

## A Review of the Nearctic Species of the Thrips-attacking Genus *Ceranisus* Walker (Hymenoptera: Eulophidae)

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### ABSTRACT

The thrips-attacking Eulophidae (subfamily Entedoninae) known from the Nearctic region are reviewed. One new species, *Ceranisus loomansi*, is described. Four other species of *Ceranisus* are redescribed and illustrated based mainly on a study of their type specimens as well as on additional material from Arizona, California, Hawaii, Mississippi and Japan. Lectotypes are designated for *Ceranisus americensis* (Girault), *C. nubilipennis* (Williams) and *C. russelli* (Crawford). A key to eight species belonging to four entedonine thrips-attacking genera is given, and host associations are indicated for those species.

Recent interest in biological control of thrips pests (Thysanoptera), in particular the western flower thrips, *Frankliniella occidentalis* (Pergande), brought to light several problems associated with the taxonomy of the thrips-attacking Entedoninae (Eulophidae). The objectives of this review are to clarify species issues in the genus *Ceranisus*, provide a key to the species of *Ceranisus* and other noteworthy entedonines.

The systematics of the Entedoninae, especially those belonging to the genus *Ceranisus* Walker, has not been treated at the specific level in North America since the turn-of-the-century description of *Ceranisus* (*Thripoctenus*) *russelli* (Crawford) (Crawford 1911) and the publication of Russell's classic work on its biology (Russell 1911, 1912). Thus, the taxonomy of this genus is in a very poor state worldwide, and no keys have been available for species recognition. The extremely small size and rarity of collection of these parasitoids has contributed to the lack of taxonomic activity and makes their identification by current workers difficult. Schauff's (1991) comprehensive revision of the Holarctic genera of Entedoninae greatly aided our review of the species of this group of minute parasitoids.

*Ceranisus* is a member of a natural group of four genera within the subfamily Entedoninae which also includes *Entedonastichus* Girault, *Goetheana* Girault, and *Thripobius* Ferrière (Bouček 1976; Schauff 1991). Apart from all being known as primary parasitoids of thrips, these genera share a combination of the following morphological features: a complete, transverse occipital suture (Schauff 1991), body size usually small (less than 1 mm); female antennae short, more or less clavate and always with 2-segmented funicle; head and mesosoma dorsally smooth, without distinct reticulation; axillae not advanced into mesoscutum (Bouček 1976,

1988).

*Ceraninus* was established as a name bearing drawing (Walker 1841). The genus *Thripoctenus* was described by Crawford (1911) (type-species *T. russelli* Crawford), but was later synonymized under *Ceraninus* by Graham (1959) who examined the types of *C. menes* (Walker) and *C. pacuvius* (Walker) from Europe. Another species of *Thripoctenus*, *T. nubilipennis* Williams, was described from Massachusetts as a parasitoid of two species from the family Phlaeothripidae (Williams 1916). One year later, Girault (1917a) established a new genus *Cryptomphale* based on *T. nubilipennis* as a type species, angrily stating in his privately published paper that: "To say this species is a *Thripoctenus*, in these days, is wrong and careless...". *Cryptomphale* was subsequently synonymized under *Ceraninus* by Peck (1963).

The other three genera of thrips-attacking entedonines, *Entedonastichus*, *Goetheana*, and *Thripobius*, are represented in the Nearctic region by one species each. No host records are available for *Entedonastichus kaulbarsi* (Yoshimoto), a brachypterous species known only from females. *E. kaulbarsi* presumably parasitizes Thysanoptera (Yoshimoto 1981).

Some species of *Ceraninus* may become important biological control agents against thrips pests, although their use to date has been limited (Loomans and Van Lenteren 1990). All known species of *Ceraninus* are solitary, internal parasitoids of the larval and pupal stages of various Thysanoptera. Loomans and Van Lenteren (1990) provided a global listing of the described species of *Ceraninus* and their associated host thrips. This list, however, omitted the Australian species *C. margiscutum* (Girault) (Bouček 1988).

Biological control with other entedonines has had variable success. *Goetheana shakespearei* Girault [= *G. parvipennis* (Gahan)] was introduced into California in 1962 from Jamaica and in 1983 from the Bahamas against greenhouse thrips, *Heliethrips haemorrhoidalis* (Bouché), infesting avocado (Hessein and McMurtry 1989). Many aspects of the biology of *G. shakespearei* on *H. haemorrhoidalis* were studied including mass-production and demography (Hessein and McMurtry 1989). However, McMurtry et al. (1991) reported that this parasitoid failed to become established in California. Recently, *G. shakespearei* was recorded from Florida (Bennett et al. 1993). The taxonomy of *G. shakespearei* is provided by Viggiani and Nieves-Aldrey (1993), and additional host records are provided by Viggiani and Nieves-Aldrey (1993) and Bennett et al. (1993).

*Thripobius semiluteus* Bouček, originally described from the island of São Tomé and India (Bouček 1976), was imported into southern California from Australia in 1986 and from Brazil in 1988 again for control of *H. haemorrhoidalis* in avocado (LaSalle and McMurtry 1989) and has become established (McMurtry et al. 1991). Other known hosts of *T. semiluteus* are *Brachyurothrips anomalus* Bagnall and *Panchaetothrips indicus* Bagnall, all three are in the subfamily Panchaetothripinae, family Thripidae (LaSalle and McMurtry 1989).

As the demand for natural enemies of thrips pests increases there will be a commensurate increase in the number of laboratory cultures of thrips parasitoids; quality control then becomes a significant issue. We have

already put a scientific name to a *Ceranisus* species being propagated for mass-release against thrips pests in glasshouses. As stated above, the key to species presented herein will serve to aid in identification of the Nearctic entedonine parasitoids.

Bouček (1976, 1988) and Schauff (1991) treated the taxonomy of *Entedonastichus*, *Goetheana*, and *Thripobius*, therefore they are not considered in this review. However, we include each Nearctic species of these genera into the key presented below because they are often confused with *Ceranisus* species.

Morphological terminology follows Schauff (1991). Specimens examined are deposited in the collections indicated by the following acronyms:

BMNH	The Natural History Museum, London
CASC	California Academy of Sciences, San Francisco
FSCA	Florida State Collection of Arthropods, Gainesville
UCRC	University of California, Riverside
USNM	National Museum of Natural History, Washington, D.C.

Abbreviations used: F = funicular segment.

#### Key to Nearctic Species of Entedonine Parasitoids of Thrips (females)

- 1 Forewing recurved along posterior margin, nearly parallel sided below marginal vein; length of marginal fringe exceeds width of wing (Fig. 1) ..... *Goetheana shakespeariei* Girault
- 1' Shape of forewing not as above (Fig. 2); length of marginal fringe less than width of wing; or brachypterous specimens ..... 2
- 2 Antennal club 1-segmented ..... 3
- 2' Antennal club either 2-segmented or 3-segmented ..... 4
- 3 Winged ..... *Ceranisus nubilipennis* (Williams)
- 3' Brachypterous ..... *Entedonastichus kaulbarsi* (Yoshimoto)
- 4 Length of marginal fringe about 1/2 width of forewing (Fig. 8); antennal flagellum with long setae and sensory ridges (Fig. 7), such ridge(s) on F1 extending well beyond distal margin ..... 5
- 4' Length of marginal fringe much shorter than 1/2 width of forewing (Figs. 2, 11); antennal flagellum with shorter setae (Fig. 9) (except in males) and sensory ridges may be absent on one or more flagellomeres and not extending as far beyond distal margin (Figs. 9, 10, 20) (genus *Ceranisus* Walker) ..... 6
- 5 Antennal funicular segments more or less transverse and relatively tightly appressed (Fig. 3) ..... *Thripobius semiluteus* Boucek
- 5' Antennal funicular segments elongated, thus appearing loosely joined (Fig. 4) ..... *Ceranisus russelli* (Crawford)

- 6 Forewing with sector of cubital vein (marked by line of hairs) beyond basal vein strongly sinuate upwards, leaving broad bare space between it and posterior margin of wing (Fig. 11); postmarginal vein very short, much shorter than stigmal vein.  
..... *C. menes* (Walker)
- 6' Forewing with sector of cubital vein beyond basal vein nearly straight or only slightly curved upwards, at most leaving a narrow bare space between it and posterior margin of wing (Figs. 14, 16); postmarginal vein subequal to or longer than stigmal vein  
..... 7
- 7' Antennal flagellum with F1 markedly shorter than F2 (Figs. 13, 21)  
..... *C. americensis* (Girault)
- 7' Antennal flagellum with F1 slightly longer than F2 (Fig. 15) .....  
..... *C. loomansi*, NEW SPECIES

### Genus **CERANISUS** Walker

Figs. 22, 23

*Ceraninus* Walker, 1841: vi, plate N, fig. 2. Type species: *Cirrospilus pacuvius* Walker; by monotypy.

*Thripoctenus* Crawford, 1911: 233. Type species: *Thripoctenus russelli* Crawford; by monotypy.

*Epomphale* Girault, 1915: 211. Type species: *Epomphale auriventris* Girault; by original designation.

*Entedonomphale* Girault, 1915: 216. Type species: *Entedonomphale margiscutum* Girault; by original designation.

*Cryptomphale* Girault, 1917a: 2. Type species: *Thripoctenus nubilipennis* Williams; by original designation.

*Diagnosis*.—(Figs. 22, 23). Occipital suture present; scrobal grooves present and V-shaped; malar groove present and straight; frontal grooves reaching eye on level with anterior ocellus; female flagellum with 2 funiculars and distinct club; hindwing acutely pointed; forewing broadened beyond submarginal vein; males often with scape swollen (Schauff 1991). Other distinguishing characters of *Ceraninus* are as follows: body usually yellow to dark brown or black; female club usually 2-segmented except in *C. russelli* (Crawford) 3-segmented, male club 3-segmented, both with distinct apical spicula; anterior margin of scutellum straight. *C. nubilipennis* (Williams) differs from this diagnosis considerably (see below).

### **Ceraninus nubilipennis** (Williams)

Figs. 5, 6

*Thripoctenus nubilipennis* Williams, 1916: 55-56.

*Cryptomphale nubilipennis* (Williams); Girault, 1917a: 2.

*Thripoctenus nubilipennis* Williams; Peck, in Muesebeck et al., 1951: 442.

*Ceraninus nubilipennis* (Williams); Peck, 1963: 117.

*Ceraninus nubilipennis* (Williams); Burks, in Krombein et al., 1979: 1006.

*Type locality*.—Forest Hills, Massachusetts, U.S.A.

*Type material*.—Lectotype female on slide, here designated (marked by arrow): U.S.A. Massachusetts: Forest Hills, VIII.1915. Paralectotypes: 1 female on same slide with lectotype; 1 male on separate slide, same data (USNM).

*Description*.—**Female**. General body coloration shining black; antennae dusky, legs dark brown except tarsi brown or light brown. Eyes very dark red, almost black, ovipositor yellow (Williams 1916). Wings with distinct medial cloud not extending far beyond venation, venation brown.

Head about as wide as or slightly wider than mesosoma. Antenna (Fig. 5) inserted just above clypeus (Williams 1916), sparsely setose except club appears more bristly. Radicle small but distinct; scape broadening in basal half and narrowing apically, about 4x longer than wide and 2x as long as pedicel; pedicel slightly broader than scape; single anellus transverse and very small; F1 markedly smaller than F2, subquadrate; F2 transverse; single segment of club oval, much wider than preceding segments, about 2x as long as wide.

Scutellum advanced into mesoscutum anteriorly. Forewing (Fig. 6) extending far beyond apex of metasoma, about 3x as long as wide, more or less uniformly covered by short setae beyond middle of submarginal vein. Postmarginal vein about as long as or only slightly longer than stigmal vein. Hindwing with longest marginal hairs exceeding maximum wing width.

Ovipositor occupying about 4/7 length of metasoma; ovipositor/hind tibia ratio 1.2: 1.

**Male**. Similar to female except tarsi darker; antennal flagellum more setose, with sensory ridges; scape slightly more swollen than in female, narrowing only in distal 1/4, about 3x as long as wide; pedicel about as wide as F1; F1 and F2 subequal in length but F2 slightly wider; club 3-segmented, well-defined, distal segment with a long apical spicula.

*Geographical distribution*.—U.S.A.: Massachusetts.

*Hosts*.—*Cryptothrips rectangularis* Hood and *Megalothrips spinosus* Hood (Thysanoptera: Phlaeothripidae) (Williams 1916).

*Comments*.—Williams (1916) did not designate any type specimen(s) nor mention their depository in the original description of this species. We presumed that at least a part of Williams's material might be kept in the Museum of Comparative Zoology at Harvard University, but inquiries about such material bore no results (Stefan P. Cover, personal communication). Therefore, our concept of this species is based mainly on Williams's original description and a study of the three specimens from the USNM collection. We believe that these slide-mounted specimens (a male and two females) in fact represent a portion of the type series of *C. nubilipennis* as they were collected in August 1915. Williams (1916) mentioned that in August 1915, "... numbers of adults and pupae of the *Thripoctenus* were obtained".

These three specimens are in relatively good condition, but had not been macerated before mounting and are oriented such that the malar sutures are not visible. The malar suture is an important character for

genus recognition. The malar suture in *Entedonastichus* is an inverted Y (Schauff 1991). Further, the author of this species was mistaken when he stated that the club of the female antenna is 3-segmented (Williams 1916); in both female specimens the club is distinctly 1-segmented (Fig. 5).

*C. nubilipennis* can be easily distinguished from other *Ceraninus* species in having antennal club of female entire and lacking apical spicula and scape expanded basally. In addition, *C. nubilipennis* has the anterior margin of scutellum angulate while in other members of *Ceraninus* it is straight.

*C. nubilipennis* closely resembles *Entedonastichus* spp., but differs by the presence of only two funicular segments on the male antenna compared to three in *Entedonastichus* according to Erdös (1954) (e.g., *E. carbonarius* (Erdös)), and Bouček (1988). Other morphological features of *C. nubilipennis* correspond with Bouček's diagnosis of *Entedonastichus* (1988) including similarities in coloration and the structure of the female antennae, wings, dorsum of the mesosoma, and having an elongate petiole. When more material of both genera is examined (in progress), these generic concepts may change and the placement of *C. nubilipennis* may be reconsidered.

### ***Ceraninus russelli* (Crawford)**

Figs. 7, 8; 18, 19

*Thripoctenus russelli* Crawford, 1911: 233.

*Thripoctenus russelli* Crawford; Russell, 1911: 235-238.

*Thripoctenus russelli* Crawford; Russell, 1912: 25-52.

*Thripoctenus russelli* Crawford; Peck, in Muesebeck et al., 1951: 442.

*Ceraninus russelli* (Crawford); Peck, 1963: 117.

*Ceraninus russelli* (Crawford); Burks, in Krombein et al., 1979: 1006.

*Type locality*.—Compton, California, U.S.A.

*Type material*.—Examined. **Lectotype**: female, here designated, on slide labelled: 1. "*Thripoctenus russelli* Cwfd. Mounted by Gahan in January 1923 being part of material in vial, were dry & shrivelled. Paratypes [Type - crossed out] No. 14353 U.S.N.M."; 2. [copied from original label from the vial which contained types] "618° - Compton - IX-18-1911 Bred from *H. fasciatus* Progeny of unfertilized female J.E. Graf."; 3. "*Thripoctenus russelli* Crawford = *Ceraninus russelli* (Crawford). LECTOTYPE female [marked by arrow] + 3 female PARALECTOTYPES, des. S. Trjapitzin & D. Headrick 1995". **Paralectotypes**: here designated, the above 3 females; 15 females, on points, same data except 3 dated 9-27.VIII.1911 and 2 dated 9-15.IX.1911. Miscellaneous body parts of other broken paralectotype material, on 10 slides, same data except some dated 9-15.IX.1911 (all USNM).

*Material examined*.—U.S.A. California: Los Angeles Co., Compton, 11.IX.1911, J.E. Graf—3 females (UCRC); same data except 9.IX.1911, H.M. Russell—3 females; Tulare Co., Lindsay, 13.VIII.1912, C.E. Pemberton, from leaf of *Lactuca scariola*—4 females (all BMNH).

*Description*.—**Female**. Head and mesosoma dark brown, almost black,

shining; metasoma light brown except distal half dark brown dorso-laterally; legs yellow, venation brown. Antenna dusky, eyes black.

Head with antenna inserted just above lower ocular line; malar suture straight (Fig. 18); antenna (Fig. 7) with small trapezoidal radicle; scape slender and curved, about 5.7x longer than wide and 2.4x as long as pedicel; pedicel elongated, wider than funicle segments; F1 subequal to F2 in size but slightly shorter, both with one sensory ridge and one stelex (finger-like) sensillum as well as long setae present; club 3-segmented, club segments bear long setae, elongate acanthae (i.e. a non-socketed, elongate integumental projection), and several sensory ridges; distal segment with distinct apical spicula.

Forewing (Fig. 8) with dense discal ciliation beyond base of marginal vein; longest fringe setae about 1/2 of maximum wing width; submarginal vein usually with 2 hypochaetae opposite to basal macrochaeta, about as long as marginal vein; postmarginal vein slightly longer than stigmal vein (Fig. 19).

Ovipositor occupying about 3/4 length of metasoma; ovipositor/hind tibia ratio about 1.2-1.4: 1.

**Male.** Unknown.

*Geographical distribution.*—USA: California; ?England.

*Hosts.*—*Caliothrips fasciatus* (Pergande), *Frankliniella tritici* (Fitch), *Heliethrips haemorrhoidalis* (Bouché), *Hercinothrips femoralis* (Reuter), *?Scirtothrips citri* (Moulton), *Taeniothrips simplex* (Morgan), and *Thrips tabaci* Lindeman (Thysanoptera: Thripidae).

*Comments.*—The type material of this species is mounted and preserved very poorly. The specimens exhibited a 3-segmented club, elongated sensory ridges on the flagellum of the female antenna, and long marginal fringes on the forewing, which are morphological features characteristic of *Thripobius* not *Ceranisus*. However, after examination of the head of *C. russelli* (Fig. 18) with scanning electron microscopy, the lack of a Y-shaped malar suture, which is present in *Thripobius* species, was confirmed. Therefore, until fresh material of *C. russelli* is collected and examined we consider this species to be a member of *Ceranisus*. We also are reluctant to erect any superspecific taxon for *C. russelli* until a world review of *Ceranisus* and *Thripobius* is completed.

Stocks of *C. russelli* were obtained in California for release in Hawaii in 1930 to attempt control of *T. tabaci*, but the parasitoids failed to establish (Clausen 1978). The record of *C. russelli* from England (Bagnall 1914) appears doubtful.

### **Ceranisus menes** (Walker)

Figs. 9-12; 20

*Pteroptrix Menes* Walker, 1839: 18.

*Pteroptrix Menes* Walker, 1841: vi, plate M, fig. 3.

*Diglyphus aculeo* Walker, 1848: 236.

*Derostenus clavicornis* Thomson, 1878: 273.

*Asecodes aculeo* (Walker); Dalla Torre, 1898: 46.

*Ganahlia clavicornis* (Thomson); Dalla Torre, 1898: 50.

- Thripoctenus brui* Vuillet, 1914: 552-554.  
*Epomphale auriventris* Girault, 1915: 211.  
*Epomphale rubensteina* Girault, 1934: 3.  
*Euderomphale menes* (Walker); Erdős, 1956: 25.  
*Euderomphale clavicornis* (Thomson); Erdős, 1956: 25.  
*Ceraninus menes* (Walker); Graham, 1959: 203.  
*Ceraninus menes* (Walker); Bouček, 1961: 26.  
*Ceraninus rosilloi* De Santis, 1961: 13-15.  
*Ceraninus menes* (Walker); Graham, 1963: 203.  
*Ceraninus russelli* (Crawford); Valentine, 1967: 1124 (misidentification), Bouček, 1988: 734.  
*Ceraninus menes* (Walker); Bouček and Askew, 1968: 137.  
*Ceraninus menes* (Walker); Bouček, 1988: 734.  
*Ceraninus menes* (Walker); De Santis and Fidalgo, 1994: 89-90.

*Type locality*.—Near London, England.

*Type material*.—Not examined.

*Material examined*.—France. Lancs, Chat Moss., 12.VIII.1933, H. Britten, ex. flowers of *Callunae*—3 females. Germany. Kirzeburg, Kiel, XI.1934, H. Blunck, taken with *Kakothrips robustus* on peas—5 females (all BMNH). Japan. [no location data], 10.VII.1933, K. Sakimura—multiple females and males on 2 slides (UCRC); [no location or collector data], lab. culture, 30.III.1992—2 females (FSCA). U.S.A. California: Orange Co., Irvine, near S.-W. Exp. Sta., 4.V.1993, A.J.M. Loomans, on *Brassica nigra*—5 females; Santa Barbara Co., Santa Maria, 15.V.1993, A.J.M. Loomans, on *Brassica nigra* at Domian Rd.—2 females; Santa Clara Co., Sunnyvale, 19.IX.1943, R. Smith, on flower thrips, det. Gahan—2 females; San Joaquin Co., Lodi, 16.V.1993, A.J.M. Loomans, from alfalfa flowers;—6 females on 3 slides; Yolo Co.: Woodland, 17.V.1993, A.J.M. Loomans, on *Brassica nigra* at intersection of FWY5 and HWY113—2 females; near Yolo, 17.V.1993, A.J.M. Loomans, on *Brassica nigra* at roadside of HWY 16—2 females (all UCRC); Hawaii: Oahu, Honolulu, VII.1936, K. Sakimura, ex. *Thrips tabaci* on onion, det. K. Sakimura—9 females on 3 slides (FSCA).

*Description*.—**Female**. Head and mesosoma dark brown, metasoma either brown or yellow, infusate dorsally, ovipositor sheath infusate apically. Antenna dusky, eyes reddish. Wing venation dusky; legs pale, coxae brown.

Face with transverse sculpturing, vertex with longitudinal sculpturing, occiput with circumscribed sculpturing.

Antenna (Figs. 9,10) inserted at midpoint of eye height; small radicle well defined; scape slender, narrower and slightly curved apically with longitudinal sculpturing, a little more than 4x longer than wide; pedicel pyriform, with longitudinal sculpturing, about 2x as long as wide and about 1/2 length of scape; single anellus very small; funicle segments rectangular with F1 either subequal or shorter than F2, if F1 short then no sensory ridge present (Fig. 10), otherwise F1 and F2 bear single sensory ridge (Figs. 9, 20), F2 sometimes bearing stelex sensillum on apical margin, setae present on F1 and F2; club 2-segmented, basal segment slightly longer, club segments bear setae, elongate acanthae, and one or two sensory ridges; distal segment with distinct apical spicula.



Forewing (Fig. 11) with dense discal ciliation beyond base of marginal vein; distal row of hairs at cubitus strongly sinuate upwards leaving broad bare space between it and posterior margin of wing; longest fringe setae 1/3 of maximum wing width; submarginal vein with only 1 hypochaeta opposite to basal macrochaeta; marginal vein relatively long, postmarginal vein shorter than stigmal vein. Hind wing slightly shorter than forewing with longest fringe slightly longer than maximum wing width.

Ovipositor slightly longer than half the length of metasoma; ovipositor/hind tibia ratio about 1.5: 1.

**Male** (Japanese material, not found in the U.S.A.). Similar in size and coloration to female, except metasoma always brown.

Antenna (Fig. 12) with very long and enlarged setae, F1 and F2 equal in length, globose, club 3-segmented.

*Geographical distribution.*—Cosmopolitan.

*Hosts.*—For detailed lists of *C. menes* hosts see Loomans and Van Lenteren (1990) or Loomans (1991). Daniel (1986) provided names of some thrips hosts of this species in India. Some of the major pest thrips attacked by *C. menes* are *Kakothrips robustus* Uzel, *Frankliniella intonsa* (Trybom), *F. occidentalis* (Pergande), *F. schultzei* (Trybom), *Thrips palmi* Karny, and *Thrips tabaci* Lindeman.

*Comments.*—The specimens of *C. menes* listed above and those of *C. americensis* (see redescription below) under "Material examined" and collected by Antoon Loomans in California in May 1993, in fact were imported as living specimens into his Laboratory at Wageningen Agricultural University, The Netherlands, and subsequently reared on *Frankliniella schultzei* (Trybom) for four generations (A.J.M. Loomans, personal communication). Therefore, we examined the progeny of the specimens originated from the indicated localities.

Females of this species exhibit either a yellow or brown metasoma, and coloration appears to be consistent among the individuals collected from a given location. We have observed that the funicle condition in which F1 and F2 are nearly equal in size and both bear a sensory ridge is consistently associated with females having a brown metasoma and does not vary among individuals. The only known males of *C. menes* also are associated with females having a brown metasoma. Females with yellow metasoma typically have the F1 smaller and the sensory ridge absent, but laboratory cultures from Hawaii where *C. menes* is being reared also had specimens with F1 nearly equal to F2 and sensory ridges present. We were not compelled to separate these into separate species or intraspecific groups based on these characters for two reasons 1) not all of the material has been examined for this apparently globally distributed species and 2) the characters are not of themselves strong enough, in our opinion, to warrant separation. We are, however, aware that individuals of the two color morphs display some differences in their biology (A.J.M. Loomans, personal communication). The laboratory cultures from Hawaii may represent hybridization. The use of RAPD PCR may help to clarify this issue for *C. menes*, thus, we err on the side of conservatism until further research is conducted.

**Ceraninus americensis** (Girault)

Figs. 13, 14; 21

*Thripoctenus americensis* Girault, 1917b: 448.

*Thripoctenus americensis* Girault; Seamans, 1923: 24.

*Thripoctenus americensis* Girault; Peck, in Muesebeck et al., 1951: 442.

*Ceraninus americensis* (Girault); Peck, 1963: 117.

*Ceraninus americensis* (Girault); Burks, in Krombein et al., 1979: 1006.

?*Ceraninus* sp.; Greene and Parrella, 1992: 69, 72.

*Type locality*.—Salt Lake City, Utah, U.S.A.

*Type material*.—Examined. Females on type slide, labelled: 1. "*Thripoctenus* [*Paromphale* - crossed out] *americensis* Girault female Type No. 20729. U.S.N.M."; 2. "Webster N° 6699 Salt Lake City, Utah July 12, 1912 Swept from alfalfa CN Ainslie Collector" (USNM): **Lectotype**: female, here designated (marked by an arrow on the type slide); **Paralectotypes**: 35 females, here designated (see comments below).

*Material examined*.—U.S.A. Arizona: Cochise Co., Willcox, 10.V.1993, A.J.M. Loomans, on *Trifolium repens*—9 females (UCRC); Yavapai Co., Camp Verde, 13.V.1993, A.J.M. Loomans, on *Melilothus officinalis*—6 females (UCRC). California: Contra Costa Co., Mount Diablo State Park, Juniper Campground, ca. 885 m, 9.VII.1977, P.H. Arnaud, Jr., at flower *Adenostoma fasciculatum* Chamise (Rosaceae)—4 females (CASC); Fresno Co., Mendota, 16.V.1993, A.J.M. Loomans, on *Brassica* weeds—13 females (UCRC); Yolo Co., Davis, University of California campus, X.1992, I. Greene, from alfalfa field—3 females (Ian Greene, personal collection), 1 female (UCRC). Mississippi: Hattiesburg, 14.VI.1995, D. Headrick, by beating crepe myrtle blossoms, 3 females. Utah: Salt Lake Co., Salt Lake City, VIII.1912, C.N. Ainslie, swept from alfalfa, multiple females on slide; same data except 1912 (no date indicated), multiple females on slide (all USNM).

*Description*.—**Female**. Head, pronotum, mesoscutum and scutellum black, remainder of mesosoma and apical half of metasoma brown to dark brown except small yellowish band at apex. General coloration of antenna pale grey, scape and pedicel slightly darker; eyes pink. Wing venation dusky; legs light brown except tarsi slightly darker and coxae dark brown to black. Basal half of metasoma dorsally and about 2/3 of metasoma laterally yellow to light brown.

Frontovertex and occiput with faint sculpturing, remainder of head smooth. Antenna (Figs. 13, 21) inserted at level of lower 1/4 of eyes height; small radicle well defined; scape slender, slightly curved, a little more than 4x longer than wide; pedicel about 2x as long as wide and about half length of scape; single anellus very small; F1 slightly elongated and much smaller than F2, sometimes bearing one short sensory ridge but usually without sensilla; F2 usually with one or two sensory ridges which extend beyond apical margin; club 2-segmented, basal segment about as long as distal segment, but markedly broader; each segment with several sensilla and long setae, distal segment with distinct apical spicula.

Forewing (Fig. 14) with dense discal ciliation beyond base of marginal vein; distal row of hairs at cubitus straight; longest fringe setae about 1/3 of maximum wing width; submarginal vein with 2 to 4 hypochaetae opposite to basal macrochaeta; marginal vein relatively long, postmarginal vein markedly longer than stigmal vein. Hindwing only slightly shorter than forewing, with longest marginal cilia as long as maximum wing width.

Ovipositor occupying slightly more than half length of metasoma; ovipositor/hind tibia ratio as 1.4-1.8: 1.

**Male.** Unknown.

*Geographical distribution.*—Canada: Alberta; U.S.A.: Arizona, California, Mississippi, and Utah.

*Hosts.*—? *Frankliniella occidentalis* (Pergande) and *F. schultzei* (Trybom) (Thysanoptera: Thripidae).

*Comments.*—The slide which contains the type series of *C. americensis* is in poor condition. The coverslip of the type slide is cracked, apparently from an errant objective lens. Moreover, most of the type specimens were dissected by Girault in such a way that it was difficult for us to count the number of individuals present. The total number of specimens on this slide is probably slightly more than 40. The best, full-bodied specimen was chosen for lectotype designation. The paralectotype designation of the remaining 35 recognizable specimens is based on a few, full-bodied specimens and those bodies to which an appropriate head or other body part(s) could be associated. The multiple-slide-mounted specimens collected in 1912 from the type locality are in relatively good condition and provided additional material for the species redescription.

The type series and the other material of *C. americensis* from Utah is comprised of specimens which are more or less uniform in body length (about 0.8-0.9 mm). However, the specimen series collected at Willcox, Arizona include both large-bodied (about 0.90-1.05 mm) and small-bodied (about 0.70-0.75 mm) individuals. The latter lack sensory ridges on F1 and usually have just one sensory ridge on F2; whereas, the large-bodied specimens usually bear a sensory ridge on F1 on at least one antenna and two sensory ridges on F2. Specimens from Mississippi are about 0.85-0.90 mm long, but have a smaller ovipositor/hind tibia ratio (1.4: 1) than the specimens from Utah (about 1.6: 1), Arizona, or California (both 1.6-1.8: 1).

### ***Ceranisus loomansi* S. Triapitsyn & Headrick, NEW SPECIES**

Figs. 15, 16, 17

*Type material.*—Described from two females and two males as follows:

**Holotype.** Female on slide, labelled: "U.S.A., Arizona, Oak Creek Canyon near Flagstaff, 13.V.1993, A.J.M. Loomans, on *Lupinus* sp. (USNM).

**Paratypes.** 1 male on slide; 1 female, 1 male, both on points, all same data as holotype (UCRC).

*Description.*—**Female.** Length about 1.1 mm. General body coloration shining black except antennae, distal 1/4 of tibiae and tarsi dark brown;

wing venation brown. Mesoscutum with a faint metallic luster.

Head about as wide as mesosoma, smooth except frontovertex and malar space with very fine sculpturing. Antenna (Fig. 15) inserted above medial ocular line; radicle small but distinct, subquadrate; scape slender, slightly curved, about 7x longer than wide and 2.3x as long as pedicel; pedicel pyriform, broader than scape; single anellus very small, length/width ratio as 2: 5; F1 elongated, slightly longer than F2 and bearing one sensory ridge; F2 markedly broader than F1, with two larger sensilla which extend beyond segment limits; club 2-segmented, dividing suture at middle of club; each segment with several enlarged sensilla, distal segment with distinct apical spicula. Scape and pedicel very sparsely setose, remainder of antenna a little more evenly covered with short setae.

Forewing (Fig. 16) length/width ratio about 3: 1; distal row of hairs at cubitus straight; marginal vein (holotype) bears 8 long setae, postmarginal vein longer than stigmal vein (ratio 1.5: 1), stigmal vein with 4 placoid sensilla; longest setae of marginal fringe in subapical area, about 1/4-1/3 of maximum wing width.

Petiole about 3x wider than long. Ovipositor occupying about 2/3 length of metasoma; ovipositor/hind tibia ratio (holotype) 1.5: 1.

**Male.** Length about 1.2 mm. Similar to female except antenna dusky, legs darker than in female. Antenna (Fig. 17) with scape swollen, about 2.1x as long as wide; pedicel relatively narrow, as wide as F1; F1 elongated, with 1 sensory ridge; F2 oval, with 2 sensory ridges; club 3-segmented and distinct; scape and pedicel sparsely setose, flagellum more densely covered by long setae. Metasoma markedly longer than in female.

*Geographical distribution.*—Known only from the type-locality.

*Hosts.*—Unknown. Attempts to rear *C. loomansi* on *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) in the laboratory failed. Although the females readily attacked, oviposited, and developed in *F. occidentalis* larvae, none of the parasitoids could survive through the pupal stage (A.J.M. Loomans, personal communication).

*Diagnosis.*—The new species is most similar to the European species *C. pacuvius* (Walker) and especially to *C. nigrifemora* De Santis known from Argentina (De Santis 1961). *C. loomansi* can be most easily distinguished from *C. pacuvius* by the shape of the antennal scape in individuals of both sexes. The female scape is markedly dilated medially in *C. pacuvius* and slender in *C. loomansi*. The length/width ratio of the scape in male *C. pacuvius* is considerably less than that of the new species. *C. loomansi* differs from *C. nigrifemora* mainly in body coloration by being more or less uniformly black or dark brown; parts of antennae, legs, and metasoma are yellow in *C. nigrifemora*.

#### ACKNOWLEDGMENTS

We are indebted to Antoon Loomans (Department of Entomology, Wageningen Agricultural University, The Netherlands) for the supply of parasitoids and cooperation throughout this study. We are especially grateful to Michael E.

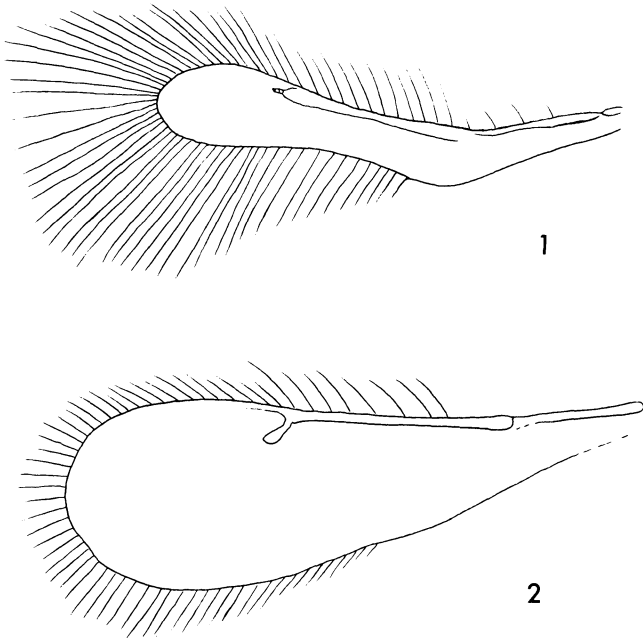
Schauff (Systematic Entomology Laboratory, c/o National Museum of Natural History, Washington, D.C.) and John LaSalle (International Institute of Entomology, c/o The Natural History Museum, London) for critical comments on the manuscript and the loan of type material. Vladimir A. Trjapitzin (Zoological Institute, Russian Academy of Sciences, St. Petersburg) kindly provided information on the literature and distribution of several European species. We thank , Wojciech J. Pulawski (California Academy of Sciences, San Francisco) and Greg Evans (Florida State Collection of Arthropods, Gainesville) for loans of specimens.

## LITERATURE CITED

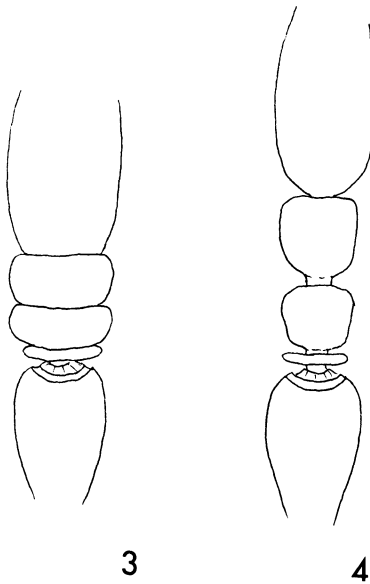
- Bagnall, R.S. 1914. A chalcid parasite on thrips. Rep. Brit. Assoc. Adv. Sci. 1913: 531.
- Bennett, F.D., H. Glenn and R.M. Baranowski. 1993. *Goetheana shakespearei* (Hymenoptera: Eulophidae) an immigrant parasitoid of thrips in Florida and Guadeloupe. Fla. Entomol. 76: 395-397.
- Bouček, Z. 1961. Materials on the chalcid (Chalcidoidea) fauna of the Moldavian SSR. Trudy Moldavskogo NII Sadovodstva, Vinogradarstva i Vinodelia 13: 15-38 (in Russian).
- Bouček, Z. 1976. Taxonomic notes on some Eulophidae [Hym.] of economic interest, mainly from Africa. Entomophaga 21: 401-414.
- Bouček, Z. 1988. Australasian Chalcidoidea (Hymenoptera): A biosystematic revision of genera of fourteen families, with a reclassification of species. CAB International Institute of Entomology, Wallingford, UK. 832 pp.
- Bouček, Z. and R.R. Askew. 1968. Index of Palearctic Eulophidae (excl. Tetrastichinae). Index of Entomophagous Insects (V. Delucchi and G. Remaudière, Eds.). Le François, Paris. 260 pp.
- Burks, B.D. 1979. Family Eulophidae, pp. 967-1022. In Krombein, K.V., P.D. Hurd, Jr., D.R. Smith and B.D. Burks (Eds.), Catalog of Hymenoptera in America North of Mexico. Vol. 1. Symphyta and Apocrita (Parasitica). Smithsonian Institution Press, Washington, D.C. 1198 pp.
- Clausen, C.P. 1978. Thysanoptera, pp. 18-21. In Clausen, C.P. (Ed.), Introduced parasites and predators of arthropod pests and weeds: A world review. U.S.D.A., Agric. Handbook No. 480. 551 pp.
- Crawford, J.C. 1911. Two new Hymenoptera. Proc. Entomol. Soc. Wash. 13: 233-234.
- Dalla Torre, C.G. de. 1898. Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus. Volumen V: Chalcididae et Proctotrupidae. Lipsiae, G. Engelmann. 598 pp.
- Daniel, A.M. 1986. Thrips-parasite interactions in some Panchaetothripine Thysanoptera (Insecta: Arthropoda). Proc. Indian Natn. Sci. Acad. B52 (4): 437-444.
- De Santis, L. 1961. Dos nuevos parasitos de tisanopteros de la Republica Argentina (Hymenoptera: Entodontinae). Not. Mus. La Plata, Zool. 20 (187): 11-19.
- De Santis, L. and P. Fidalgo. 1994. Catálogo de los Himenópteros

- Calcidoideos de América al sur de los Estados Unidos. Tercer suplemento (Insecta). Serie de la Academia Nacional de Agronomía y Veterinaria, No. 13. 154 pp.
- Erdős, J. 1954. Eulophidae hungaricae indescriptae. Ann. Hist. Natur. Mus. Nat. Hung. (Ser. Nov.) 5: 323-366.
- Erdős, J. 1956. Additamenta ad cognitionem faunae Chalcidoidarum in Hungaria et regionibus finitimis. VI. Eulophidae. Fol. Entomol. Hung. (Ser. Nov.) 9: 1-64.
- Ferrière, C. 1936. Un nouveau parasite de thrips de la Suisse. Mitt. Schw. Entomol. Ges. 16: 637-639.
- Girault, A.A. 1915. Australian Hymenoptera Chalcidoidea I-IV. Mem. Qd Mus., Suppl. 3: 142-346.
- Girault, A.A. 1917a. Speciosissima Genera Nuova Eulophidorum. Privately published. Washington, D.C. 4 pp.
- Girault, A.A. 1917b. Notes and descriptions of miscellaneous chalcid-flies (Hymenoptera). Proc. U.S. Nat. Mus. 53 (2213): 445-450.
- Girault, A.A. 1934. New Capsidae and Hymenoptera, with note on an unmentionable. Privately published. Queensland. 4 pp.
- Graham, M.W.R. de V. 1959. Keys to the British genera and species of Elachertinae, Eulophinae, Entedontinae, and Euderinae (Hym., Chalcidoidea). Trans. Soc. Brit. Entomol. 13 (10): 169-204.
- Graham, M.W.R. de V. 1963. Additions and corrections to the British list of Eulophidae (Hym., Chalcidoidea), with descriptions of some new species. Trans. Soc. Brit. Entomol. 15: 167-275.
- Greene, I. and M. Parrella. 1992. The basics of biocontrol. Natural enemies of WFT. Greenhouse Grower, December 1992.
- Hessein, N.A. and J.A. McMurtry. 1989. Biological studies of *Goetheana parvipennis* (Gahan) (Hymenoptera: Eulophidae), an imported parasitoid, in relation to the host species, *Heliothrips haemorrhoidalis* (Bouché) (Thysanoptera: Thripidae). Pan-Pacif. Entomol. 65: 25-33.
- LaSalle, J. and J.A. McMurtry. 1989. The first record of *Thripobius semiluteus* (Hymenoptera: Eulophidae) from the New World. Proc. Entomol. Soc. Wash. 91: 634.
- Loomans, A.J.M. 1991. Collection and first evaluation of hymenopterous parasites of thrips as biological control agents of *Frankliniella occidentalis*. SCOP/WPRS Bull. 14 (5): 73-82.
- Loomans, A.J.M. and J.C. Van Lenteren. 1990. Hymenopterous parasites as biological control agents of *Frankliniella occidentalis* (Perg.)?. SCOP/WPRS Bull. 13 (5): 109-114.
- McMurtry, J.A., H.G. Johnson and S.J. Newberger. 1991. Imported parasite of greenhouse thrips established on California avocado. Calif. Agric. 45 (6): 31-32.
- Peck, O. 1951. Superfamily Chalcidoidea, pp. 410-594. In Muesebeck, C.F.W., K.V. Krombein and H.K. Townes (Eds.), Hymenoptera of America North of Mexico. Synoptic catalog. U.S.D.A. Monograph No. 2. Washington, D.C. 1420 pp.
- Peck, O. 1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). Can. Entomol., Suppl. 30: 1-1092.
- Russell, H.M. 1911. A true internal parasite of Thysanoptera. Proc. Entomol.

- Soc. Wash. 13: 235-238.
- Russell, H.M. 1912. An internal parasite of Thysanoptera. U.S.D.A., Bur. Entomol., Techn. Ser. 23 (II): 25-52.
- Schauff, M. E. 1991. The Holarctic genera of Entedoninae (Hymenoptera: Eulophidae). Contrib. Amer. Entomol. Inst. 26 (4): 1-109.
- Seamans, H.L. 1923. The alfalfa thrips and its effect on alfalfa seed production. Can. Entomol. 55 (5): 101-105.
- Thomson, C.G. 1878. Hymenoptera Scandinaviae. Vol 5. Lund. 307 pp.
- Valentine, E.W. 1967. A list of the hosts of entomophagous insects of New Zealand. N. Z. J. Sci. 10: 1100-1210.
- Viggiani, G. and J.L. Nieves-Aldrey. 1993. Prima segnalazione di *Goetheana shakespearei* Girault (Hymenoptera Eulophidae), parassitoide esotico di Thysanoptera, per l'Europa. Boll. Zool. Agr. Bachic., Ser. II, 25 (1): 105-108.
- Vuillet, A. 1914. Note sur un chalcidien parasite du thrips des pois. Comp. Rend. Habd. Séanc. Mem. Soc. Biol., Paris 76: 552-554.
- Walker, F. 1839. Monographia Chalciditum. Vol. 1. H. Bailli'ere, London. 333 pp.
- Walker, F. 1841. [No title]. Entomologist 1, pl. A-P.
- Walker, F. 1848. List of the specimens of hymenopterous insects in the collection of the British Museum. Part II. - Chalcidites. Additional species. London, pp. i-iv & 99-237.
- Williams, L.T. 1916. A new species of *Thripoctenus* (Chalcidoidea). Psyche 23: 54-61.
- Yoshimoto, C.M. 1981. First record of *Thripoctenoides* from North America, with description of a new species (Hymenoptera: Eulophidae). Can. Entomol. 113: 723-725.

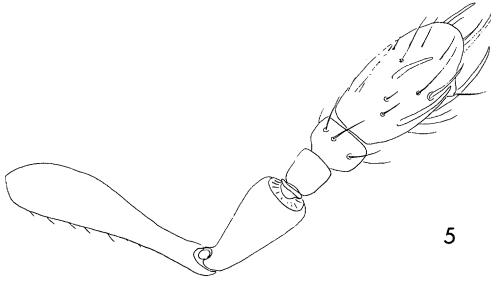


**Fig. 1.** Diagrammatic representation of the wing of *Goetheana*.  
**Fig. 2.** Diagrammatic representation of the wing of *Ceranisus*.

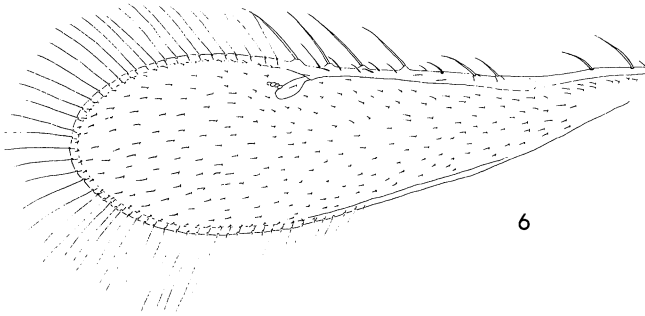


**Fig. 3.** Diagrammatic representation of the antenna of *Thripobius semiluteus*.  
**Fig. 4.** Diagrammatic representation of the antenna of *Ceranisus russelli*.



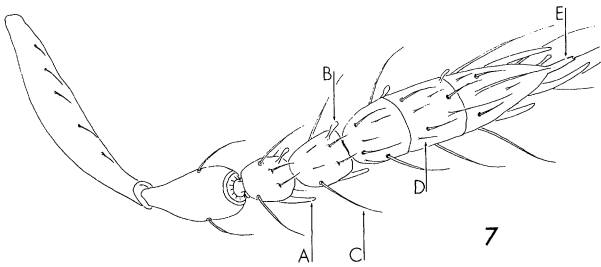


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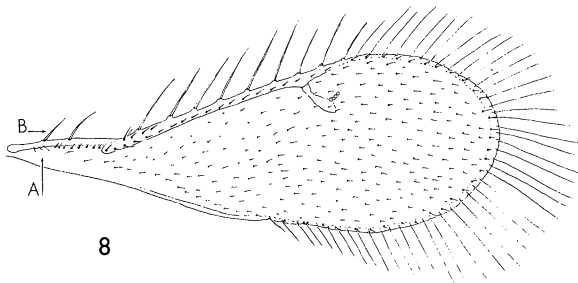


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Fig. 5. Antenna of *Ceranisus nubilipennis* female.  
Fig. 6. Wing of *Ceranisus nubilipennis* female.

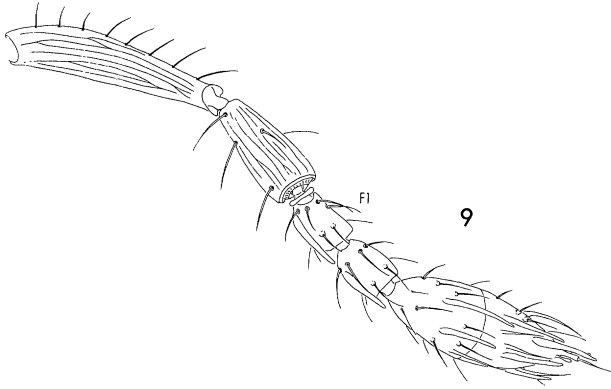


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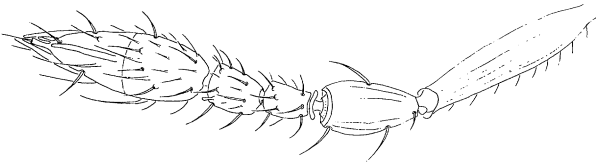


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Fig. 7. Antenna of *Ceranisus russelli* female: A, elongate sensory ridge; B, stelex sensillum; C, seta; D, elongate acanthus; E, spicula.  
Fig. 8. Wing of *Ceranisus russelli* female: A, hypochaetae; B, macrochaetae.

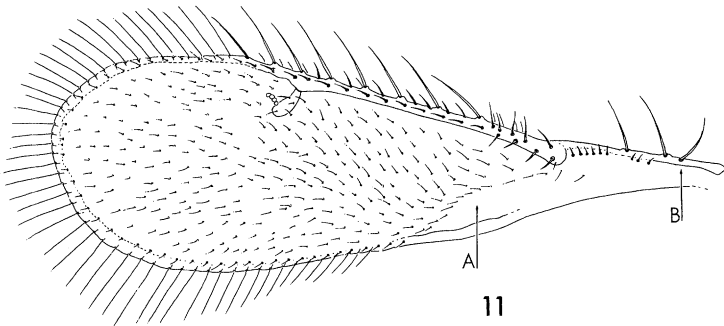


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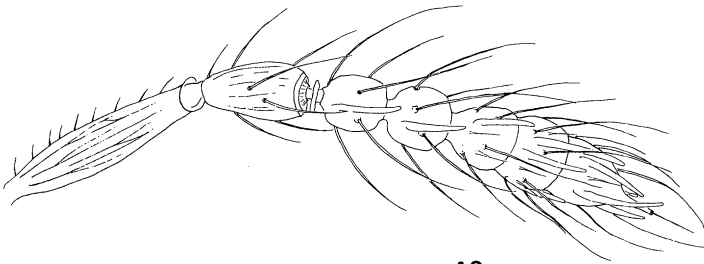


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**Fig. 9.** Antenna of *Ceranisis menes* female (brown metasoma).  
**Fig. 10.** Antenna of *Ceranisis menes* female (yellow metasoma).



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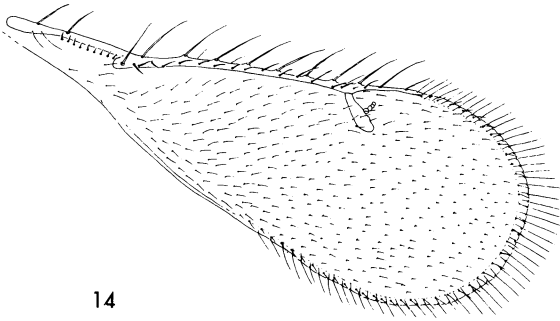


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**Fig. 11.** Wing of *Ceranisis menes* female: A, Sinuate cubitus and bare area;  
 B, single hypochoaeta.  
**Fig. 12.** Antenna of *Ceranisis menes* male.

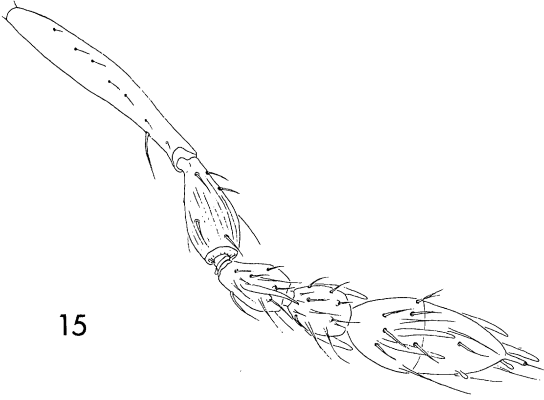


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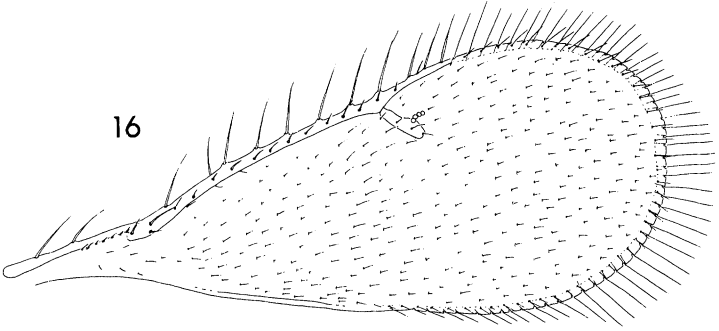


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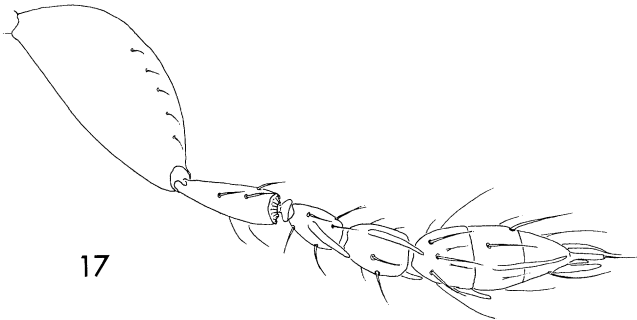
**Fig. 13.** Antenna of *Ceranisus americensis* female.  
**Fig. 14.** Wing of *Ceranisus americensis* female.



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Fig. 15. Antenna of *Ceranisus loomansi* female.

Fig. 16. Wing of *Ceranisus loomansi* female.

Fig. 17. Antenna of *Ceranisus loomansi* male.

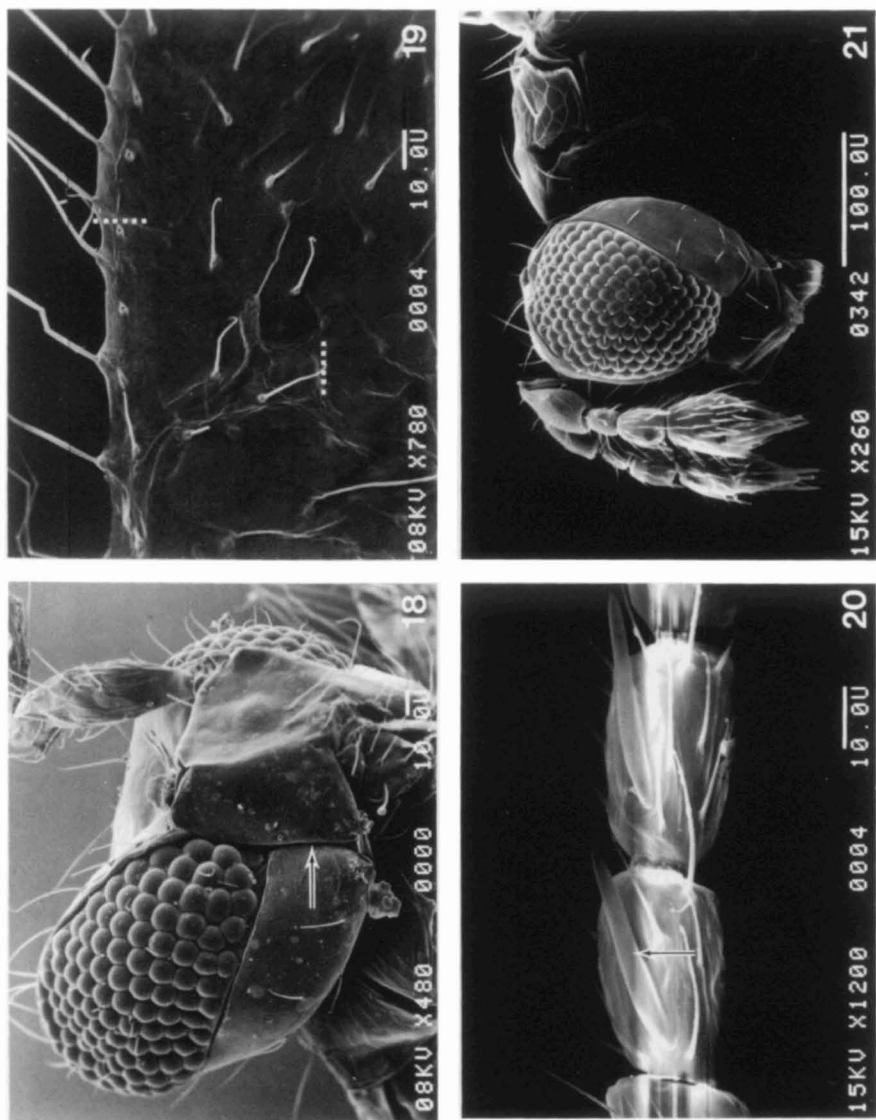


Fig. 18. Head of *Ceranisis russelli* female, arrow indicates malar groove.

Fig. 19. Wing venation of *Ceranisis russelli* female, dotted lines indicate the distal margins of the stigmal and post-marginal veins.

Fig. 20. Antennal funicular segments of *Ceranisis menes*, arrow indicates sensory ridge.

Fig. 21. Head and antennae of *Ceranisis americensis* female.

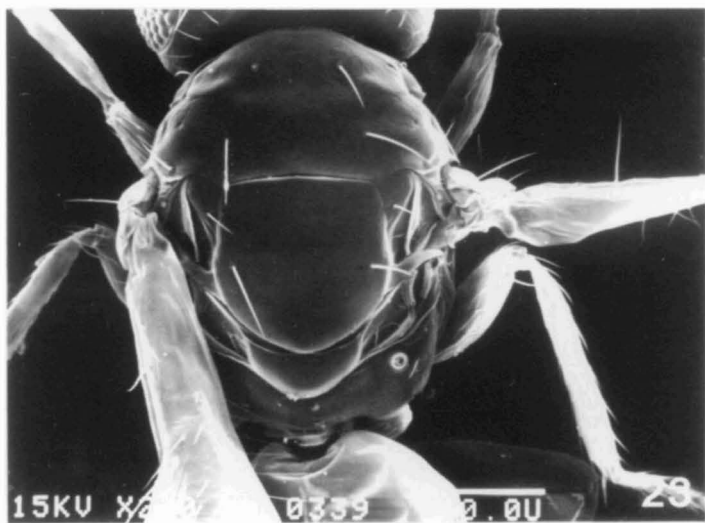
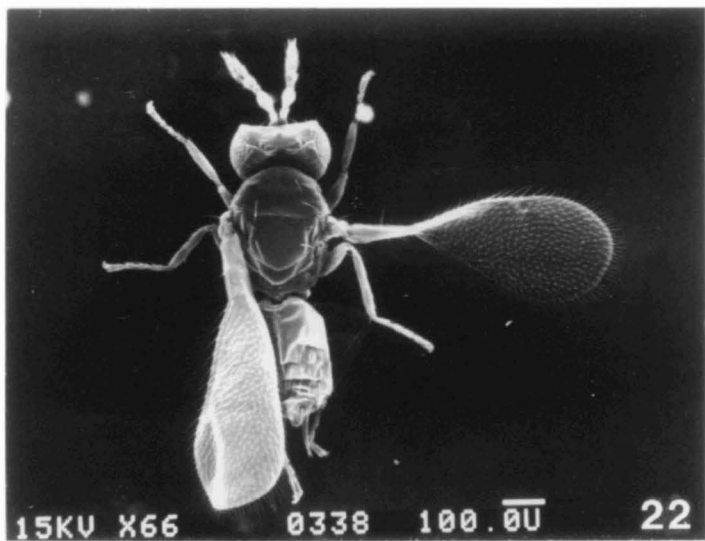


Fig. 22. Habitus of the genus *Ceranisis* (*Ceranisis americanensis* female shown).

Fig. 23. Detail of the dorsal mesosoma of *Ceranisis* (*Ceranisis americanensis* female shown).