

A CATALOGUE OF ENEMIES OF SOME IMPORTANT PLANTHOPPERS AND  
LEAFHOPPERS

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ABSTRACT

The planthoppers Nilaparvata lugens Stål, Sogatella furcifera (Horvath) and the leafhoppers Nephotettix virescens (Distant), Nephotettix nigropictus (Stål) are very serious pests of rice. Several species of mymarid and trichogrammatid parasites have been reared from the eggs of the pest referred to but their specific identity in most cases is uncertain. An effort has been made to critically examine the material available to me for examination and on the basis of these authentically reared material keys have been prepared to facilitate the identification of species of Anagrus, Paracentrobia and Oligosita which are the most dominant among parasites that certainly contribute in the natural control of the hoppers. At least four species of Gonatocerus are known to be parasitic on hoppers, but their identity is not established in this paper. Notes have been appended on their distribution and hosts known.

INTRODUCTION

The leaf and planthoppers are very serious pests of rice in the rice-growing areas of the world. Outbreaks of rice hoppers have very often threatened the total destruction of the rice crop for the season. These pests are also known to be vectors of several virus diseases.

Among the many hopper pests of rice, the following have been recognised as the most serious: Nilaparvata lugens (Stål) (Brown plant hopper); Sogatella furcifera (Horvath) (White back plant hopper); Nephotettix nigropictus (Stål) (Green leaf hopper) and Nephotettix virescens (Distant).

The sporadic increases in hopper populations are perhaps due to indiscriminate use of insecticides, destroying natural enemies which otherwise would have maintained a balanced population of the pest. There are a number of papers published and unpublished manuscripts on the bionomics of the parasites of rice leaf and plant-hoppers and the most important of these are Chandra (1980); Greathead (1979); Vungsilabutr (1981); Douth (1961). In view of the excellent contributions made on the biology and ecology of the parasites and also on the catalogue of parasites and predators by the authors referred to, I am restricting myself to some aspects of the identity of the mymarid and trichogrammatid parasites that have been investigated and reported.

Nearly 25 species of parasites belonging to the families Dryinidae, Mymaridae, Trichogrammatidae, Eulophidae and Scelionidae of the order Hymenoptera have been recorded in addition to the pipunculid parasites (Diptera) and Strepsiptera. Among Hymenoptera, dryinids are represented by species of Gonatopus, Dryinus, Echthrodelpas, Echthrogonatopus, Epigonatopus, Haplogonatopus, Paragonatopus and Pseudogonatopus; the mymarids by Anagrus, Gonatocerus, Mymar, Ooctonus and Polynema; the trichogrammatids by Aphelinoidea, Chaetostricha, Oligosita, Paracentrobia and Trichogramma; the eulophids by Tetrastichus; finally scelionids by Baeus, Gryon and Oxyscelio.

KEY TO THE FAMILIES OF HYMENOPTERA INCLUDING SPECIES PARASITIC ON LEAF AND PLANTHOPPERS, EXCLUDING SCELIONIDAE

- 1 Tarsi three-segmented, small to minute species; antennae with 5 to 8 segments and usually very short; discal ciliation more often in longitudinal lines ..... parasitic in the eggs ..... Trichogrammatidae
- Tarsi four or five-segmented, small to somewhat large species; antennae with more than 9 segments and usually long; discal ciliation more evenly distributed and not in longitudinal lines ..... 2
- 2 Hind wing basally narrowed into a stalk; wings and legs unusually long and slender, marginal fringe of wings mostly very long; antennal sockets (toruli) far apart, gaster often petiolate ..... parasitic in the eggs ..... Mymaridae
- Hind wing basally not narrowed into a stalk; wings and legs stout and differently formed; marginal fringe of wings not long, other characters differing ..... 3
- 3 In females the forelegs extremely long and with the last tarsomere modified into a chelate claw; medium to large species; wing venation complete in winged forms, brachypterous forms also present, parasitic in the nymphs of jassids, fulgorids and other leaf-hoppers ..... Dryinidae
- In the female, forelegs with the last tarsomere simple, not modified; species small to medium sized; forewings with submarginal, marginal and stigmal veins and often with postmarginal vein, never with cells; parasitic in the eggs of various insects particularly of Lepidoptera and Heteroptera-Homoptera ..... Other chalcid families (Eulophidae)

Of the various parasites mentioned, the mymarids and trichogrammatids are not only numerically important, but also cosmopolitan in their distribution, and as far as is known exert a great check on the population increase of leaf and planthopper pests. In view of this the main objective of this paper is to determine the specific identity of the mymarid and trichogrammatid parasites and therefore,

the following key to genera and species is presented in the hope that biological control protagonists will be able to use it to identify the parasites.

KEY TO MYMARID AND TRICHOGRAMMATID GENERA ASSOCIATED WITH LEAF AND PLANTHOPPERS OF RICE

- 1 Tarsi four or five-segmented; hind wing basally narrowed into a stalk ..... 3
- Tarsi three-segmented; hind wings basally not narrowed into a stalk ..... 2
  
- 2 Female antenna with 2-segmented funicle (ring and funicle); discal ciliation more often in rows but sparse; marginal fringe of forewing at least half the width of the wing at its widest ..... Oligosita Walker
- Funicle of antenna consists of 2 ring-like segments and 2 longer segments; discal ciliation variable, from densely covered with short randomly distributed cilia to somewhat sparse more or less arranged rows of cilia; marginal fringe of forewing always short, less than half the wing width ..... Paracentrobia Howard
  
- 3 Gaster broadly attached with propodeum; mesopostphragma plainly projecting into the gaster; antennal club solid, funicle 6-segmented, scutellum followed by a pair of distinctly separated plates (= postscutellum); male with 13-segmented antenna ..... Anagrus Haliday
- Gaster convexly rounded at base with more or less distinct petiole; mesopostphragma not or hardly projecting into the gaster ..... 4
  
- 4 Tarsi 5-jointed ..... 5
- Tarsi 4-jointed ..... 6
  
- 5 Petiole short, wider than long; propodeum without or with poorly developed longitudinal carinae .....  
..... Gonatocerus Nees
- Petiole at least as long as wide; propodeum with well developed carinae ..... Ooctonus Haliday
  
- 6 Hind wings abbreviated, filiform or poorly developed into a whip-like structure without the wing blade; forewing oar-shaped and distinctly petiolate; scape long and medially constricted ..... Mymar Curtis

KEY TO SPECIES OF ANAGRUS ASSOCIATED WITH LEAF AND PLANTHOPPERS  
OF RICE

- 1 Antennal scape with definite cross carinae, first funicle segment very short ..... 3
- Antennal scape without cross carinae, smooth, the first funicle segment at least twice longer than its own width ..... 2
- 2 Gaster oval; ovipositor sheath extremely short, hardly exerted; disc of forewing narrow, almost parallel sided, discal ciliation in only one row in the basal two-thirds and two rows in the apical one-third; antenna long and narrow ..... optabilis (Perkins)
- Gaster acuminate; ovipositor sheath exerted more than half the length of gaster; disc of forewing in the apical one-third somewhat dilated, discal ciliation in an irregular row in the basal half and two to three irregular rows in the apical one-third; antennae not very long but progressively wider and the club distinctly wider than funicle ..... perforator Perkins
- 3 Gaster acuminate; ovipositor exerted, as long as half the length of the gaster or more; disc of forewing somewhat dilated in the apical one-third, one row of cilia in the basal half and two rows of irregular cilia in the apical one-third. Fore tibia with a row of 5 very strong teeth .... sp. nov.
- Ovipositor not exerted or only slightly exerted ..... 4
- 4 Disc of wing comparatively rather more dilated in the distal one-third; second funicle segment as long as the 4th and 6th; marginal fringe of forewing slightly less than 2.5 times as long as the wing width at its widest; discal ciliation in the distal one-third in 3 to 4 irregular rows ..... flaveolus Waterhouse
- Disc of forewing not dilated in the distal end; second funicle segment variable; discal ciliation in the distal end in 3 or less than 3 rows ..... 5
- 5 Second funicle segment the longest; discal ciliation in the distal end arranged in such a way that a clear hyaline area is formed; marginal fringe nearly three times the maximum wing width ..... frequens Perkins
- Second funicle segment as long as the 4th or 6th segment; discal ciliation in the distal end arranged in two or three rows without forming a clear hyaline area; marginal fringe slightly longer than the wing width at its widest ..... armatus (Ashmead)

KEY TO SPECIES OF PARACENTROBIA HOWARD ASSOCIATED WITH LEAF  
AND PLANTHOPPERS OF RICE

- 1 Forewing disc evenly distributed with short cilia, vein tracks incomplete ..... subgenus Brachistella Girault
- Forewing disc with somewhat sparse cilia arranged more or less in a few lines ..... subgenus Paracentrobia Howard
- 2 Forewing with a round smoky patch beneath the stigmal vein; scape slightly longer than the combined length of pedicel and funicle; gaster with tergites one to four uniformly brown ..... Paracentrobia (B) andoi Ishii
- 3 Forewing with a narrow smoky area across the wing beneath the stigmal vein; scape as long as the combined lengths of pedicel plus funicle; gaster pale yellow with the tergites dark brown latero-dorsally .....  
..... Paracentrobia (P) yasumatsui Subba Rao

KEY TO SPECIES OF OLIGOSITA ASSOCIATED WITH LEAF AND PLANTHOPPERS  
OF RICE

- 1 Marginal fringe of forewing less than half the wing width at its widest; pedicel 3 times as long as the distinctly wider than long funicle segment; scape dilated basally; discal cilia long and coarse .....  
..... brevicilia Girault
- Marginal fringe of forewing only slightly shorter or longer than the wing width at its widest; pedicel as long as the funicle or at most twice as long; scape cylindrical; discal cilia fine ..... 2
- 2 Funicle much narrower than pedicel and as long; club as long as the combined lengths of pedicel, ring and funicle segments; discal cilia very sparse, one complete row bordering the distal end of the wing and about 10 cilia also at the distal end distributed irregularly ..... shibuyae Ishii
- Funicle half or less than half the length of pedicel; discal ciliation in definite rows ..... 3
- 3 Marginal fringe of forewing only slightly shorter than the wing width; stigmal vein subtriangular .. aesopi Girault
- Marginal fringe of forewing as long as or longer than the wing width at its widest; stigmal vein longer and petiolate ..... 4
- 4 Marginal fringe of forewing as long as the wing width at its widest; funicle half as long as pedicel and nearly as wide; ovipositor sheath clearly exerted ...  
..... yasumatsui Viggiani & Subba Rao
- Marginal fringe of forewing clearly longer than the wing width; funicle less than half as long as and slightly wider than pedicel; ovipositor sheath not exerted ...  
..... naias Girault

NOTES ON PARASITES ASSOCIATED WITH LEAF AND PLANTHOPPERS OF RICE

Mymaridae

Anagrus flaveolus Waterhouse

Anagrus flaveolus Waterhouse, 1913. Bull. ent. Res.: 87-88.

Perhaps this species is the most widely distributed and important from the point of biological control of hopper pests. The type-material was reared from Peregrinus maidis in Trinidad. According to Chandra, flaveolus is both parthenogenetic as well as gametogenic in reproduction. The females live for 2-6 days when fed with 30% honey solution and parasitise the leafhopper egg mass soon after emergence and continue to do so for 3 days, after which no oviposition takes place. The life cycle from egg to emergence of the imagines occupied 11-13 days under laboratory conditions.

Distribution: India, Sri Lanka, West Malaysia, Thailand, Pakistan, Philippines, Taiwan, Japan and Korea.

Hosts: Nilaparvata lugens; Sogatella furcifera; Nephotettix nigropictus; Nephotettix virescens; Nephotettix cincticeps; Delphacodes samashimai; Dicranotropis nagaragawana; Hirozuunka japonica; Nilaparvata bakeri; Stenocranus minutus; Tettigella viridis; Peregrinus maidis.

Anagrus optabilis (Perkins)

Paranagrus optabilis Perkins, 1905. Rept. expt. St. Hawaii Sug. Pl. Assocn. No. 1 (6): 199.

This species is also widely distributed, though misidentified often in the past. optabilis is easily recognised by its extremely short ovipositor and the long, narrow antenna with the funicle segment 1 the longest.

Distribution: India, West Malaysia, Sri Lanka, Thailand, New Guinea, Fiji.

Hosts: Probably restricted to delphacids. Nilaparvata lugens; Sogatella furcifera; Perkinsiella saccharicida.

Anagrus perforator (Perkins)

Paranagrus perforator Perkins, 1905. Rep. Expt. St. Hawaii Sug. Pl. Assocn. No. 1 (6): 199.

This species was originally recorded from Fiji, parasitising the eggs of a delphacid and subsequently introduced into the Hawaiian Islands; it has not been recorded from other areas of the rice growing tracts. perforator is extremely closely allied to optabilis but differs from it in the ovipositor being exerted more than half the length of the gaster. The pedicel is also much longer and is about four-fifths the scape.

Distribution: Australia, Fiji, Hawaii, Japan.

Hosts: Hirozuunka japonica.

Anagrus frequens Perkins

Anagrus frequens Perkins, 1905. Rep. Expt. St. Hawaii Sug. Pl. Assocn. No. 1 (6): 198.

frequens Perkins has not been recorded since its discovery. The species was reared from delphacids in Queensland, Australia.

According to Perkins, the species also occurs in Fiji, though probably a different race.

Distribution: Australia, Fiji.

Hosts: Delphacidae (species not known).

Anagrus armatus (Ashmead)

Litus armatus Ashmead, 1887. Can. Ent. 19: 193.

Anagrus columbi Perkins, 1905. Rep. Expt. St. Hawaii Sug. Pl. Assocn. No. 1 (6): 198.

This species is very difficult to separate from frequens Perkins. The only distinguishing character is that in frequens the discal ciliation is so arranged that a basal hyaline area is formed in the distal one-third of the forewing, and in armatus the hyaline area is absent.

Distribution: North America, West Indies, South America, Australia, Hawaii.

Hosts: Delphacodes sp.; Edwardsiana rosae; Empoasca fabae; Typhlocyba pomaria.

Anagrus sp. nov.

The new species yet to be described is very close to flaveolus Waterhouse but can be separated by the characters provided in the key to species. This species also appears to be widely distributed in South East Asia. The new species will be described in full elsewhere.

Distribution: India, Sri Lanka, West Malaysia.

Hosts: Nilaparvata lugens; Sogatella furcifera.

Mymar taprobanicum Ward

Mymar taprobanicum Ward, 1875. Ent. mon. Mag. 11: 197.

Chandra (1980), Chu, Yau-i & Hirashima (1979) have recorded Mymar sp. and Mymar indica from Philippines and Taiwan. M. indica is a synonym of taprobanicum.

Distribution: India, Sri Lanka, Thailand, Philippines, Taiwan, Japan, Korea.

Hosts: Nephotettix cincticeps; Nilaparvata lugens.

Gonatocerus spp.

At least four species are known to be reared from the green leafhopper Nephotettix sp. and it appears that these are specific to green leafhoppers. However, Chu-yau-i and Hirashima have recorded Gonatocerus spp. from Nephotettix cincticeps as well as Nilaparvata lugens in Taiwan. Girault described about 75 species from Australia and I am almost certain that the Gonatocerus spp. reared from leafhoppers must have a name. I have presently undertaken the study of Girault types of Gonatocerus spp. and in due course it is hoped that the leafhopper parasites of the genus Gonatocerus will be named.

Trichogrammatidae

Paracentrobia (Brachistella) andoi Ishii

Japania andoi Ishii, 1938. Kontyu 12: 179.

Paracentrobia (Brachistella) garuda Subba Rao, 1974. Mushi 48: 5  
Syn. nov.

This trichogrammatid species is the most widely distributed and important in South East Asia. Chu, Yau-i and Hirashima (1981), Vungsilabutr (1981) have dealt with the ecology of the parasite. According to Vungsilabutr, andoi parasitised the eggs of rice leafhoppers Nephotettix virescens and Nephotettix nigropictus, but not those of planthoppers. Contrary to this observation, Miura et al. (1981) have observed that andoi parasitises Nephotettix cincticeps, Nilaparvata nigropictus and Nilaparvata lugens, Nephotettix virescens in Taiwan. Though I have synonymised garuda with andoi purely on morphological characters, the study of Hsieh (1975) has shown that andoi is thelytokous and is therefore uniparental in reproduction and according to Vungsilabutr (1981) garuda produced both females and males. Here is a case for further critical studies to decide whether garuda is biologically distinct from andoi. Percentage of parasitism achieved by andoi varied from 25 to 60% in Taiwan.

Distribution: Philippines, Japan, Thailand, Taiwan, Korea.

Paracentrobia (Paracentrobia) yasumatsui Subba Rao

Paracentrobia (P) yasumatsui Subba Rao, 1974. Mushi 48: 1-2.

This species is so far known only from Thailand and in rather low numbers. However, the species is very distinct from other known species of Paracentrobia and can be identified by the key characters. Further intensive work on the parasites of leafhoppers in the rice growing tract of South East Asia would certainly reveal its distribution and its role in the subjugation of leafhoppers.

Host: Not known but was collected from rice fields in Thailand.



Oligosita brevicilia Girault

Oligosita brevicilia Girault, 1915. Mem Ql. Mus. 3: 144-45.

Girault described this species from Queensland, Australia, taken in the forest and since not referred to. Viggiani and Subba Rao (1978) identified the species from the material that Prof. Yasumatsu collected in Thailand from the rice fields.

Distribution: Australia, Thailand.

Host: Not known.

Oligosita aesopi Girault

Oligosita aesopi Girault, 1929. North Amer. Hym. Mymaridae, Private Publ. 28.

The specimens reared from the eggs of leaf and planthoppers by Mr. Barrion (International Rice Research Institute, Philippines) were made available to me for examination, and I was able to distinguish two species. One of these was aesopi Girault and the other was naias Girault. Chandra (1980) gave a good account of the Oligosita sp. that he was studying. It is more than probable that Chandra was dealing with two species of Oligosita rather than one species that he thought to be dealing with.

Distribution: Australia, Thailand, Philippines.

Hosts:

Oligosita naias Girault

Oligosita naias Girault, 1938. Rev. Ent. Rio de Jan. 9: 384.

Girault described this species just in three lines, but indicated that this species is very close to aurea Girault, the description of which is sufficient to recognise the species. In all probability naias and yasumatsui Subba Rao are widely distributed in the South-East Asia. References made by Vungsilabutr and others as Oligosita sp. A and sp. B may pertain to naias and yasumatsui.

Distribution: India, Thailand, Philippines, Australia, Taiwan.

Hosts: ?Nephotettix virescens; Nephotettix nigropictus;  
Nilaparvata lugens; Sogatella furcifera.

Oligosita yasumatsui Viggiani & Subba Rao

Oligosita yasumatsui Viggiani & Subba Rao, 1978. Boll. Lab. Ent. agr. Port. 35: 5-6.

This species was collected in good numbers by Prof. Yasumatsu during his work on the integrated control of rice pests in Thailand (Yasumatsu et al. 1975). According to the authors, the species was very effective in suppressing the populations of leaf and plant-hoppers of Rice.

Distribution: Thailand.

Hosts: ?Nephotettix virescens; Nephotettix nigropictus;  
Nilaparvata lugens; Sogatella furcifera.

Oligosita shibuyae Ishii

Oligosita shibuyae Ishii, 1938. Kontyu 12: 180.

Chu, Yau-i and Hirashima record shibuyae as an egg parasite of leaf and planthoppers in Taiwan based on the literature published in Taiwan. However, Miura et al. (1981) in their investigations on the egg and nymphal parasites of leaf and planthoppers do not refer to shibuyae but mention the parasite reared as Oligosita sp.

Distribution: Japan, Taiwan.

Hosts: Nephotettix cincticeps; Nilaparvata lugens.

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#### EXPLANATION OF FIGURES

Anagrus species, antenna ♀

Figure 1 frequens Perkins; 2 flaveolus Waterhouse; 3 sp.nov.;  
4 armatus Ashmead; 5 optabilis (Perkins);  
6 perforator Perkins.

Anagrus species, forewing, distal half ♀

Figure 7 flaveolus Waterhouse; 8 sp.nov.; 9 perforator Perkins;  
10 optabilis (Perkins); 11 frequens Perkins.

Anagrus species, ovipositor sheath

Figure 12 frequens Perkins; 13 optabilis (Perkins);  
14 flaveolus Waterhouse; 15 perforator Perkins; 16 sp.nov.

Paracentrobia species, forewing antenna, ♀

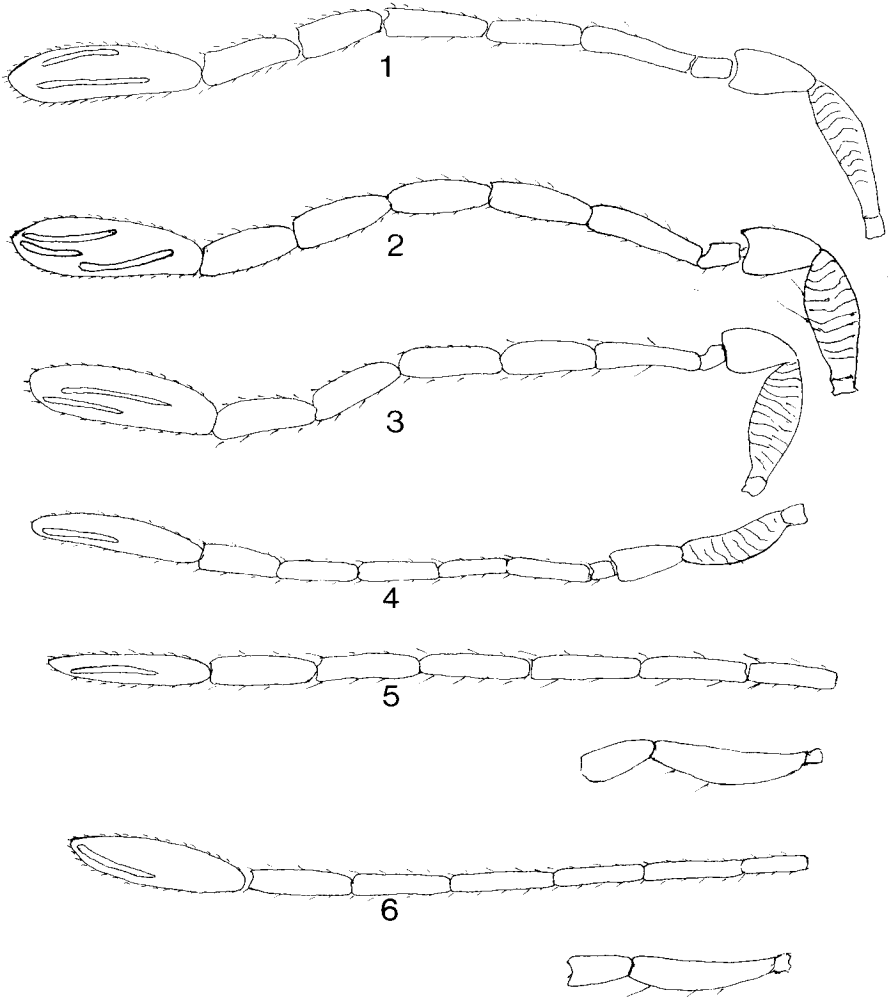
Figure 17, 18 yasumatsui Subba Rao; 19, 20 andoi Ishii.

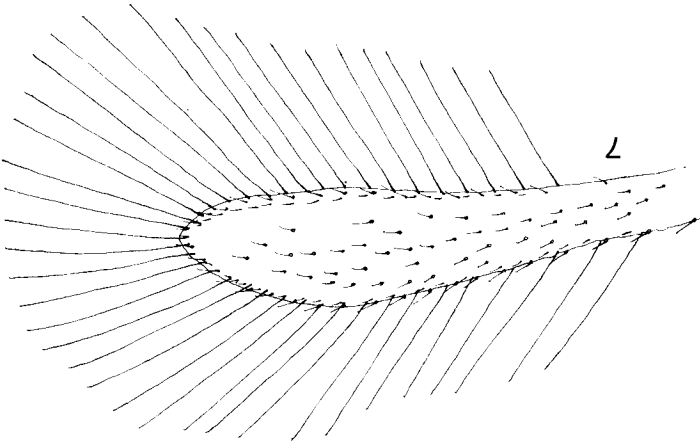
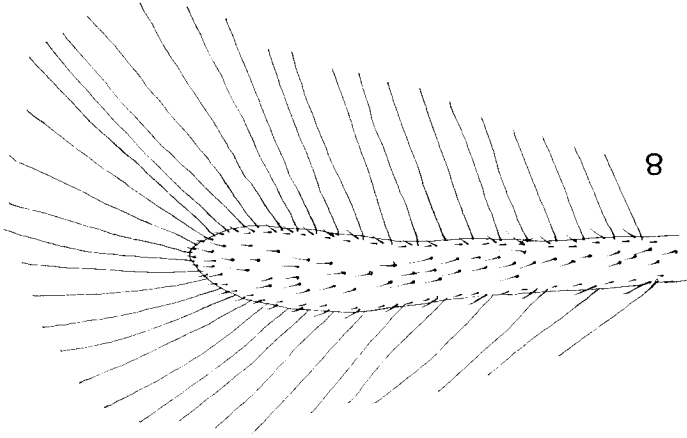
Oligosita species, forewing and antenna ♀

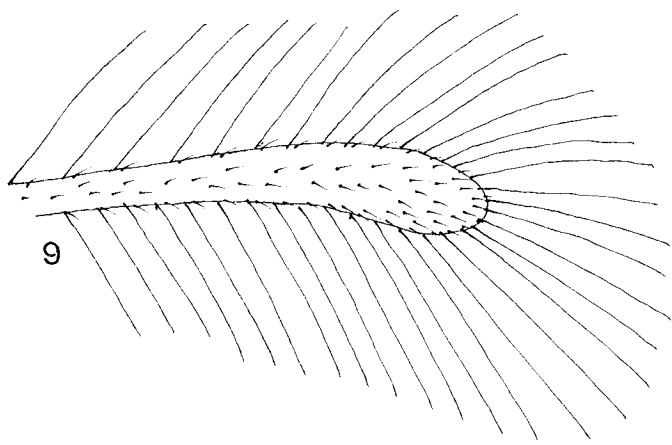
Figure 21, 22 yasumatsui Viggiani & Subba Rao; 23, 24 naias Girault;  
25, 26 isopae Girault.

Figure 27 Anagrus sp.nov. fore tibia ♀.

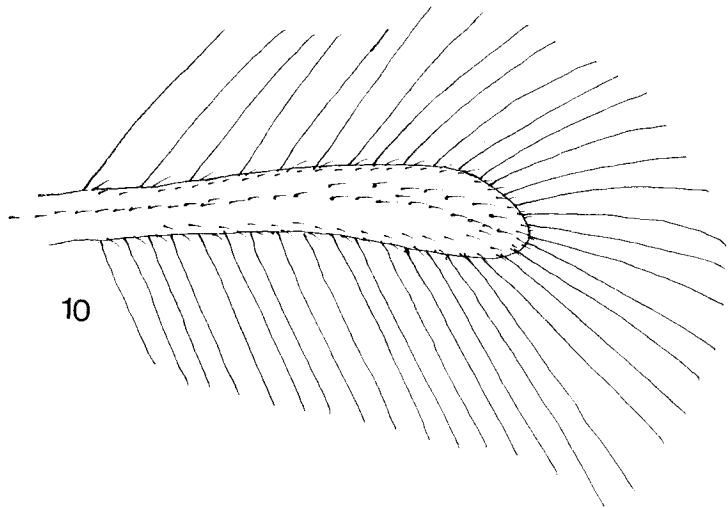
Figure 28 Mymar taprobanicum Ward ♀.



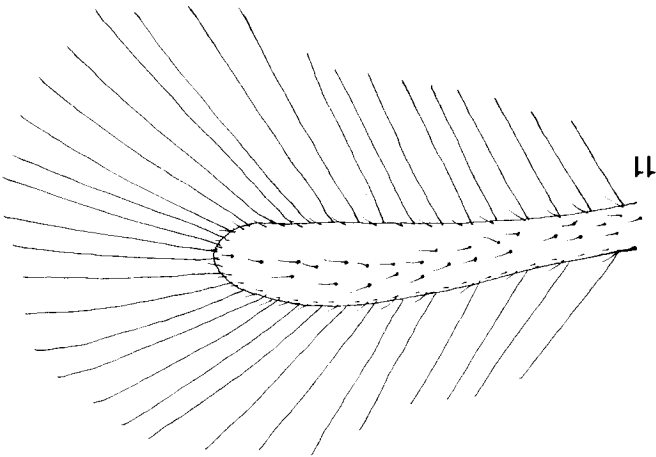
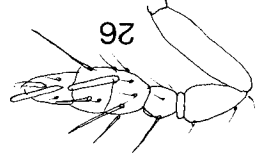
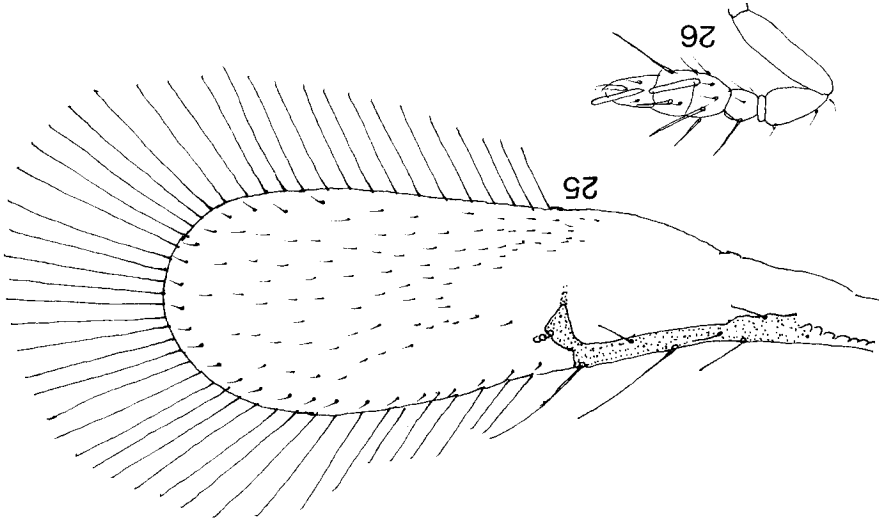


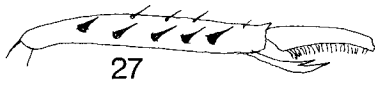
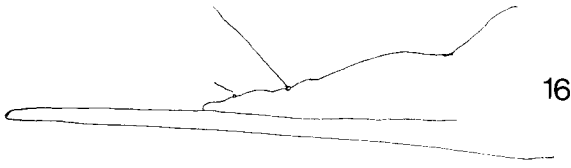
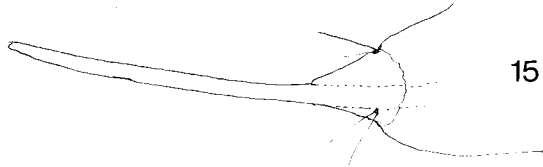
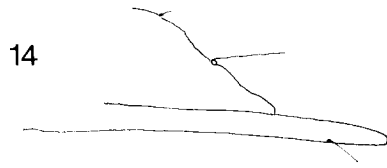
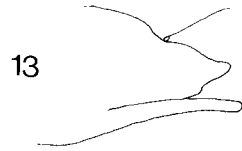
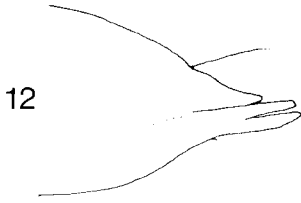


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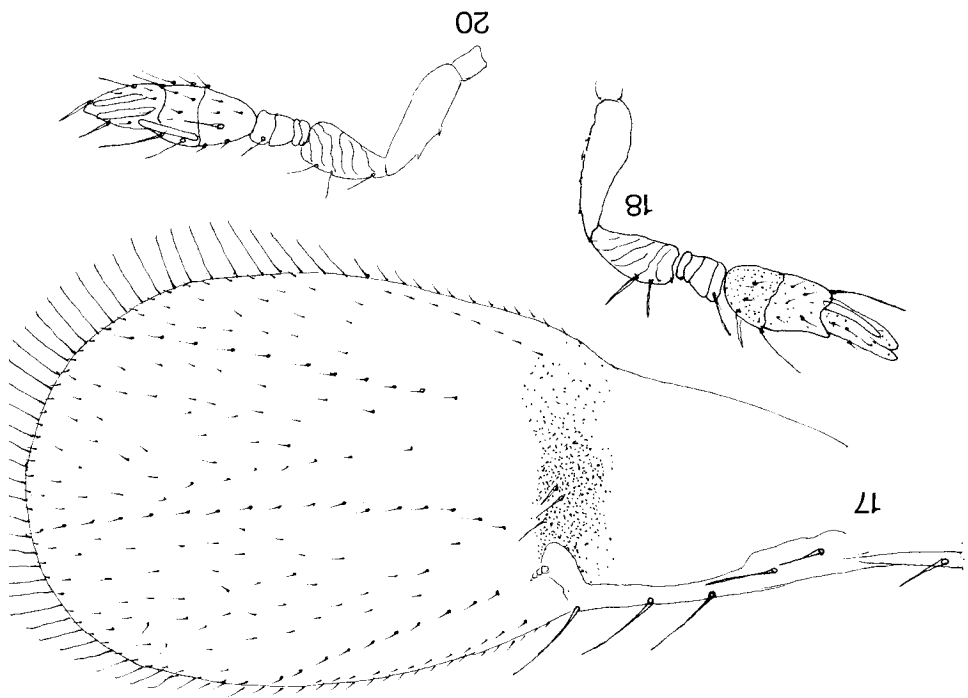
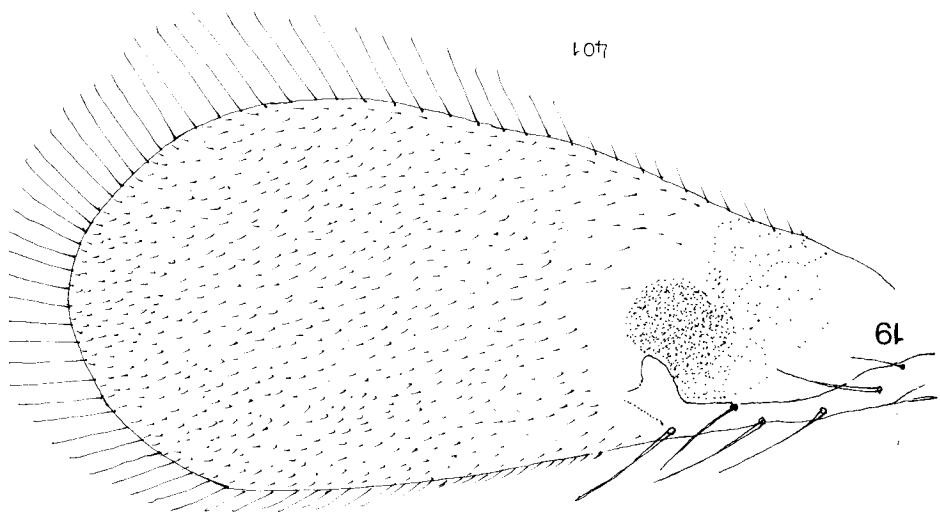


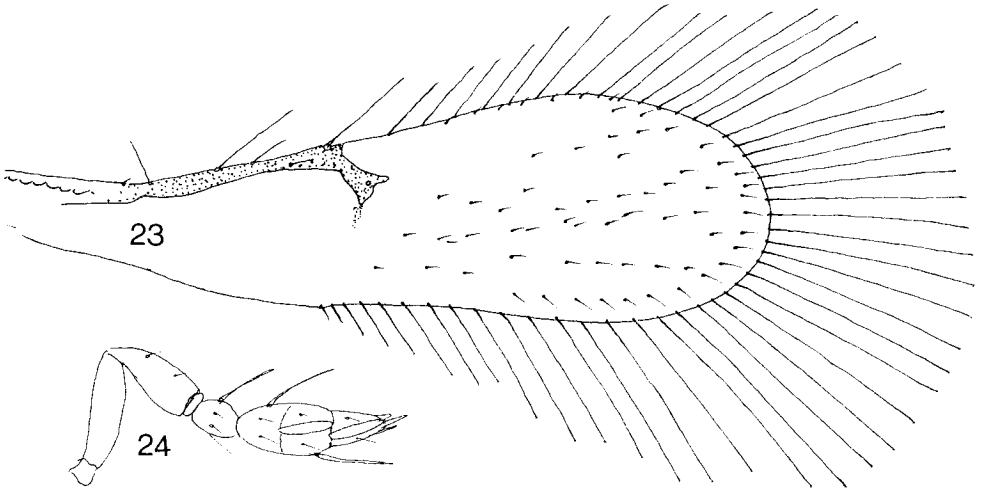
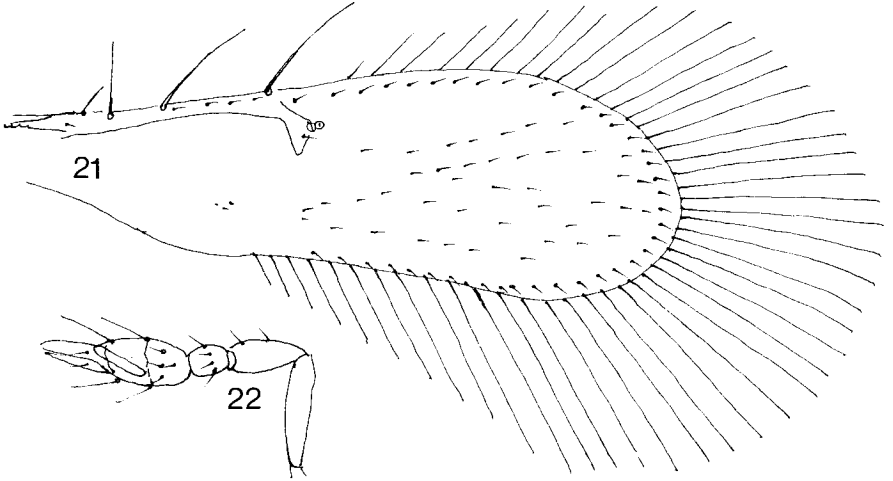
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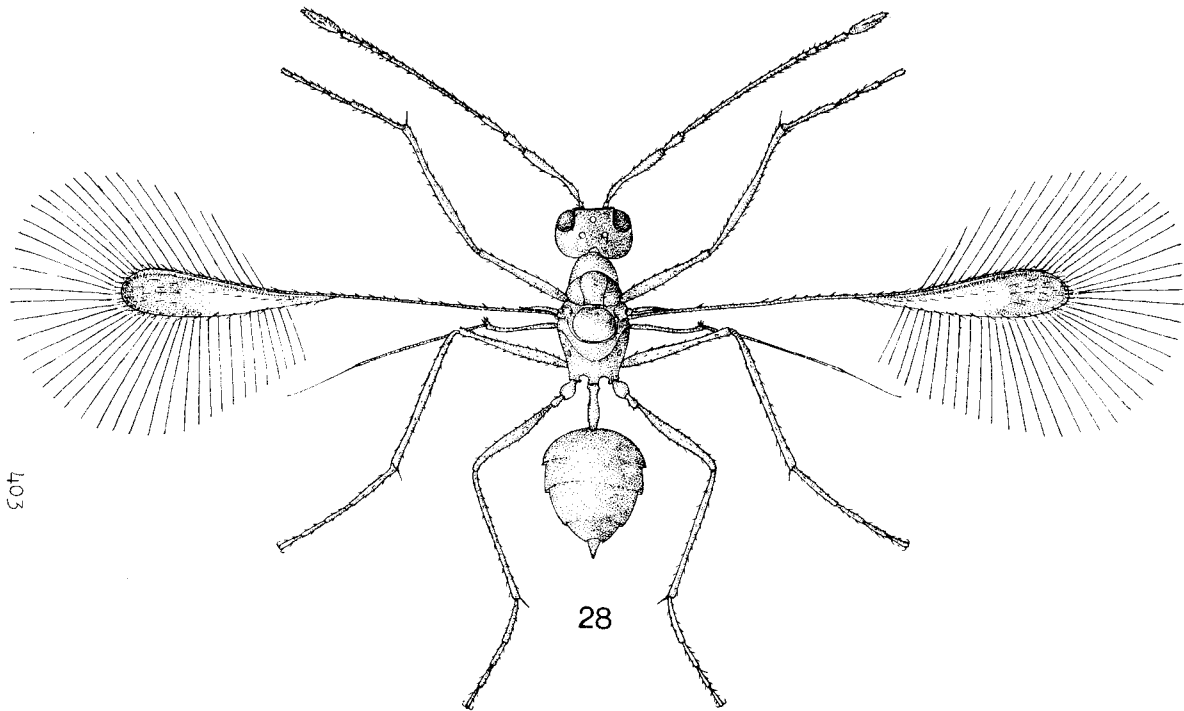












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