventral setae, disc with moderate covering of fine, short setae, dorsal setae sparse and minute, venation mostly distinct but postmarginal vein slightly longer than the stigmal vein; forewing of male 2.4–2.7 times as long as broad (Fig. 9), costal cell with dense covering of long ventral setae, disc with dense covering of long setae on both surfaces; both sexes without marginal fringe. Hind wing venation incomplete medially; short marginal fringe along posterior margin and disc with moderate covering of fine setae.

Metasoma: Petiole of female triangular in cross section, flat dorsally and with dorsolateral carina, 1.3–1.8 times as long as hind coxa; petiole of male cylindrical, 5.4–7.7 times as long as hind coxa; base of petiole truncate, with basal carina and not overlapping nucha; gastral terga smooth, and glabrous. Ms2 smooth, in males articulating with apex of petiole. Hypopygium with 6 long hairs on each side of midline. Valvulae acicular; apex of first valvula

smooth; gonostylus fused. Posterior margin of Mt2 with one longitudinal line of weakness.

Phylogenetic affinities.—*Dilocantha* is a distinctive member of the Eucharitini (Heraty 1994) in the kapaline clade, a New World group recognized by the following synapomorphic features: 1) presence of a distinct anteclypeus, 2) scutellar spines generally exceeding the metasoma and divided almost to their bases, 3) lateral axillar lobe minute and hidden behind tegula, and 4) propodeal spiracle emarginate. Its position within the kapaline clade as closely related to the genera *Liratella* Girault, *Isomeralla* Shipp, *Galearia* and *Thoracantha* is indicated by possession of 1) short F2 (basal flagellomere less than 3 times as long as broad), 2) absence of a metepimeral groove, and 3) labial palpus 1 or 2 segmented. The presence of strongly impressed notaular grooves and a pilose callus, both plesiomorphic with respect to the above-mentioned genera, suggest that *Dilocantha* is the potential sister group of these taxa. The presence of a metepimeral sulcus in *Kapala* would place this genus as the sister group of the above taxa. Notably, none of the three other kapaline genera with carapace-like scutellar spines (*Dicoelothorax*, *Galearia* and *Thoracantha*) are placed as the sister group of *Dilocantha*, and current analyses of generic relationships suggest at least three independent origins of this feature (unpublished). This would reinforce the notion that *D. lachaudii*, with cylindrical spines, is plesiomorphic to the other species. Other characteristics such as serrate flagellomeres and rounded scutellar apex are autapomorphic in the other taxa and no characteristics appear to indicate relationships among the remaining species in which females have a distinct carapace. The extreme sexual dimorphism is unusual in Eucharitidae, but occurs to a similar degree in *Galearia*. The patch of setae in the scutoscutellar sulcus is unique within Eucharitidae.

Distribution.—Neotropical, ranging from Central America to Argentina.

Biology and hosts.—Unknown.

KEY TO SPECIES OF *DILOCANTHA*

- 1. Female (Figs. 5, 8). Antennal flagellum cylindrical or serrate 2
- Male (Fig. 9). Antennal flagellum with elongate rami (not known in *albicoma*) 6
- 2. Scutellar spines narrow, cylindrical and broadly separated medially (Fig. 14) *lauchaudii*, n. sp.
- Scutellar spines broad and flattened, carapace-like and narrowly separated medially (Figs. 6, 13, 19) 3
- 3. Apex of scutellum broadly rounded in profile (Fig. 12) *flavicornis* (Walker)
- Apex of scutellum abrupt in profile with strong marginal carina (Figs. 4, 5, 8, 18) 4
- 4. Basal flagellomeres serrate (Fig. 17) *serrata*, n. sp.
- Basal flagellomeres cylindrical (Figs. 7, 11) 5
- 5. Scutellar spines narrowly separated, basal separation of spines wider than medial separation (as in Fig. 19); flagellum short, 0.83 times height of head; petiole stout, 3.4 times as long as broad and 1.3 times as long as hind coxa *bennetti*, n. sp.
- Scutellar spines more broadly separated medially, basal separation narrower than medial separation (Fig. 6); flagellum length 0.86–1.0 times height of head; petiole longer, 3.5–4.0 times as long as broad and 1.5–1.8 times as long as hind coxa *albicoma*, n. sp.
- 6. Scutellar spines very narrow and tapering to a fine blunt point apically (Figs. 9, 10) *bennetti*, n. sp.
- Scutellar spines evenly cylindrical to apex (Figs. 15, 21) 6
- 7. Antennal rami short, ramus of F2 as long as height of head *flavicornis* (Walker)
- Antennal rami long, ramus of F2 1.28–1.3 times as long as height of head (Fig. 24) 8
- 8. Spines broadly separated basally, spines narrow and diverging (Fig. 15); frons evenly reticulate without striae; apex of scutellum bilobed in posterior view; wings hyaline *lauchaudii*, n. sp.
- Spines separated by less than twice the spine width basally (Fig. 21); frons reticulate with numerous irregular striae; apex of scutellum rounded in posterior view; wings weakly infusate *serrata*, n. sp.

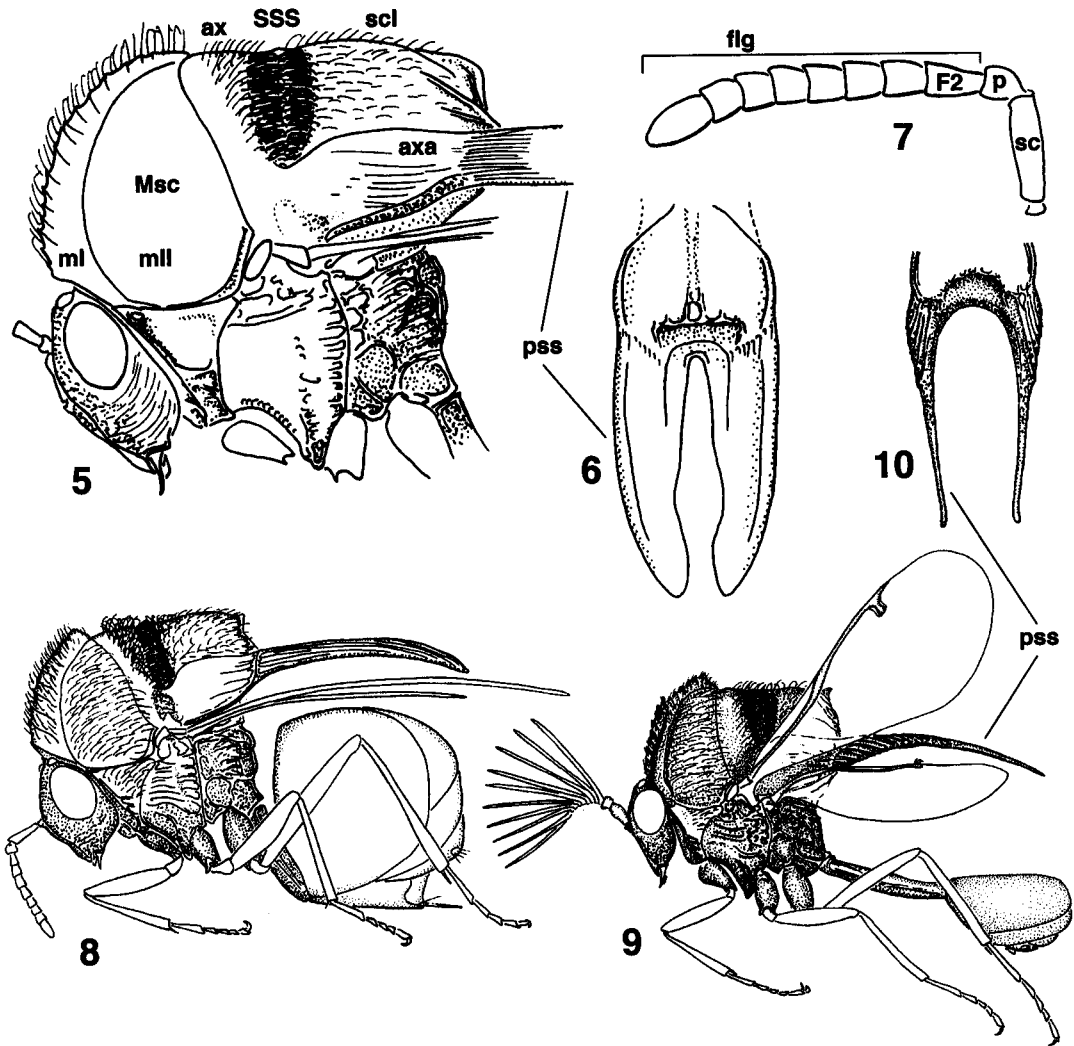
***Dilocantha albicoma* Heraty,
new species
(Figs. 5–7)**

Type material.—Holotype, ♀, “MEX [Mexico]: Campeche, 4 mi E Francisco Es-

carcega, 23.vii.83, R. Anderson.” Deposited in CNCI. Paratypes (4 ♀): MEXICO: Campeche, 6 km W Francisco Escarcega, 110 m, El Tormento, Res. Sta., 23.vii.83, M. Kaulbars (1, UCR). Veracruz, 36 km W Las Choapas, 9.ix.1975, R. Villegas (1, UCD). GUATEMALA: Sacatepequez, Volcan Agua, 1700m above Antigua Guatemala, 23.xi.1986, M. Sharkey, sweep (1, CNC). HONDURAS: Atlantida Tela, Lancetilla, 5.vii.1990, R. Cave (1, HOND).

Diagnosis.—Female recognized by the simple antennal flagellomeres, angulate apex of the scutellum, broad separation of the postscutellar spines medially so that the basal separation is the narrower, flagellum more than 0.86 times the height of the head, and petiole 1.5–1.8 times as long as hind coxa. Males are unknown.

Female.—Length, 3.2–3.3 mm. Body black, apex of Mt2 and following tergites brown. Wings weakly infusate, forewing venation light brown to translucent. Head 1.46–1.6 times as broad as high. Frons and face very finely reticulate with few fine striae lateral to scrobes and across genae, nearly smooth adjacent to eyes. Occipital carina weak and extending just beyond lateral ocellus. Eyes separated by 2.32–2.5 times their height. Malar space 1.05–1.19 times height of eye. Labrum with 6 elongate digits, each terminated by a long spatulate seta. Mouthparts relatively large, galea able to extend beyond clypeus by a distance about equal to height of clypeus; maxillary palpus with 2 segments, apical segment short, only twice as long as broad; labial palpus 2-segmented, apical segment short and only slightly longer than broad. Antennal scape reaching 0.7 times distance to median ocellus; length of flagellum 0.88–1.0 times height of head, F2 tapering, following segments cylindrical (Fig. 7), F2 1.2 times as long as F3, apical flagellomere slightly longer than broad and rounded apically; MPS numerous on all flagellomeres and recessed into deep broad depressions, surface of each flagellum strongly scalloped, sculpture finer toward base of each flagellum.



Figs. 5-10. 5-7, *Dilocantha albicoma*, female. 5, Head and mesosoma, lateral view. 6, Scutellum and post-scutellar spines, dorsal view. 7, Antenna. 8-10, *D. bennetti*. 8, Female habitus. 9, Male habitus. 10, Postscutellar spines of male, dorsal view. Abbreviations: ax = axilla, axa = axillula, F2 = second flagellomere, flg = flagellum, ml = midlobe of mesoscutum, mll = lateral lobe of mesoscutum, Msc = mesoscutum, p = pedicel, pss = postscutellar spine, sc; eq scape, scl = scutellum, SSS = scutoscutellar sulcus.

Mesoscutal height 1.25 times head height (Fig. 5). Midlobe of mesoscutum with dense covering of fine setae, sparser medially and dense laterally; median area of midlobe with strong transverse carinae and median weak longitudinal carina, the strong carina bordering the anterior declivous face of the midlobe continuing dorsally only to level of second transverse carina; lateral lobes of mesoscutum smooth and covered

with fine, long setae (0.25 mm) that have the extreme apices very thin and bent. Scutellum medially with shallow longitudinal impression, at SSS the median channel bordered by two distinct raised knobs; SSS impression filled with erect, golden to whitish apically, bent-tipped setae (0.15 mm in length), longer, white setae covering most of axilla except narrow anterior band, setae finer dorsally and more bent than hooked,

pression, carinae bordered laterally by a short vertical carina that extends dorsally 0.15 times the distance up the vertical face or the midlobe and ventrolaterally continues as a border of the anterior declivous face of the midlobe; lateral lobes of mesoscutum smooth and covered with fine, long setae (0.18 mm) that have the extreme apices bent. Scutellum medially with shallow longitudinal impression, deeply impressed at SSS and forming a distinct pit, at SSS the median channel bordered by slightly raised knobs; SSS depression filled with erect, golden, bent-tipped setae (0.12 mm in length), longer, white setae covering most of axilla except for narrow anterior band, setae finer dorsally and more bent, scutellum excluding axillula with finer and shorter white setae; axillula weakly longitudinally carinate and bare; posterior margin of scutellar disc carinate and abruptly angled in profile, posterior declivous face of scutellum angled about 90° to dorsum, posterior face vertically carinate and finely reticulate, scutellar spines broad, dorsoventrally flattened and narrowly separated medially (as in Fig. 19), gently arched in lateral profile; ventral surface of spines obliquely carinate; declivous face of scutellum ventral to spines finely reticulate with a strong median carina. Femora smooth and with sparse adpressed setae. Upper prepectus smooth apically, granulate anteriorly and moderately setose, apex narrowly separated from tegula, anterior margin of prepectus carinate. Marginal vein of forewing with few minute setae apically, but otherwise bare. Hind wing with short marginal fringe. Petiole 3.4–3.6 times as long as broad, 1.3–1.5 times as long as hind coxa.

Male.—Length, 3.0–4.7 mm. Differs from female in the following features: antenna brown, apical half of scape dark brown. Forewing weakly infusate. Head 1.46–1.66 times as broad as high. Facial reticulations shallow, frons with few irregular carinae. Eyes separated by 2.11–2.44 times their height. Malar space 1.0–1.11 times

height of eye. Labial palpus with one segment. Antennal scape reaching 0.7 times distance to median ocellus; F2 as long as broad basally, ramus of F2 1.05–1.32 times as long as head height (Fig. 9), terminal segment (clavus) undifferentiated and as long as ramus of penultimate flagellomere. MPS absent; setae along rami long, about equal to width of ramus. Posterior margin of scutellar disc abruptly angled in profile (Figs. 1, 9), apex emarginate and projection bifid in posterior view; scutellar spine abruptly narrowed to a very thin elongate process, broadly separated along entire length, basally with strong oblique carinae, apically with few fine longitudinal carinae (Fig. 10), spines broadly curved in profile, apex of spine rounded. Forewing with speculum closed basally. Petiole 1.9–2.4 times as long as broad, 5.7–7.5 times as long as hind coxa. Dorsal length of gaster slightly shorter than petiole, Ms8 broadly rounded and pilose. Genitalia; parameres with 4 long setae, digitus rounded with 5–6 marginal spines; tip of aedeagus acute.

Comments.—A morphologically similar female collected in Argentina (Tucuman, San Javier, 1100m, FLA) appears to be a different species based on having the scutellum distinctly bilobed and the spines more evenly spaced basally and broadly spaced apically. This female lacks a complete antennal flagellum and was not described.

Etymology.—Named on honor of Dr. Fred Bennett, former director of the Commonwealth Institute of Biological Control and collector of many of the specimens.

Dilocantha flavicornis (Walker)
(Figs. 11–13)

Thoracantha flavicornis Walker, 1862: 382.

Type data: Brazil: Villa Nova. Type female, BMNH, type no. 5.630 (examined).
Described: female.

Schizaspidia flavicornis; Walker, 1871: 66.
Change of combination.

Thoracantha flavicornis; Westwood, 1874: 153. Illust. Subsequent description.

...e. Labial palpus with one seg-
 ...anal scape reaching 0.7 times
 ...median ocellus; F2 as long as
 ...y, ramus of F2 1.05–1.32 times
 ...head height (Fig. 9), terminal
 ...lavus) undifferentiated and as
 ...us of penultimate flagellomere.
 ...; setae along rami long, about
 ...dth of ramus. Posterior margin
 ...disc abruptly angled in profile
 ...apex emarginate and projection
 ...posterior view; scutellar spine
 ...rowed to a very thin elongate
 ...roadly separated along entire
 ...lly with strong oblique carinae,
 ...th few fine longitudinal carinae
 ...spines broadly curved in profile,
 ...ne rounded. Forewing with spec-
 ...d basally. Petiole 1.9–2.4 times
 ...broad, 5.7–7.5 times as long as
 ...Dorsal length of gaster slightly
 ...n petiole, Ms8 broadly rounded
 ...Genitalia; parameres with 4 long
 ...us rounded with 5–6 marginal
 ...of aedeagus acute.

...ts.—A morphologically similar
 ...lected in Argentina (Tucuman,
 ...1100m, FLA) appears to be a
 ...pecies based on having the scu-
 ...tinctly bilobed and the spines
 ...ly spaced basally and broadly
 ...ally. This female lacks a com-
 ...anal flagellum and was not de-

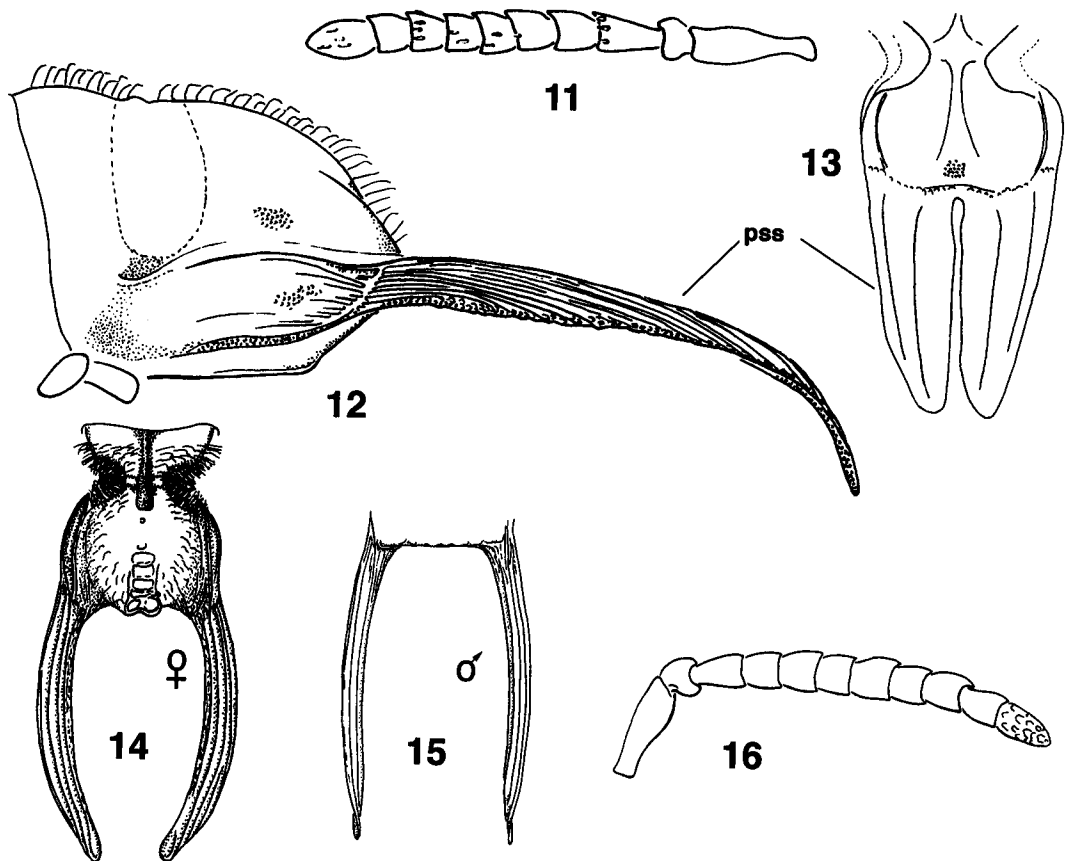
...gy.—Named on honor of Dr.
 ...ett, former director of the Com-
 ...Institute of Biological Control
 ...tor of many of the specimens.

Dilocantha flavicornis (Walker)
 (Figs. 11–13)

Dilocantha flavicornis Walker, 1862: 382.
 ...ta: Brazil: Villa Nova. Type fe-
 ...MNH, type no. 5.630 (examined).
 ...d: female.

Dilocantha flavicornis; Walker, 1871: 66.
 ...of combination.

Dilocantha flavicornis; Westwood, 1874:
 ...st. Subsequent description.



Figs. 11–16. 11–13, *Dilocantha flavicornis*, female. 11, Antenna. 12–13, Scutellum and postsutellar spines (pss). 12, Lateral view. 13, Dorsal view. 14–16, *D. lachaudii*. 14, Scutellum of female. 15, Scutellar spines of male. 16, Antenna of female.

Dilocantha flavicornis; Shipp, 1894: 188.
 Change of combination.

Type material.—Lectotype, ♀ (here des-
 ignated), “Type; Villa Nova; Kapala flavi-
 cornis Walker; B.M. Type—5.630”. Depos-
 ited in BMNH (examined).

Diagnosis.—Female recognized by the
 simple antennal flagellomeres and rounded
 apex of the scutellum. Males have evenly
 cylindrical spines that are longitudinally
 carinate along their length and strongly
 emarginate at the tip, the antennal ramus of
 F2 is 1.05 times as long as the height of the
 head, and the frons has numerous fine ir-
 regular carinae lateral to the scrobes. Unlike
D. flavicornis, the male and female of *D.*
bennetti both have very long fine setae on

the mesoscutal lateral lobe and the facial
 sculpture is very fine and shallow. Other-
 wise it is difficult to make a direct associ-
 ation between the different sexes, especially
 on the basis of specimens from such widely
 divergent localities in eastern Brazil. How-
 ever, *D. bennetti* is the only other South
 American species known, and both sexes
 are distinct from *D. flavicornis*.

Female [measurements do not include the
 type].—Length, 3.7 mm. Body black, apical
 tergites of gaster brown. Wings infuscate,
 forewing venation light brown. Head 1.55
 times as broad as high. Frons and face very
 finely reticulate and without any striae lat-
 eral to scrobes or on genae. Occipital carina
 weak and extending just beyond lateral

ocellus. Eyes separated by 2.05 times their height. Malar space 0.96 times height of eye. Labrum with 4 elongate digits [not clearly visible], each terminated by a long spatulate seta. Mouthparts relatively small, galea not extending beyond margin of clypeus; maxillary palpus with 2 segments, apical segment 3 times as long as broad; single labial palpus minute. Antennal scape reaching 0.8 times distance to median ocellus; length of flagellum 0.90 times height of head, at least the basal 3 flagellomeres weakly serrate, following segments progressively more cylindrical (Fig. 11), F2 1.2 times as long as F3, apical flagellomere slightly longer than broad and rounded apically; MPS numerous on all flagellomeres and recessed into shallow depressions. Mesoscutum height 1.04 times head height. Midlobe of mesoscutum medially with dense covering of fine long setae, sparser and shorter on anterior vertical face; median area of midlobe with transverse carinae, these carinae not bordered laterally by a vertical carina but with a weak carinae bordering the declivous face laterally; lateral lobes of mesoscutum smooth and covered with fine, long setae (0.3 mm) that have the extreme apices bent. Scutellum medially with shallow longitudinal impression, at SSS the median channel not bordered by distinct raised knobs; SSS depression filled with erect, golden to whitish apically, bent-tipped setae (0.15 mm in length), longer, white setae covering most of axilla except narrow anterior band, setae finer, relatively long, and more bent than hooked, scutellum excluding axillula with finer, relatively long white setae [continuing to base of spines]; axillula bare with few longitudinal striae; posterior margin of scutellar disc broadly rounded in profile to base of spine (Fig. 12), posterior face with broad shallow depression and finely reticulated (colliculate) as rest of scutellum; postscutellar spines broad and somewhat dorsoventrally flattened but with lateral margins very thick and medially thin and platelike, lateral margins tapered to apex, spines narrowly separated

medially (Fig. 13), strongly bent apically; declivous face of scutellum ventral to spines finely reticulate with several strong median carinae. Femora smooth and with sparse adpressed setae. Upper prepectus smooth and moderately setose, apex separated from tegula, anterior margin of prepectus carinate. Marginal vein of forewing with few minute setae along entire length, but otherwise bare. Marginal fringe of hind wing relatively long. Petiole 4.2 times as long as broad, 1.4 times as long as hind coxa.

Male.—Length, 3.7 mm. Differs from female in the following features: scape and pedicel dark brown, rest of antenna yellowish brown. Forewing hyaline. Head 1.53 times as broad as high. Facial reticulations shallow, smooth adjacent to margin of eye. Eyes separated by 2.2 times their height. Malar space 0.9 times height of eye. Labrum with 6 digits. Labial palpus with one segment. Antennal scape reaching 0.6 times distance to median ocellus; F2 slightly broader than long basally, ramus of F2 1.05 times as long as head height, terminal segment (clavus) undifferentiated, shorter in length than ramus of penultimate flagellomere by more than its width. MPS present as single row along outer lateral margin in apical two-thirds of each ramus, MPS recessed in shallow depression; setae along rami long, slightly shorter than width of ramus. Posterior margin of scutellar disc abruptly angled in profile, apex weakly bilobed; scutellar spines evenly cylindrical along entire length and broadly separated, strong longitudinal carinae along entire length, apical quarter of spines bent ventrally in profile, apex of spine emarginate. Forewing with speculum open basally. Petiole 1.9 times as long as broad, 5.4 times as long as hind coxa. Dorsal length of gaster slightly shorter than petiole, 1.3 times as long as petiole; Ms8 broadly rounded and pilose. Genitalia not observed.

Additional specimens examined.—BRAZIL: Para, 12.12.1893 (1 ♀, IZW); Rio De Janeiro, Silva Jardim, viii.1974, F.M. Oli-

(Fig. 13), strongly bent apically; face of scutellum ventral to finely reticulate with several strong carinae. Femora smooth and with adpressed setae. Upper prepectus and moderately setose, apex separated from tegula, anterior margin of prepectus carinate. Marginal vein of forewing with minute setae along entire length, otherwise bare. Marginal fringe of hind wing relatively long. Petiole 4.2 times as long as broad, 1.4 times as long as hind

Length, 3.7 mm. Differs from female in the following features: scape and labrum dark brown, rest of antenna yellowish brown. Forewing hyaline. Head 1.53 times as broad as high. Facial reticulations smooth adjacent to margin of eye, separated by 2.2 times their height. Malar space 0.9 times height of eye. Labrum with 6 digits. Labial palpus with one segment. Antennal scape reaching 0.6 times distance to median ocellus; F2 slightly longer than long basally, ramus of F2 1.05 times as long as head height, terminal segment (basal) undifferentiated, shorter than ramus of penultimate flagellomere, more than its width. MPS present in a row along outer lateral margin in two-thirds of each ramus, MPS in shallow depression; setae along margin, slightly shorter than width of ramus. Posterior margin of scutellar disc angled in profile, apex weakly bicarinate. Scutellar spines evenly cylindrical along entire length and broadly separated, longitudinal carinae along entire length, apical quarter of spines bent ventrally in profile, apex of spine emarginate. Forewing with speculum open basally. Petiole 4.2 times as long as broad, 5.4 times as long as hind coxa. Dorsal length of gaster 1.3 times as long as petiole, 1.3 times as long as petiole; Ms8 broadly rounded and not observed. Genitalia not observed.

Additional specimens examined.—BRAZIL: Bahia, 12.12.1893 (1 ♀, IZW); Rio de Janeiro, Silva Jardim, viii.1974, F.M. Olivieri

(1 ♀, CNCI); Rio Grande do Norte, Baixa Verde, [no date], W.M. Mann (1 ♂, LACM).

Dilocantha lachaudii Heraty,
new species
(Figs. 14–16)

Type material.—Holotype, ♀, "Mexico: Chiapas, Finca Santa Elena, Municipio Tapachula, 22.i.1994, J.P. Lachaud, ex: *Ectatomma ruidum*". Deposited in USNM.

Diagnosis.—This is the only known species of *Dilocantha* in which the scutellar spines are cylindrical and not carapace-like. The female also has cylindrical antennal flagellomeres and angulate apex of the scutellum. Males have evenly cylindrical spines that are separated basally by 3.0 times the basal width of the scutellar spines, the spines are longitudinally carinate along their length and weakly emarginate at the tip, and the antennal ramus of F2 is 1.28 times as long as the height of the head.

Female.—Length, 4.6 mm. Body black, Mt2 entirely black, following tergites brown. Wings infusate, forewing venation dark brown. Head 1.46 times as broad as high. Frons and face very finely reticulate, without fine striate. Occipital carina pronounced and extending barely beyond lateral ocellus. Eyes separated by 2.6 times their height. Malar space 1.1 times height of eye. Labrum with 6 elongate digits, each terminated by a long spatulate seta. Mouthparts relatively small, galea not extending beyond margin of clypeus; maxillary palpus with 2 segments, apical segment 3 times as long as broad; two labial palpomeres. Antenna with 10 segments; scape reaching 0.7 times distance to median ocellus; length of flagellum 0.91 times height of head, all segments cylindrical (Fig. 14), F2 1.3 times as long as F3, apical flagellomere slightly longer than broad and rounded apically; MPS numerous on all flagellomeres and recessed into shallow depressions. Mesoscutum height 1.1 times head height. Midlobe of mesoscutum with moderately dense covering of fine setae, sparser and shorter on an-

terior vertical face; median area of midlobe with strong transverse carinae, carinae bordered laterally by a strong carina that extends dorsally 0.3 times the distance up the vertical face of the midlobe and ventrally continues as a border of the anterior declivous face of the midlobe; lateral lobe of mesoscutum smooth and covered with fine long setae (0.30 mm) that have the extreme apices hooked or bent. Scutellum with deep, medial longitudinal impression anteriorly, broad and crenulate posteriorly, a shallow SSS the median channel bordered by distinct raised knobs; SSS depression filled with erect, golden, hook-tipped setae (0.14 mm in length), longer, white setae covering most of axilla except narrow anterior band of setae finer dorsally and more bent than hooked, scutellum excluding axillula with finer and shorter white setae; axillula smooth and bare; posterior margin of scutellar disc carinate and abruptly angled in profile, posterior declivous face of scutellum angled 90° to dorsum, posterior face shagreened; scutellar spines cylindrical and broadly separated medially (Fig. 14), only slightly bent apically; declivous face of scutellum ventral to spines finely reticulate with strong median carina. Femora smooth and with sparse adpressed setae. Upper prepectus smooth and moderately setose, apex separated from tegula, anterior margin of prepectus carinate. Forewing with speculum small and closed basally; marginal vein bare. Hind wing with short marginal fringe. Petiole 4.2 times as long as broad, 2.2 times as long as hind coxa.

Male.—Length, 4.4 mm. Differs from female in the following features: antenna dark brown, scape black. Forewing hyaline. Head 1.5 times as broad as high. Facial reticulations shallow, without carinae. Eyes separated by 2.6 times their height. Malar space 1.0 times height of eye. Labrum with 6 digits. Antennal scape reaching 0.6 times distance to median ocellus; F2 about as long as long basally and with an elongate dorsal ramus, ramus of F2 1.28 times as long as head height, terminal segment (cla-

vus) undifferentiated, as long as ramus of penultimate flagellomere. MPS present as single or double row along outer lateral margin in apical two-thirds of each ramus, MPS recessed in shallow depression; setae along rami slightly shorter than width of ramus. Posterior margin of scutellar disc abruptly angled in profile, apex projecting and truncated in posterior view; scutellar spines evenly cylindrical along entire length and separated basally by 3 times the basal width of the spines (Fig. 18), strong longitudinal carinae along entire length, apical third of spine bent ventrally in profile, apex of spine weakly emarginate. Petiole 6.7 times as long as broad, 2.5 times as long as hind coxa. Dorsal length of gaster as long as petiole; Ms8 and genitalia not observed.

Etymology.—Named after Jean-Paul Lachaud and Gabriela Lachaud-Perez.

***Dilcantha serrata* Heraty, new species**
(Figs. 4, 18–25)

Type material.—Holotype, ♀, "COSTA RICA: Prov. Heredia, F La Selva, 3 km S Pto. Viejo, 10°26'N 84°01'W; 28.vi.1996, H.A. Hespeneheide." Deposited in USNM. Paratypes (15 ♀, 1 ♂): COSTA RICA: Heredia: F La Selva, 3 km S Pto. Viejo, 10°26'N 84°01'W, 15.vii.1982 (1), 23.vii.1982 (1), 30.vii.1982 (1), 18.vi.1985 (1), 19.vi.1985 (1), 28.vi.1986 (2), 4.iv.1987 (2), 5.iv.1987 (1), 10.vii.1993 (1), H.A. Hespeneheide (2 females UCR, 8 ♀ UCLA); Alejuela, Rio-Laguna de Arenal, 500m, 14.viii.1988, Paul Hanson (1 ♀, UCR); Puntarenas Prov., Osa Peninsula, 2.5 mi SW Rincon, 08°42'N 83°29'W, 21–28.ii.1967, OTS course (1 ♀, MCZ). HONDURAS: La Ceiba, x.29.1916, F.J. Dyer, no. 20810 (1 ♀, USNM). PANAMA: Canal Zone, Farfan to Palo Seco, 4 km S of Balboa, 08°56'N 79°34'W, 20.vii.1978, H.A. Hespeneheide (1 ♀, UCLA); Canal Zone, Plantation Rd C29, 6.5 km ENE Gamboa, 09°8'N 79°39'W, 5.viii.1978, H.A. Hespeneheide (1 ♀, UCR); Coiba, Estacion Biol., Malaise, 21–23.i.1994, J.L. Nieves (1 ♂, MADR).

Diagnosis.—Female recognized by the serrate antennal flagellomeres and angulate apex of the scutellum. Males have evenly cylindrical spines that are longitudinally carinate along their length and weakly emarginate at the tip, and the antennal ramus of F2 is 1.3 times as long as the height of the head.

Female.—Length, 3.5–4.8 mm. Body black, Mt2 entirely black, following tergites brown. Wings infusate, forewing venation dark brown. Head 1.46–1.6 times as broad as high. Frons and face very finely reticulate with few fine striae lateral to scrobes and across genae. Occipital carina pronounced and extending to or almost to margin of eye. Eyes separated by 2.3–2.55 times their height. Malar space 1.1–1.2 times height of eye. Labrum with 5–6 elongate digits, each terminated by a long spatulate seta. Mouthparts relatively large, galea able to extend beyond clypeus by a distance about equal to height of clypeus; maxillary palpus with 2 segments, apical segment 5–6 times as long as broad; single labial palpus long and thin. Antenna with 10 segments; scape reaching 0.7–0.8 times distance to median ocellus; length of flagellum 0.78–1.0 times height of head, at least the basal 3–4 flagellomeres strongly serrate, the following segments progressively more cylindrical (Fig. 17), F2 1.2 times as long as F3, apical flagellomere slightly longer than broad and acuminate; MPS numerous on all flagellomeres and recessed into shallow depressions. Mesoscutum height 1.4–1.5 times head height. Midlobe of mesoscutum with dense covering of fine seta, sparser and shorter on anterior vertical face; median area of midlobe with strong transverse carinae and median weak longitudinal carina, carinae bordered laterally by a strong carina that extends dorsally 0.3–0.5 times the distance up the vertical face of the midlobe and ventrally continues as a border of the anterior declivous face of the midlobe; lateral lobe of mesoscutum smooth and covered with fine, long setae (0.18–0.21 mm) that have the extreme api-

posterior margin of scutellar disc carinate and abruptly angled in profile, posterior declivous face of scutellum angled about 60° to dorsum (Fig. 18), posterior face usually vertically carinate; scutellar spines broad, dorsoventrally flattened and narrowly separated medially (Fig. 19), strongly bent apically; declivous face of scutellum ventral to spines finely reticulate with strong median carina. Femora smooth and with sparse adpressed setae. Upper prepectus smooth and moderately setose, apex separated from tegula, anterior margin of prepectus carinate. Forewing (Fig. 25) with speculum small and open basally; marginal vein with few minute setae apically, but otherwise bare. Hind wing with short marginal fringe. Petiole 3.3–3.9 times as long as broad, 1.4–1.6 times as long as hind coxa.

Male.—Length, 4.2 mm. Differs from female in the following features: antenna brown, apical half of scape and rami dark brown to black. Forewing weakly infusate. Head 1.6 times as broad as high. Facial reticulations shallow, frons with numerous irregular carinae. Eyes separated by 2.1 times their height. Malar space 0.86 times height of eye. Labrum with 8 digits. Labial palpus with two segments. Antennal scape reaching 0.7 times distance to median ocellus; F2 about as broad as long basally and with an elongate dorsal ramus (Fig. 24), ramus of F2 1.3 times as long as head height, terminal segment (clavus) undifferentiated, as long as ramus of penultimate flagellomere. MPS present as single or double row along outer lateral margin in apical two-thirds of each ramus, MPS recessed in shallow depression; setae along rami slightly shorter than width of ramus. Posterior margin of scutellar disc abruptly angled in profile (Fig. 20), apex projecting and rounded in posterior view; scutellar spines evenly cylindrical along entire length and broadly separated (Fig. 21), strong longitudinal carinae along entire length, apical third of spine bent ventrally in profile, apex of spine weakly emarginate. Petiole 2.4 times as long as broad, 7.7 times as long as hind

coxa. Dorsal length of gaster as long as petiole; Ms8 and genitalia not examined.

Immature.—The description of the first-instar (planidium) is based on two larvae attached to one adult female from La Selva (4.iv.1987). The indiscriminate attachment of planidia to adults of the same species is common among parasitoids of large ponerine ants and virtually unknown in any of the other groups of Eucharitidae. Presumably this behavior is correlated with very active larvae and probable phoretic attachment of larvae to foraging workers for transport to the host brood (cf. Clausen 1940b), or in this case, attachment to females visiting a site used for oviposition by a previous female. The first instar of *D. serrata* (Fig. 22) is similar to other Eucharitini (Heraty 1994). Larvae are 0.16–0.18 mm in length, possess a distinct labial plate, dorsal fusion of tergites I and II, a distinct tergo-pleural line separating the pleural region on tergites II–VIII, and two ventral setae on tergite III. The prominent narrow and rounded ventral margin of the cranium, elongate ventral process on tergites IV to IX and relative lengths of setae are the same as for *Kapala* (see Heraty and Darling 1984). *Kapala* has only two minute dorsal cranial sensillae; *D. serrata* has three pairs of sensillae: the anterior pair are relatively large and connected to the lateral margin by a thin line of desclerotization; the medial pair give rise to a minute setae, which is unknown in other Eucharitidae; the posterior pair are minute as in *Kapala*.

Comments.—One female paratype from Panama is distinct from the other specimens in having almost completely clear forewings, a shorter flagellum (0.78 times height of head), laterally smooth scutellum and axillula, medial carina on the scutellum, and no lateral carinae on the petiole, but these were considered as extremes of acceptable variation. A smooth scutellum and axillula, medial carina bordering one side of the median scutellar channel, weak petiolar carinae and only slightly infusate wings occur in the female paratype from the Osa peninsula that

sal length of gaster as long as petiole and genitalia not examined.

ure.—The description of the first-instar (anidium) is based on two larvae from one adult female from La Selva (1977). The indiscriminate attachment of larvae to adults of the same species is common among parasitoids of large ponerine ants and virtually unknown in any other groups of Eucharitidae. Presumably, this behavior is correlated with very large larvae and probable phoretic attachment to foraging workers for transport to the host brood (cf. Clausen 1940). In this case, attachment to feeding sites used for oviposition by the female. The first instar of *D. serrata* (22) is similar to other Eucharitini (Heraty 1994). Larvae are 0.16–0.18 mm in length, possess a distinct labial plate, dorsal setae on tergites I and II, a distinct tergo-pleural region separating the pleural region on tergites III–VIII, and two ventral setae on tergite II. The prominent narrow and shallow ventral margin of the cranium, the shallow ventral process on tergites IV to VI, and relative lengths of setae are the same as in *Kapala* (see Heraty and Darling 1989). *Kapala* has only two minute dorsal setae; *D. serrata* has three pairs of setae: the anterior pair are relatively widely connected to the lateral margin by a band of desclerotization; the medial pair arise to a minute setae, which is similar to other Eucharitidae; the posterior pair are minute as in *Kapala*.

ents.—One female paratype from La Selva is distinct from the other specimens in having almost completely clear forewings, a long flagellum (0.78 times height of petiole), a generally smooth scutellum and axillary carina on the scutellum, and no setae on the petiole, but these were not as extremes of acceptable variation as in a smooth scutellum and axillula, median bordering one side of the median channel, weak petiolar carinae and darkly infusate wings occur in the female paratype from the Osa peninsula that

is otherwise more similar to all of the other Costa Rican specimens.

Etymology.—Latin *serra* for saw—referring to the serrate antennal flagellomeres.

ACKNOWLEDGEMENTS

Dave Hawks (UCR) helped with the measurements and photographs, and critiqued the manuscript. Chris Darling and one anonymous reviewer also provided helpful comments on the manuscript. This research was sponsored by a National Science Foundation Grant BSR-96-29515 to the author.

LITERATURE CITED

Ashmead, W.H. 1904. Classification of the chalcid flies, or the superfamily Chalcidoidea, with descriptions of new species in the Carnegie Museum, collected in South America by Herbert H. Smith. *Memoirs of the Carnegie Museum* 1: i–ix, 225–551, pls. xxxi–xxxix.

Ayre, G.L. 1962. *Pseudometagea schwarzii* (Ashm.) (Eucharitidae: Hymenoptera), a parasite of *Lasius neoniger* Emery (Formicidae: Hymenoptera). *Canadian Journal of Zoology* 40: 157–164.

Clausen, C.P. 1940a. The immature stages of the Eucharitidae. *Proceedings of the Entomological Society of Washington* 42: 161–170.

———. 1940b. The oviposition habits of the Eucharitidae (Hymenoptera). *Journal of the Washington Academy of Sciences* 30: 504–516.

———. 1941. The habits of Eucharitidae. *Psyche* 48: 57–69.

Guérin-Méneville, F.E. 1838 (1845). *Iconographie du Règne Animal de G. Cuvier, Insectes*. 576 pp.

Heraty, J.M. 1985. A revision of the Nearctic Eucharitinae (Hymenoptera: Chalcidoidea: Eucharitidae). *Proceedings of the Entomological Society of Ontario* 85: 61–103.

Heraty, J.M. 1989. Morphology of the mesosoma of *Kapala* (Hymenoptera: Eucharitidae) with emphasis on its phylogenetic implications. *Canadian Journal of Zoology* 67: 115–125.

Heraty, J.M. 1994. Classification and evolution of the Oraseminae in the Old World, with revisions of two closely related genera of Eucharitinae (Hymenoptera: Eucharitidae). *Life Sciences Contributions, ROM* 157: 174 pp.

Heraty, J.M. And D.C. Darling 1984. Comparative morphology of the planidial larvae of Eucharitidae and Perilampidae (Hymenoptera: Chalcidoidea). *Systematic Entomology* 9: 309–328.

Jordan, K.H.C. 1913. Zur morphologie und biologie der myrmecophilen Gattungen *Lomechusa* und *Atemeles* und einiger verwandter Formen. *Zeitschrift für Wissenschaftliche Zoologie* 107: 346–386.

Kistner, D.H. 1979. Social and evolutionary significance of social insect symbionts, pp 340–413. In Hermann H.R., ed., *Social Insects*, Vol. I. Academic Press, New York. 437 pp.

Pasteels, J.M. 1968. Le système glandulaire tégumentaire des Aleocharinae (Coleoptera, Staphylinidae) et son évolution chez les espèces termitophile du genre *Termitella*. *Archives de Biologie* 79: 381–469.

Schmiedeknecht, O. 1909. Hymenoptera für Chalcidoidea. *Wytsman Genera Insectorum* 97: 1–550.

Shipp, J.W. 1894. A new classification of the genus *Thoracantha*, Latr. *The Entomologist* 27:188–190.

Vander Meer, R.K., D.P. Jouvenaz and D.P. Wojcik 1989. Chemical mimicry in a parasitoid (Hymenoptera: Eucharitidae) of fire ants (Hymenoptera: Formicidae). *Journal of Chemical Ecology* 15: 2247–2261.

Walker, F. 1862. Mr. F. Walker's notes on chalcidites and characters of undescribed species. *Transactions of the Entomological Society of London* 1: 380–385.

———. 1871. Notes on Chalcididae. Part IV. Chalcididae, Leucospididae, Agaonidae, Eucharitidae, Perilampidae, Ormyridae, Encyrtidae. London, pp. 55–70.

Westwood, J.O. 1874. *Thesaurus Entomologicus Oxoniensis*; or illustrations of new, rare, and interesting insects, for the most part contained in the collections presented. Oxford. 205 pp., 40 pls.

Wheeler, W.M. 1907. The polymorphism of ants with an account of some singular abnormalities due to parasitism. *Bulletin of the American Museum of Natural History* 23: 1–100.