

**TWO NEW EULOPHID PARASITOIDS (HYMENOPTERA:
CHALCIDOIDEA: EULOPHIDAE) OF *LIRIOMYZA
TRIFOLII* (BURGESS) (DIPTERA: AGROMYZIDAE)**

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ABSTRACT. *Cirrospilus ambiguus* and *Quadrastichus liriomyzae* (Hymenoptera: Eulophidae) are newly described, both reared from *Liriomyza trifolii* in Taiwan. *C. ambiguus* is known from Taiwan, India, Tanzania and South Africa, and *Q. liriomyzae* from Taiwan. These species are potential biological control agents against *L. trifolii*.

Introduction

Leafminers belonging to genus *Liriomyza* Mik cause damage to crops and flowers (Minkenberg & van Lenteren, 1986), and *L. trifolii* (Burgess) is one of a handful species causing the most severe damage in many areas of the world (Spencer 1973; Parrella, 1982; Minkenberg & van Lenteren, 1986). Knowledge of the natural enemies of *Liriomyza* species is thus important to workers attempting to implement biological control or integrated pest management programmes against these pests.

This paper describes two new species of Eulophidae, *Cirrospilus ambiguus* (Eulophinae) and *Quadrastichus liriomyzae* (Tetrastichinae) which are parasitoids of *Liriomyza trifolii*. *C. ambiguus* has a wide distribution in the Old World tropics, while *Q. liriomyzae* is known only from Taiwan.

Species of *Cirrospilus* are parasitoids or hyperparasitoids of a variety of hosts which are generally concealed in plant tissue, such as leafminers, leaf-rollers, and gall formers (Bouček, 1988). Leafmining hosts are mainly Lepidoptera (Bouček, 1959; Bouček & Askew, 1968, Burks, 1979); only a few species are known from Agromyzidae and hitherto none from *Liriomyza trifolii*. Australasian species of *Cirrospilus* were listed by Bouček (1988), and some Asian species of *Cirrospilus* have been treated by Kamijo (1987, 1992) and Sheng & Wang (1992). Altogether ten species are known from Asia: eight from Japan (three of which are also found in Europe), and two from China.

Quadrastichus species are mainly parasitoids of Cecidomyiidae galls and some Coleoptera, although a few other hosts are known such as Tephritidae,

Cynipidae, and gall-forming mites (Graham, 1991; LaSalle, 1994). Members of *Quadrastichus* have until recently been included under the generic name *Tetrastichus*, but this latter genus was shown to be an artificial assemblage which was divided into more natural genera by Graham (1987). Graham (1991) revised the European species of *Quadrastichus*, and LaSalle (1994) listed North American species; treatments of this genus in other areas are not available.

The acronyms of the museums where the type specimens are housed are given below:

- BMNH The Natural History Museum, London, UK.
LUZM Lund University Zoological Museum, Lund, Sweden.
PPRI Plant Protection Research Institute, Pretoria, South Africa.
TARI Taiwan Agricultural Research Institute, Taichung, Taiwan.
USNM United States National Museum of Natural History,
Smithsonian Institution, Washington, D.C.

***Cirrospilus ambiguus*, sp. nov. (Figs. 1-5)**

Diagnosis: Dorsum of mesosoma predominantly metallic, with only posterior half of axilla yellow and nonmetallic. Notaulus curved, meeting axilla at a distance well separated from posterior margin of mesoscutum; axilla protruding, mostly placed in front of the anterior margin of scutellum; midlobe of mesoscutum with two pairs of setae.

Both sexes: Length 0.7-1.1 mm. Frons pale yellow with infusate to dark metallic stripes as indicated on Fig. 3; vertex yellow with parts around ocelli partly to completely infusate; temple and occiput metallic greenish-blue, except pale yellow part close to mouth opening; malar space pale yellow with a narrow transverse metallic stripe between eye and mouth opening. Scape pale with apical part infusate, pedicel and flagellum dark. Mesosoma (Fig. 1) predominantly metallic greenish-blue to golden-green, but with lower part of lateral pronotum, posterior half of axilla, a median broad stripe on postspiracular sclerite and upper part of mesepisternum yellow. Coxae metallic greenish-blue; fore and middle femora pale, hind femur predominantly dark with base and apex pale; fore and middle tibiae pale, hind tibia predominantly dark with apical third pale; tarsi pale with apical segment infusate. Fore wing (Fig. 5) hyaline with part around stigmal vein infusate. Metasoma (Figs. 1-2) predominantly dark with metallic tinges and with pale yellow parts laterally, male also with pale subbasal spot.

Head (Fig. 3): Malar space 0.8 times the height of an eye. Anterior margin of clypeus almost straight. Frons and vertex with strong small-meshed reticulation, hence dull.

Antenna (Fig. 4) with two anelli, two funicular segments, and a three-segmented club. The first funicular segment as long as wide, the second

segment transverse. Flagellar segments with multiporous plate sensillae as indicated on Fig. 4.

Mesosoma (Fig. 1): Dorsum with rather strong and dense reticulation. Mesoscutum with complete and distinct notaulus, which meets axilla at a distance well separated from posterior margin of mesoscutum; midlobe of mesoscutum with two pair of setae. Axilla protruding, the major part placed anterior to border between mesoscutum and scutellum. Scutellum as long as wide, somewhat rounded, with sublateral grooves and with two pairs of setae close to grooves. Propodeum without median carina; propodeal callus with 2-4 setae.

Fore wing (Fig. 5) with postmarginal vein 0.7 times as long as stigmal vein; costal cell with 7-12 setae on lower surface and with 4-7 setae on upper surface in apical part of cell; submarginal vein with 4-8 setae; lower surface of wing membrane with 10-25 admarginal setae.

Metasoma (Figs. 1-2): Petiole short and transverse. Gaster about as long as length of mesosoma in both sexes, ratio length of mesosoma/length of gaster 0.9-1.0; tergites with weak and superficial reticulation.

Holotype: ♀, TANZANIA: Uluguru Mountains, near Morogoro, 8.viii.1994, J. LaSalle & J. Ismay (in BMNH).

Paratypes: 37 ♀, 36 ♂. Same label data as holotype, 2 ♂ (BMNH). TANZANIA: Morogoro: Sokoine University of Agriculture, 5-6.viii.1994, J. LaSalle & J. Ismay, 1 ♀, 2 ♂ (BMNH); 1 ♀, 1 ♂ (LUZM). SOUTH AFRICA: Natal: Winkelspruit: La Lucia, 16.i.1986, H. de Beer, ex. leaves of *Lantana camara* with mines of *Calycomyza lantanae*, 3 ♀, 6 ♂ (PPRI); 2 ♀, 2 ♂ (BMNH). TAIWAN: Taken, 25.xii.1993, C.C. Chien, ex *Liriomyza trifolii*, 7 ♀, 6 ♂ (BMNH); 7 ♀, 5 ♂ (LUZM); 13 ♀, 11 ♂ (TARI). INDIA: Delhi, IARI area, 14.x.1979, Z. Bouček, 1 ♀, (BMNH); same data as previous but collected 3.x.1979, 1 ♂ (BMNH); INDIA: Uttar Pradesh: Aligarh, 8-10.xi.1979, J.S. Noyes, 1 ♀ (BMNH); INDIA: Madhya Pradesh: Gwalior, 1958, O.S. Bindra, 1 ♀ (USNM); INDIA: Tamil Nadu: Madras, 2.xi.1979, Z. Bouček, 1 ♀, (BMNH).

Distribution: Taiwan, India, Tanzania, South Africa.

Hosts: *Liriomyza trifolii*, *Calycomyza lantanae* (Agromyzidae). Several species of *Cirrospilus* are known to attack a wide range of hosts (Bouček & Askew, 1968; Burks, 1979). *C. ambiguus* might also be quite polyphagous; our knowledge of its host range will depend upon future rearings.

Discussion: *Cirrospilus ambiguus* can be distinguished quite easily from other species of *Cirrospilus* by the notaulus, which extends from the anterior margin of the mesoscutum to the anterior margin of the axilla (rather than extending to the hind margin of the mesoscutum). No other *Cirrospilus* has this character, and it has previously been used as one of the diagnostic characters to separate *Zagrammosoma* from *Cirrospilus* (see discussion below).

The presence of metallic coloration will distinguish *C. ambiguus* from members of the closely related genus *Zagrammosoma*.

Cirrospilus is quite closely related to *Zagrammosoma*. Bouček (1959) and Peck *et al.* (1964) considered *Zagrammosoma* as a subgenus of *Cirrospilus*. More recently, authors have considered *Zagrammosoma* to be worthy of generic status (Gordh, 1978; Bouček, 1988; LaSalle, 1989).

An interesting feature of *Cirrospilus ambiguus* is the shape and placement of the notaulus. Bouček (1988) and LaSalle (1989) both used the shape of the notaulus as a character which could be used to separate the genera *Cirrospilus* and *Zagrammosoma*. In *Cirrospilus*, the notaulus is generally straight posteriorly, and extends to the posterior margin of the mesoscutum; in *Zagrammosoma* the notaulus is curved, and extends to the anterior margin of the axilla. A second character used to distinguish these genera is that in *Zagrammosoma* the vertex is vaulted and extends much higher than the compound eye, while in *Cirrospilus* the head is normal and does not have a vaulted vertex (this is clearly an autapomorphic character for *Zagrammosoma*).

Cirrospilus ambiguus has the notaulus extending to the anterior margin of the axilla, as is characteristic for *Zagrammosoma* rather than *Cirrospilus*. However, we feel that it is best to place this species in *Cirrospilus* because it does not have the vaulted vertex, and it is mainly metallic in coloration. Although *Cirrospilus* species can range in colour from metallic to non-metallic, *Zagrammosoma* species are always non-metallic.

The presence of this form of notaulus in *Cirrospilus* might serve to question the validity of *Zagrammosoma* as a genus, particularly as *Zagrammosoma* may represent merely a derived lineage from within *Cirrospilus*, and its recognition may leave *Cirrospilus* as paraphyletic.

Another interesting feature of this species is its distribution. Specimens were originally reared from *L. trifolii* in Taiwan, but recent collections and examination of museum specimens have shown this species also to be present in Africa and India (although not necessarily as a parasitoid of *L. trifolii*). It may have a quite widespread distribution in the Old World tropics; whether this is natural or due to accidental introductions is not known.

***Quadrastichus liriomyzae*, sp. nov. (Figs. 6-9)**

Diagnosis: Body dark brown to black with extensive yellow markings; midlobe of mesoscutum mainly yellow but with dark area anteromedially. Frons with a broad median area rather than a distinct median line. Malar sulcus distinctly curved, without fovea beneath eye. Anterior margin of clypeus truncate, without distinct teeth or lobes. Antennal scape not reaching above vertex (although it is generally about as long as or slightly longer than eye). Midlobe of mesoscutum with a single adnotaular seta on each side,

placed in posterior half. Anterior seta on scutellum distinctly longer than posterior seta. Dorsellum flattened.

Female: Length 0.75-1.1 mm. Body dark brown to black, with extensive yellow markings as follows: head except for ocellar triangle; antennal scape; pronotum; mesoscutum except for anteromedial dark patch; sometimes axilla; sometimes scutellum laterally; prepectus; mesopleuron anteriorly; basal half of gaster; all legs and coxae.

Head: Frons with a broad median area rather than a distinct median line. Eyes sparsely to moderately clothed with short setae. Malar space 0.5-0.6 times eye height; malar sulcus distinctly curved, without fovea. Anterior margin of clypeus truncate, without distinct teeth or lobes.

Antenna (Fig. 9): Scape 3.7-4.3 times as long as wide, about equal in length to or slightly longer than eye height, not reaching above apex of vertex. All funicular segments distinctly longer than wide; F1 slightly shorter than F2 and F3, which are subequal in length. Club 3.5-4.0 times as long as wide; slightly longer than F2 and F3 combined; with distinct terminal spine; suture between apical two segments oblique.

Mesosoma (Figs. 6, 7): Pronotum uniformly sculptured. Midlobe of mesoscutum with a weak median line, with a single adnotaular seta on each side placed in posterior half. Scutellum without offset border, distinctly broader than long; anterior seta on scutellum distinctly longer than posterior seta. Dorsellum large, flattened, extending posteriorly over the propodeum. Propodeum with broad, weak median carina; with weak paraspiracular carina which encloses a concave area associated with the spiracle.

Fore wing (Fig. 8) with a single seta on the submarginal vein; 2.15-2.3 times as long as broad (this slightly longer than in *anysis*, which is 2.0-2.1 times as long as broad). Marginal vein long and narrow, 3.8-4.4 times as long as stigmal vein. Marginal fringe 0.1-0.15 the width of wing. Hind wing long and narrow; distinctly pointed apically; marginal fringe about as long as maximum wing width.

Metasoma ovate acuminate, about as long as, or slightly shorter than, head plus mesosoma. Hypopygium extending slightly past half the length of the gaster. Cercus with one seta which is distinctly longer than the remaining setae, and sinuate or kinked.

Male: Length 0.65-0.80 mm. Similar to female except in genital and antennal characters; and basal tergite darkened dorsally. Funicular segments 1-3 with basal whorls of long setae dorsally; F4 and club segments with a few scattered long setae, but these not arranged in a distinct basal whorl. F1 quite short, about half the length of F3 (which is the longest segment); F4 distinctly shorter than F3, F2 slightly shorter than F3.

Holotype: ♀, TAIWAN: Taken, 7.x.1992, C. C. Chien, ex *Liriomyza trifolii* (in BMNH).

Paratypes: 4 ♀, 10 ♂. Same data as the holotype, 2 ♀, 4 ♂ (BMNH); 1 ♀, 3 ♂ (LUZM); 1 ♀, 3 ♂ (TARI).

Distribution: Taiwan.

Host: *Liriomyza trifolii* (Agromyzidae).

Discussion: Graham (1991) characterized the genus *Quadrastichus* and revised the European species. This species would key to couplet 20 in Graham's (1991) key to European *Quadrastichus* based on the following characters: body dark brown to black with extensive yellow markings; frons without median carina, with wide median area; malar sulcus distinctly curved, and without a subtriangular fovea beneath eye; pronotum uniformly sculptured. Other species which come to this couplet are *anysis*, *citrinus* and *xanthosoma*.

At couplet 20, *Q. liriomyzae* would appear to be closest to *Q. anysis* (Walker), with which it shares the following characters: antennal scape not reaching above vertex (although it is generally about as long as or slightly longer than eye); midlobe of mesoscutum with a single adnotaular seta on each side, placed in posterior half; gaster only about as long as or slightly shorter than mesosoma plus head; anterior margin of clypeus truncate, without teeth; anterior seta on scutellum distinctly longer than posterior seta.

Q. liriomyzae and *Q. anysis* are quite close, and may best be separated as follows: *liriomyzae* has the midlobe of mesoscutum mainly yellow but with dark area anteromedially, the dorsellum (Figs. 6,7) flattened, the ventral plaque on the male scape covering about 0.66 the length of scape; *anysis* has the entire midlobe of the mesoscutum dark brown to black; the dorsellum noticeably rounded, the ventral plaque on the male scape covering about 0.5 the length of scape.

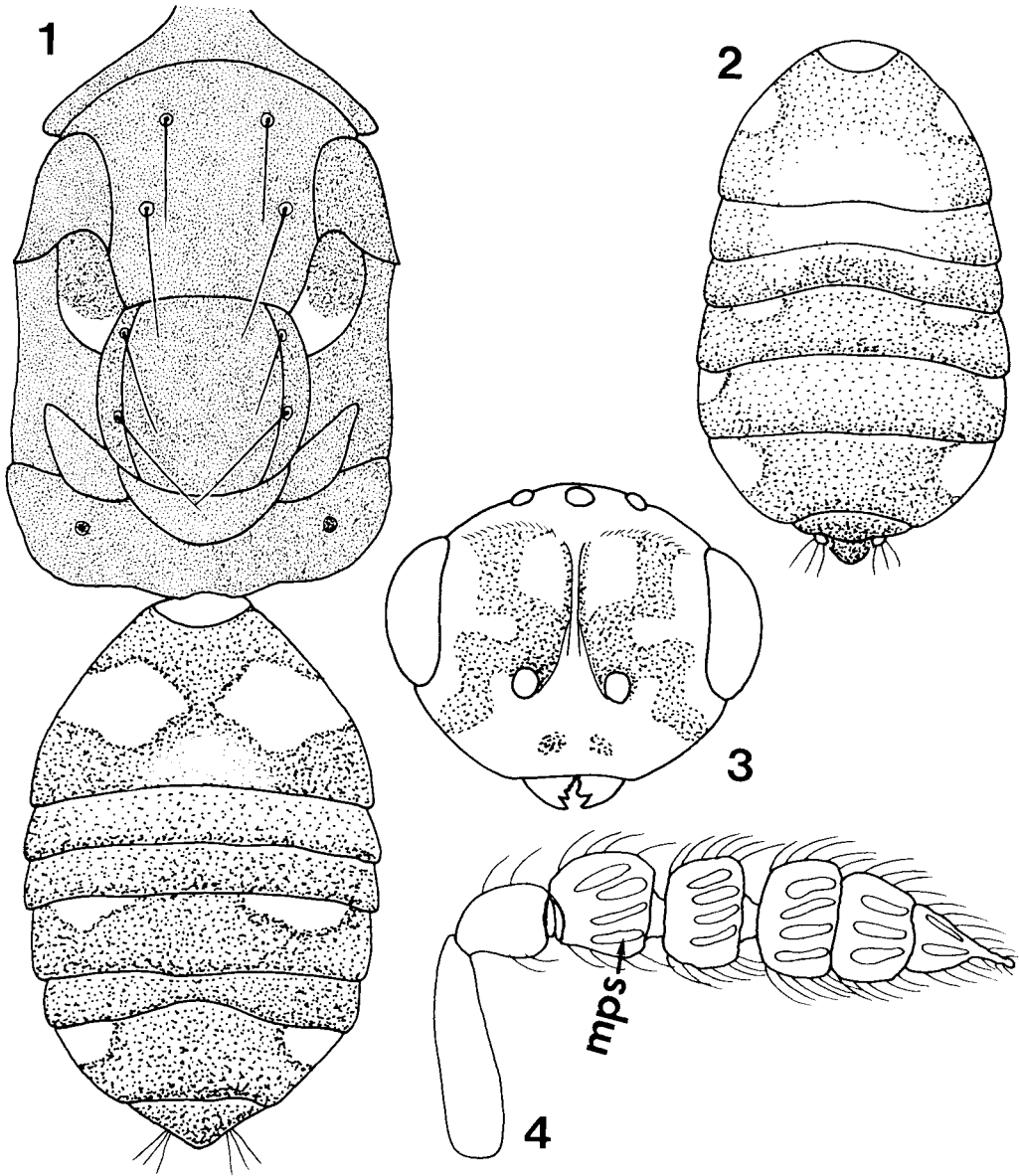
Acknowledgments

We thank Dr. Liang-yih Chou (TARI), who made the Taiwanese specimens of these species available to us. Drs. Gerhard Prinsloo (PPRI), and Michael Schauff (USNM) kindly loaned material from their collections. Space and facilities during this study were kindly provided to JL by the Department of Entomology, The Natural History Museum, London; technical assistance from the SEM and photography units of the BMNH is also gratefully acknowledged. We would like to thank Miss Inger Norling for help with the photograph of the *C. ambiguus* wing, and Mrs Linda Millar for preparing the line drawings of *Q. liriomyzae*.

References

- BOUČEK, Z., 1959. A study of Central European Eulophidae, II: *Diaulinopsis* and *Cirrospilus* (Hymenoptera). *Acta Entomologica Musei Nationalis Pragae*, 33: 171-194.
- BOUČEK, Z., 1988. Australasian Chalcidoidea (Hymenoptera). CAB International, Wallingford, UK. 832 pp.
- BOUČEK, Z. & ASKEW, R. R., 1968. Palearctic Eulophidae (excl. Tetrastichinae). *Index of Entomophagous Insects*. Le Francois Paris. 254 pp.

- BURKS, B. D., 1979. Family Eulophidae. Pp. 967-1022, in Krombein, K.V., Hurd, P.D. Jr., Smith, D.R. & Burks, B.D. (Eds), *Catalog of Hymenoptera in America North of Mexico*, Vol. 1., *Symphyla and Apocrita (Parasitica)*. Smithsonian Institution Press, Washington, D.C. 1198 pp.
- GORDH, G., 1978. Taxonomic notes on *Zagrammosoma*, a key to the nearctic species and descriptions of new species from California (Hymenoptera: Eulophidae). *Proceedings of the Entomological Society of Washington*, 80: 344-359.
- Graham, M. W. R. de V., 1987. A reclassification of the European Tetrastichinae (Hymenoptera: Eulophidae), with a revision of certain genera. *Bulletin of the British Museum (Natural History)*, Entomology Series, 55 (1): 1-392.
- Graham, M. W. R. de V., 1991. A reclassification of the European Tetrastichinae (Hymenoptera: Eulophidae): revision of the remaining genera. *Memoirs of the American Entomological Institute*, 49: 1-322.
- KAMIJO, K., 1987. Notes on Japanese species of *Cirrospilus* (Hymenoptera, Eulophidae), with descriptions of two new species. *Kontyu*, 55: 43-50.
- KAMIJO, K., 1992. Two new species of *Cirrospilus* (Hymenoptera, Eulophidae) from Japan. *Japanese Journal of Entomology*, 60: 391-395.
- LaSALLE, J., 1989. Notes on the genus *Zagrammosoma* (Hymenoptera: Eulophidae) with description of a new species. *Proceedings of the Entomological Society of Washington*, 91: 230-236.
- LaSALLE, J., 1994. North American genera of Tetrastichinae (Hymenoptera: Eulophidae). *Journal of Natural History*, 28: 109-236
- MINKENBERG, O. P. J. M. & van LENTEREN, J. C., 1986. The leafminers *Liriomyza bryoniae* and *L. trifolii* (Diptera: Agromyzidae), their parasites and host plants: a review. *Agricultural University of Wageningen Papers*, 86 (2): 1-50.
- PARRELLA, M. P., 1982. A review of the history and taxonomy of economically important serpentine leafminers in California. *Pan-Pacific Entomologist*, 58: 302-308.
- PECK, O., BOUČEK, Z. & HOFFER, A., 1964. Keys to the Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). *Memoirs of the Entomological Society of Canada*, 34: 1-120.
- SHENG, J. & WANG, G., 1992. Two new species and two new records of *Cirrospilus* Westwood (Hymenoptera: Eulophidae) from Jiangxi. *Acta Agriculturae Universitatis Ji-angxiensis*, 14: 35-39.
- SPENCER, K. A., 1973. Agromyzidae (Diptera) of economic importance. *Series Entomologica*, 9. The Hague: W. Junk. 418 pp.



Figures 1-4. *Cirrospilus ambiguus*: 1, Meso- and metasoma, dorsal, ♀; 2, Gaster, dorsal, ♂; 3, Head, frontal, ♀; 4, Antenna, lateral, mps = multiporous plate sensilla, ♀.

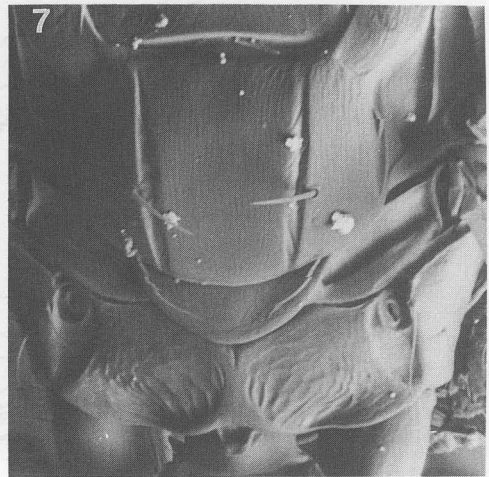
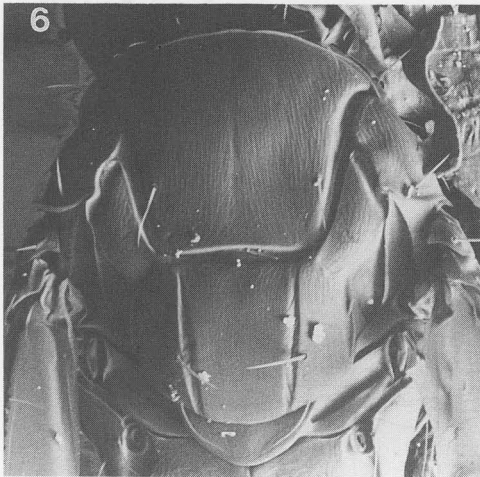
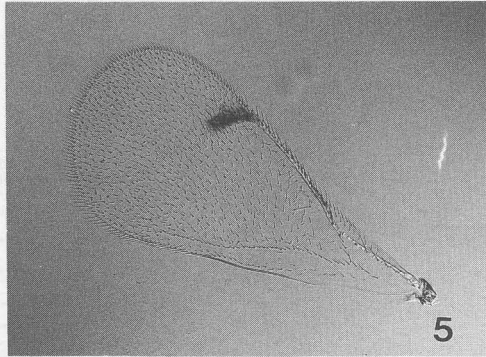
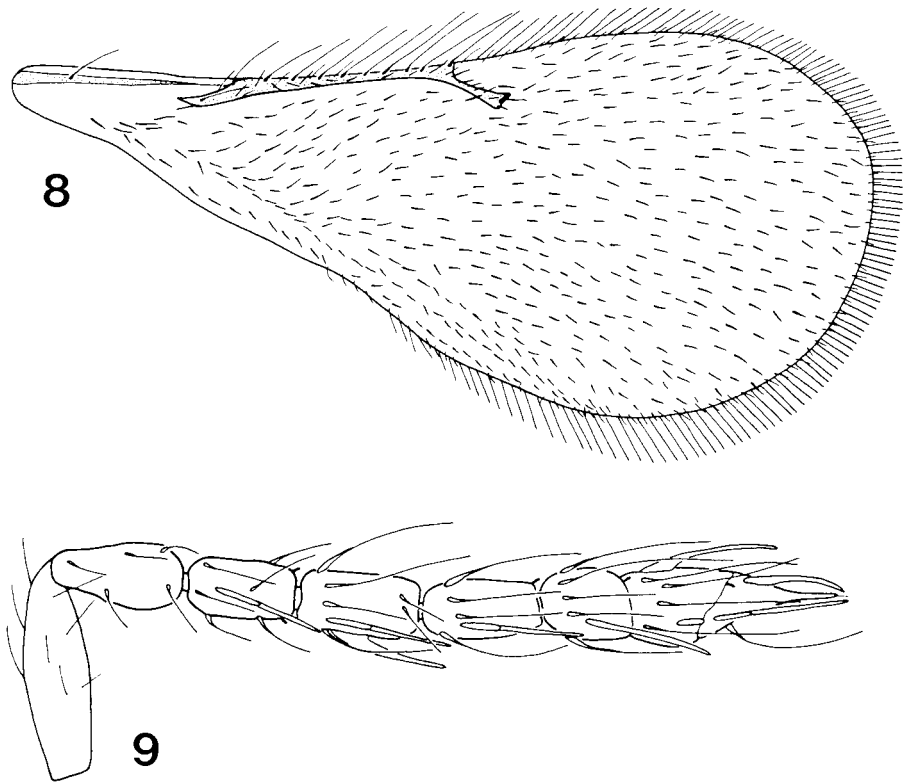


Fig. 5, Fore wing of *Cirrospilus ambiguus*, ♀.

Figs. 6-7. *Quadrastichus liriomyzae*, ♀: 6, Mesosoma; 7, Scutellum and propodeum.



Figs. 8-9. *Quadrastichus liriomyzae* ♀: 8, Fore wing; 9, Antenna.