STUDIES ON TRICHOGRAMMATOIDEA
(HYMENOPTERA : TRICHOGRAMMATIDAE)*

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ABSTRACT. Egg parasites belonging to Trichogrammatoidea Girault (Hym.
Trichogrammatidae) are poorly known. In this paper 10 new species and a sub-
species: T. armigera, T. bactrae, T. fumata, T. cryptophlebiae, T. fulva, T. guamenstis,
T. hysipyla, T. prabhakeri, T. robusta, T. simmondsi and T. thoseae, reared
from different lepidopterous pests occurring under different ecological conditions
are described. Applying numerical taxonomy, Trichogrammatoidea was found to
contain two species groups: lutea-group and nana-group. Some of the known
species, namely, T. lutea Gir., T. nana (Zehnt.), T. rara Gir. and T. flava Gir.
have been redescribed. The taxonomic status of some other species included
under Trichogrammatoidea by earlier authors has been discussed. T. lutea and
T. prabhakeri are considered as semispecies with respect to each other.

INTRODUCTION

Members of the family Trichogrammatidae (Hymenoptera) are egg-parasites,
mostly of Lepidoptera, and to a lesser extent of some other orders. They
are minute parasites, some of which like Megaphragma measure only about
0.15 mm.

Species of Trichogramma and Trichogrammatoidea, especially the former
have been used for biological control of various farm, vegetable and forest
pests, mostly Lepidoptera, in different parts of the world. While species of
Trichogramma have extensively been studied, those of Trichogrammatoidea by
and large received scant attention although two of them, T. lutea and T. nana
are well known parasites of several lepidopterous pests. The present study
was taken up to fill this lacuna in our knowledge of these economically impor-
tant parasites. The earliest species of Trichogrammatoidea described was T.
nodicornis by Westwood (1879) under Oligoseta. Girault (1911) erected
Trichogrammatoidea with “Chaetosticha” nana Zehntner as the type-species,
reared from the sugarcane stem borer, Chilo sacchariphagus (Bojer) (=Diatraea
striatalis (Suellen), in Java. He also described T. lutea (1911), T. flava (1912)
and T. rara (1925). Novicky (1946) described T. stammeri from Germany while
Risbec (1951) described T. kayo from Sudan and T. combretae from Senegal
and later (1955) T. citri from Madagascar, placing the first species in Tricho-
gramma and the rest in Chaetostricha. The most comprehensive work on the

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Trichogrammatidae is by Doutt & Viggiani (1968) who provisionally transferred some species to Trichogramma. Viggiani (1971) has given a comprehensive account of the male genitalia of Trichogrammatids.

In this paper various characters of Trichogrammatidae are described in detail with keys to differentiate Trichogramma from Trichogrammatidae, and different species of the latter. Specimens of Trichogrammatidae obtained for study were from Africa, Australia, India, Indonesia, Costa Rica, Malaysia, Pakistan, Taiwan and West Indies. Ten new species and a new subspecies are described and four known species are redescribed. The taxonomic identities of some other species is also examined.

Numerical taxonomy has been attempted for only 12 members of the genus taking 40 morphological and 5 biological characters using an IBM computer and a desk calculator.

**Materials and Methods**

For studying the pigmentation, live specimens were killed and transferred to 70% alcohol and dead specimens were treated in glacial acetic acid.

The mounting technique involved treating the specimens for 24 hrs in glacial acetic acid, 5m each in 50 : 50 mixture of absolute alcohol and phenol and pure phenol, and finally mounting in a 50 : 50 mixture of phenol and
balsam as suggested by Wirth & Marston (1968). Before placing the cover-slips the genital capsules were dissected out.

The specimens of the new species obtained from Guam (received from the U.S. National Museum) and described here as *T. guamensis*, were originally mounted in an aqueous medium. The slides were treated with water to soften the medium for remounting the specimens. After softening, the specimens were removed and remounted as above. With specimens of *T. nana* and others mounted together originally in balsam by Zehntner (received from the U.S. National Museum), the slides were treated with xylol to dissolve the medium and the specimens individually remounted in a desired position. Drawings were made using a camera lucida.


The taxonomic status of *T. fulva* had to be determined. In *T. flavus* and *T. rara* the type-specimens examined were very few (1 in *flava* and 3 in *rara*) and mutilated. In *flava* the specimen was a female and without males its taxonomic status could not be determined. These three species were therefore not included in the numerical taxonomy.

The following abbreviations are used for the Museums from where specimens were obtained for the study and wherein the types are deposited: CIBC-Commonwealth Institute of Biological Control, Indian Station, Bangalore; CIE-Commonwealth Institute of Entomology, C/O British Museum (Natural History), London; IARI-Indian Agricultural Research Institute, New Delhi; OMB-Queensland Museum, Brisbane; USNM-United States National Museum, Washington, D.C. In all the male specimens deposited the genital capsules are dissected out.

**Phylogeny**

According to Ashmead the family Trichogrammatidae is related to Eulophidae connecting the latter to Mymaridae (Imms, 1957). Trichogrammatid's resembling modern species were found in Oligocene amber from Chiapas, Mexico (Doutt & Viggiani, 1968).

Based on the male genitalia of the members of the family Trichogrammatidae, Viggiani (1971) has divided the family into two subfamilies: Trichogrammatinae and Oligosetinae. In the former, the aedeagus is distinctly surrounded by phallical structures like phallobase (gonobase), parameres (gonoforceps) and volsellar-digitii (chelate structures), while in the latter, the phallical structures are undifferentiated from the aedeagus. *Trichogramma* and *Trichogrammatatoidea* show great similarity in morphology and habits. Viggiani stated that the phallus in Trichogrammatids shows a gradation of forms towards a very simplified structure. If Viggiani's hypothesis should be considered valid,
Trichogrammatoidae with its simplified male genitalia seems to have evolved from Trichogramma. If the number of species in a genus has any evolutionary significance, Trichogramma which has many species must be considered ancestral to Trichogrammatoidae.

Mention may be made of a Trichogrammatid reared from Epiphyas postvittana (Walk.) in New Zealand and Australia. This species has Trichogramma-like male genitalia and wings but segmented male flagellum (club unsegmented) as in Trichogrammatoidae. This species appears to be a transitional form between Trichogramma and Trichogrammatoidae.

Of the species of Trichogrammatoidae studied the lutea-Group (see dendrogram) with short wing fringe and broad remigium is closest to Trichogramma. In addition, the gonobase in T. lutea and T. prabhakeri is indistinctly connected dorsally, forming oval shaped genital foramen enclosing the aedeagus. It is therefore likely that Trichogrammatoidae has evolved from a Trichogramma-like ancestor and that forms like T. lutea appeared first.

**Taxonomy**

Genus *Trichogrammatoidae* Girault


**Head**: Antenna of female six-segmented excluding basal segment below scape, including a ring segment; club unsegmented. In order of decreasing length the segments can be arranged as: scape, club, pedicel, funicle segments and the ring segment (Fig. 4). Male flagellum segmented with two movable funicular and three immovable but flexible club segments. Each flagellar segment with long, filamentosus hairs. Number and length of hairs diagnostic (Fig. 3).

There is also an incomplete ring segment at the base of the first funicular segment in addition to a complete ring segment.

**Thorax**: fore wing: Fringe long; length diagnostic. Longest fringe measuring about one half the width while shortest about one fifth the width of wing. Wing remigium with sparsely distributed setae. Vein track R₅ absent. Length and density of setae on remigium diagnostic. Basal infuscation present with varying intensity and range (Fig. 6). Hind wing: Relative length of fringe of fore and hind wings differs among some species (eg. *T. lutea*).

**Colour**: Varies from light yellow to dark fuscous. Anterior most terga of abdomen mostly blackish. Dark shade varies from dark fuscous in yellowish species to blackish in species having fulvous ground colour.

**Size**: Female: 0.4 mm to 0.6 mm long, 0.15 mm to 0.2 mm wide. Males: 0.35 mm to 0.55 mm long, 0.15 mm to 0.2 mm wide. Marked variations in size is found among individuals of the same species, depending upon the number developing a single host egg.
Figs. 7-10. Schematic sketch of 7, a Hymenopteran male genitalia (after Michener, 1958). Male genitalia of: 8 Trichogramma and 9, Trichogrammatoidae; 10, female genitalia of Trichogrammatoidae. Aed-Aedeagus; Ap-Apodemes; C-Cuspis; CR-Central ridges; CS-Chelate structures; D-Digitus; DC-Dorsal connective; DEG-Dorsal expansion of gonobase; GB-Gonobase; GF-Gonoforceps; GS-Gonostylus; MVP-Median ventral projection; P-Pygoyle; PI-Ovipositor plate; Vlf1, 2-1st and 2nd Valvifers; Vlv1, 2-1st and 2nd Valvulae.
Male genitalia* (Fig. 9): Basically consists of gonobase (GB), gonocoxites and a pair of volsellae, completely fused with each other. Intromittant aedeagus held in the middle and connected with an indistinct membrane. Tip of the volsellae with a movable structure analogous with the digitus and cuspis of other Hymenoptera, termed here as 'chelate structures' (CS). Gonoforceps (GF) situated on either side of the chelate structures. Level of chelate structures in relation to the tips of the gonoforceps diagnostic. Junction of the volsellae with a projection, the 'median ventral projection' (MVP), inconspicuous in some species; the latter with a pair of minute tubercles below, one on either side, followed by a pair of thin chitinized ridges (CR) running anteriorly to some extent.

Unlike in Trichogramma (Fig. 8) there is no dorsal expansion of gonobase. Instead, the expanded sides of the gonocoxites are conspicuously or inconspicuously connected with a membrane, thus giving evidence of genital foramen. The aedeagus with a pair of apodemes is held in between the dorsal expansions of the gonocoxites by means of a membrane. The relative length of these apodemes is of taxonomic importance.

Female genitalia (Fig 10): Consists of two pairs each of valvulae and valvifers, and a pair of gonostyli ('third valvulae' of Imms, 1957). Valvifers on either side supported by strong ovipositor plates and a pair of cercal plates. First valvifer small, about one-fourth the second; the second narrow, elongate and about ten times as long as wide. Valvulae not extending beyond gonostyli. Gonostylus short, about 2 to 2.5 times the length of second valvifers. Ovipositor plate with an internal longitudinal chitinized bar. Cercal plate with 2 short and 2 long setae.

The female genitalia are not very diagnostic except perhaps the relative length of the ovipositor and the hind tibia, and the relative width of the ovipositor plate.

KEY TO DIFFERENTIATE TRICHOGRAMMA AND TRICHOGRAMMATOIDEA

Male antenna with segmented flagellum having two funicular and three club segments. Fore wing with long marginal fringe, measuring one-fourth to three-fourths the width of wing; setae on vein track Rs₁ absent. Male genitalia without dorsal expansion of gonobase.

Trichogrammatoidae Girault

Male antenna with unsegmented flagellum having two slight constrictions below in the region of funicular segments. Fore wing with short marginal fringe, measuring not more than one-fifth the width of wing; setae on vein track Rs₁ present. Male genitalia with dorsal expansion of gonobase of different shapes.

Trichogramma Westwood

*Viggiani (1971, figs. 4, 5) has illustrated the genitalia of two species of Trichogrammatoidae, under the names (1) T. nana and (2) Trichogrammatoidae sp. The first one resembles T. robusta (identified as T. nana by the Commonwealth Institute of Entomology but found to be a new species) and the second one resembles T. lutea.
KEY TO SPECIES OF TRICHOGRAMMATOIDEA

1. Male genitalia with chelate structures extending beyond tips of gonoforceps; region between the ventral ridges highly chitinized; fore wing with fringe setae long, longest being about 0.5 the width of remigium. Light yellow species. Ghana

   T. simmondsi, sp. nov.

   Male genitalia not as above; colour, wing fringe variable

   2

2. Chelate structures far below gonoforceps; wing fringe longer. Yellow species

   3

   Chelate structures slightly below gonoforceps; wing fringe, colour variable

   4

3. Male genitalia with prominent median ventral projection; basal infuscation in fore wing in line with stigma. India, Indonesia

   T. nana (Zehnt.)

   Male genitalia without median ventral projection; basal infuscation in fore wing not in line with stigma. South Africa

   T. cryptophlebiae, sp. nov.

4. Male antenna with short hairs, longest of which about 1.5 times the width of flagellum; fore wing fringe shorter

   5

   Male antenna with long hairs, fore wing fringe variable

   6

5. Median ventral projection small but distinct. Fulvous species. India

   T. fulva, sp. nov.

   Median ventral projection absent. Yellow species. Malaysia

   T. thoseae, sp. nov.

6. Median ventral projection present but small

   7

   Median ventral projection absent or minute

   8

7. Basal infuscation in fore wing in line with stigma; median ventral projection dark. Fulvous species. Guam

   T. guamensis, sp. nov.

   Basal infuscation in fore wing not in line with stigma; median ventral projection normal. Yellow species. Africa (lutea); India (prabhakeri)

   T. lutea Gir.* and

   T. prabhakeri, sp. nov.*

8. Male genitalia with tapering anterior and broader posterior ends. Fulvous species. India

   T. robusta, sp. nov.

   Male genitalia with broader anterior end

   9

9. Male genitalia with distinctly tapering posterior end

   10

   Male genitalia not as above

   11

10. Species with dimorphic males, alate and apterous, the latter being very small; median cleft in male genitalia about 0.17 the length of genitalia. Dark reddish brown species. India, Indonesia

   T. armigera, sp. nov.

   No dimorphic males encountered; median cleft in male genitalia about 0.25 the length of genitalia. Fulvous species. W. Indies, Costa Rica

   T. hypsitylae, sp. nov.

11. Median ventral projection minute; fore wing with longest fringe setae on tornus about 0.33 the width of remigium. Yellow species. Australia

   T. rara Gir.

   Median ventral projection absent; fore wing with longest fringe setae on tornus more than 0.33 the width of remigium. Dark fuscous species

   12

*These are morphologically totally alike but reproductively isolated.
12. Fore wing with fringe on tornus about 0.5 the width of remigium, the latter with
denser and longer setae, basal infuscation normal. Throughout the Orient

T. bactrae, sp. nov.

Fore wing with fringe on tornus less than 0.5 the width of remigium, the latter
with sparser and shorter setae, basal infuscation dark. India

T. bactrae fumata, subsp. nov.

1. Trichogrammatoidae armigera, sp. nov.

Trichogrammatoidae armigera Nagaraja: In Manjunath, 1972, Entomophaga,
17 (2): 131-147 (MS).

Male: Alate male: Length 0.42 to 0.5 mm; width (across head) 0.18 to
0.2 mm. Head light ochreous yellow, eyes and ocelli bright red, antenna
ochreous yellow. Thorax ochreous brown, scutum and parapsides suffused
with dark reddish brown, scutellum and propodeum lighter. Abdomen with
anteriormost tergum light ochreous, rest dark reddish brown with posterior
extremity light. Legs light ochreous with dark brown suffusion on mid-
femora. Wings with basal infuscation lighter and in line with stigma. Antenna
with flagellum nearly 1.5 x the scape; pedicel slightly more than 0.33 x the
scape, with moderately long 25-32 hairs, longest of which being slightly more
than twice the width of flagellum (Fig. 11).

Fore wing: Width nearly half the length, remigium with short setae,
basal infuscation in line with stigma. Fringe setae on tornus about 1.5 x as
long as the ones on costal margin, and a quarter the width of wing (Fig. 25).
Hind wing with fringe setae longer than those on tornus of fore wing. Genitalia
width about a third of the length; base rounded, apex tapering. CS small,
close to tip of GF. Median cleft about 0.17 the length of genitalia. MVP
indistinct, lateral tubercles indistinct, CR indistinct (Figs. 39, 39a). Aedeagal
with apodemes of equal length, together about 0.6 the length of hind
tibia (Fig. 53).

Apterous male: Length 0.15 to 0.25 mm; width 0.06 to 0.1 mm. Colour
uniformly light fuscous. Flagellum about 1.25 x the scape; pedicel about 0.5 x
the scape; club somewhat enlarged. Antenna with flagellum having 11-13
short hairs, the longest being equal to width of flagellum. Tarsi, femora and
tibiae somewhat stouter than in alate male. Genitalia as in alate male.

Female: Length 0.45 to 0.5 mm; width 0.18 to 0.2 mm. Colour same as
in male except that it is brownish and lighter. Antennal flagellum 1.25 x the
length of scape; pedicel slightly less than 0.5 x the scape; club width 0.66 x
its length, slightly shorter than scape. Fringe on tornus of fore wing slightly
less than a quarter the width of wing. Fringe on hind wing longer than that
of fore wing. Ovipositor slightly longer than hind tibia; width of ovipositor
plate slightly less than half the length (Fig. 53).


T. armigera differs from other species of Trichogrammatoidea in having dimorphic males. This was originally my manuscript species. T.M. Manjunath (1972) published a paper on morphology and biology of T. armigera with the specific name ascribed to me and stated in his paper that I would be describing the species. As Manjunath has clearly ascribed the species to me, I alone am responsible for this name.

This species seems to have a wide distribution since specimens have also been obtained from Java. It appears to have adapted to terrestrial dry habitat.

2. Trichogrammatoidea bactrae, sp. nov.

Male: Length 0.4 mm to 0.5 mm, width 0.15 mm to 0.18 mm. Head light fulvous; eyes, ocelli carmine; antenna light fuscous. Pro- and mesothorax fulvous-black. Scutellum and metanotum fulvous. Legs fulvous, mid and hind femora smoky. Abdomen with tergites black, venter lighter. Antenna with flagellum about one and three quarters the scape. Flagellum with 22 to 26 long hairs, longest being nearly 3 times the maximum width of flagellum. Club segments normal (Fig. 17). Fore wing with remigium narrow, width less than 0.4 the length of wing with long setae, basal infuscation in line with stigma, fringe setae long, almost uniformly long from apical angle to tornus, longest setae about half the width of wing (Fig. 32). Hind wing with fringe setae as long as in fore wing. Genitalia narrow, length nearly 3.0 the width. Apex and base indistinctly tapering, median cleft slightly less than a fifth the length of genitalia. MVP not conspicuous, lateral tubercles distinct, CR paired and short. CS large, slightly below the level of GF. Aedeagus and apodemes of nearly equal length (Figs. 46 & 46a), aedeagus with apodemes nearly three-fifths the length of hind tibia (Fig. 61).

Female: Length 0.42 mm to 0.5 mm; width 0.15 mm to 0.18 mm. Colour same as in male. Antennal flagellum 1.2× the length of scape, pedicel half of the scape, club width slightly less than half the length, length equal to scape. Wing fringe setae more than a third the width of wing. Ovipositor as long as hind tibia. Width of ovipositor plate 0.33× its length.


T. bactrae has a wide distribution in the Oriental Region. It is adapted to terrestrial humid habitat. Cherian & Margabandhu (1949) reared a species under the name 'T. nana' from Chilo infuscatus Sn. on sugarcane in Tamil Nadu. From their brief description, it is evident that they were referring to T. bactrae and not T. nana.

3. Trichogrammatoidea bactrae fumata, subsp. nov.

Female: Length 0.4 to 0.45 mm; width 0.15 to 0.18 mm. Colour as in T. bactrae. Antenna with flagellum slightly less than one and one-third the length of the scape, pedicel slightly less than 0.5 the scape, club with width more than 0.33 the length and slightly shorter than scape (Fig. 18). Fore wing with remigium somewhat wide, width nearly 0.5× the length, with short sparse setae, basal infuscation marked, in line with stigma. Fringe setae long, ones on tornus longer, longest of which is about 0.33× the width of remigium (Fig. 33). Hind wing with fringe setae slightly longer than those of fore wing. Ovipositor as long as hind tibia. Width of ovipositor plate 0.4× the length (Fig. 58).

Male: Length 0.4 mm; width 0.15 mm. The only dead ♂ was in the teneral stage with crumpled wings. Colour same as in T. bactrae. Antenna same as in T. bactrae. Genitalia same as in T. bactrae (Figs. 48 & 48a).

Holotype ♀, INDIA: UTTAR PRADESH: Golagokaranath, 1971, ex Unidentified Lepidopterous eggs on Achihranthus aspera. K. C. Mathur and K. Ramachandran Nair coll. Allotype ♂, same details as the holotype. Paratypes: ♀ the same details as the holotype and the allotype. Holotype and
allotype deposited in IARI. Paratype ♀ in USNM and rest in the collection of CIBC.

One male and 4 female specimens were received from CIBC, Golagokarannath substation. These very closely resemble *T. bactrae*. The only differences from *T. bactrae* are: (1) shorter wing fringe, (2) short and sparse setae on remigium, (3) darker basal infuscation in the fore wing and (4) relatively longer hind wing fringe. I was unable to obtain a live culture to conduct crossing experiments with *T. bactrae*. The subspecific status hence is only provisional.

4. *Trichogrammatoidae cryptophileiae*, sp. nov.

*Male*: Length 0.44 to 0.5 mm; width 0.15 to 0.18 mm. General body colour orange yellow; pronotum and mesoscutum light fuscous; abdomen dark fuscous. Antenna with flagellum about 1.5 × the length of scape; pedicel less than 0.5 × the scape; club segments normal with 21-24 hairs, longest being thrice the width of flagellum (Fig. 14). *Fore wing* somewhat wide, width slightly less than 0.5 the length, remigium with long setae, basal infuscation not reaching stigma, fringe setae long, those on tornus of moderate length, longest of which is slightly more than a third the width of wing (Fig. 28). *Hind wing* with fringe hairs as long as those of fore wing. *Genitalia* narrow, width nearly 0.33 × the length, apex and base not distinctly tapering, with indistinct dorsal connecting membrane. *CS* far below level of GF. Median cleft a quarter the length of genitalia. MVP wanting, lateral tubercles indistinct. CR paired, not reaching base (Figs. 42 & 42a). Aedeagus with apodemes of equal length, together about 0.6 × the hind tibia (Fig. 56).

*Female*: Length 0.4 mm to 0.55 mm; width 0.18 mm to 0.2 mm. Colour more yellow than in male; abdomen with anterior two terga dark fuscous. Antennal flagellum a little less than 1.5 × the length of scape; club as long as scape and width 0.4 × its length; pedicel 0.5 × the length of scape. Fore wing with fringe setae 0.33 × the width, hind wing fringe setae somewhat longer than those of fore wing. Ovipositor as long as hind tibia. Width of ovipositor plate half its length (Fig. 56).

*Holotype* ♂, SOUTH AFRICA: Pretoria, ii. 1970, ex *Cryptophlebia leucotreta* Meyr. (false codling moth) on Citrus, Miss C.J. Cilliers coll. *Allotype* ♀, same details as the holotype. *Paratypes*: ♂♂ and ♀♀, same details as the holotype and the allotype. Holotype and allotype deposited in IARI, paratypes (♂♂ and ♀♀) in the USNM, CIE and CIBC.

This species is related to *T. nana*. The adults did not oviposit in *Corcyra* eggs and hence a laboratory culture could not be built up. The genitalia are slightly different from those of *nana* in not having a median ventral projection and in having the basal infuscation far behind the stigma in the fore wing. It appears to have adapted to terrestrial dry habitat.
5. Trichogrammatoidea flava Girault


**Male** : Unknown.

**Female** : Length 0.4 mm; width appr. 0.15 mm. Colour could not be determined since the specimen was mounted in 1912. From the general description of Girault (_loc. cit._) the colour is uniformly orange-yellow. Antennal character could not be studied since the only specimen available was badly mutilated. _Fore wing_ width about half the length with remigium having short sparse setae. Basal infuscation very light, in line with stigma. Fringe setae moderately long, those on tornus longer, longest being about 0.33 the width of remigium. _Hind wing_ with fringe setae longer than those of _fore wing_. _Ovipositor_ almost as long as hind tibia. Width of ovipositor plate about one-third the length.

**Specimen examined** : A single ♀, _AUSTRALIA_ : _NORTH QUEENSLAND_ : Rossville in the Cooktown District, 23.ii.1912, host unknown, A. Girault coll., Type No Hy 995 (QMB).

The type slide was examined. The species was described from a single female collected at Rossville. The mounted specimen was very badly mutilated and hence did not permit proper examination. The wing characters however indicate that it is a short to moderately long fringed species with light basal infuscation. Since the host itself is not unknown, collection of the species is difficult unless the type locality is thoroughly combed.

Viggiani (1976) has considered _T. flava_ a synonym of _T. nana_. But the following characters indicate _flava_ to be different : (1) wing fringe in _flava_ is distinctly shorter than in _nana_, and (2) hind wing fringe are longer than in _fore wing_ in _flava_ while these are equal in _nana_.

Swezey (1915) recorded "_Trichogramma flavum_ Perkins" attacking several Lepidoptera in Hawaii. The true identity of this parasite has to be established. _T. flava_ is described by Girault in Australia while the above mentioned one is a Perkin's species (Flanders (in litt.) has communicated that the species is _Trichogramma pretiosum_ Riley).

6. Trichogrammatoidea fulva, sp. nov.

**Male** : Length 0.45 mm; width 0.18 mm. Head fulvous. Thorax fulvous with dark fuscous pronotum and mesoscutum; legs light fulvous. Abdomen dark fuscous. Antenna with flagellum about 1.33× the scape; pedicel slightly more than 0.33× the scape. Club segments normal. Flagellum with about 25mm stout short setae, longest of which slightly less than two times the width of flagellum (Fig. 13). _Fore wing_ width nearly 0.5× the length with moderately long fringe setae, those on tornus longer, longest of which is about 0.33× the width of wing. Basal infuscation in line with stigma. Remigium with sparsely distributed moderately long setae (Fig. 28). _Hind wing_ with fringe setae as long as those

of fore wing. *Genitalia*: Apex and base tapering; length 3.0× the width; with no perceptible dorsal connecting membrane of GB. Median cleft about 0.17× the length of genitalia. CS somewhat larger, almost reaching tips of GF. MVP distinct, triangular with distinct lateral median tubercles. CR paired but not very distinct, extending about 0.5× the distance anteriorly. Aedeagus as long as apodemes (Figs. 42 & 42a). Aedeagus with apodemes a little more than 0.5× of hind tibia (Fig. 56).
Female: Length 0.5 mm; width 0.2 mm. Head and thorax fulvous. Mesoscutum slightly infuscated. Abdomen with anterior 3 terga dark fuscous, rest dull fulvous. Antenna with flagellum $1.25 \times$ the scape; club width almost half the length, length slightly less than scape; pedicel less than $0.5 \times$ the scape. Fringe hairs of hind wing slightly longer than those of fore wing. Ovipositor longer than hind tibia. Width of ovipositor plate about one-third the length (Fig. 56).

Holotype $\delta$, India: Karnataka: Gangenahalli, Bangalore, ii.1973, ex Cryptoplebia ombrodelta (Lower) on Acacia concinna, H. Nagaraja coll. Allotype $\varphi$, same details as the holotype. Paratypes: $\delta \delta$ & $\varphi \varphi$. India: Karnataka: Bangalore, ex C. ombrodelta on Tamarindus indicus, vi.1974; the same host on A. concinna, Kamalashile, v.1975. Assam: Gauhati, $\delta \delta$ & $\varphi \varphi$, ex C. ombrodelta on Poinciana regia and Cassia spp., viii.1973, R.K. Subba coll. Holotype and allotype deposited in IARI. Paratypes $\delta$ and $\varphi$ in the USNM, CIE, and CIBC.

This species resembles T. guamensis except in the length and thickness of male antennal hairs. In T. guamensis the hairs are thin and long, longest being nearly $3.0 \times$ the maximum width of flagellum. In T. fulva the hairs are thick, being the thickest among species dealt with in this paper and the length is slightly less than $2.0 \times$ the maximum width of flagellum. It is an arboreal species.

Its taxonomic position has to be finally determined by crossing with T. guamensis.

7. Trichogrammatoidea guamensis, sp. nov.

Male: Length 0.4 mm to 0.45 mm; width 0.15 to 0.18 mm. Specimens obtained from the U.S. National Museum had been mounted in balsam in 1936. Therefore, the actual pigmentation could not be made out. It is fulvous with blackish thoracic region, femora and abdomen. Antenna with flagellum $1.25 \times$ the length of scape, pedicel slightly more than an $0.33 \times$ the scape, club segments normal. Flagellum with about 30 long hairs, longest of which nearly $3.0 \times$ the maximum width of flagellum (Fig. 14). Fore wing Remigium wide, width $0.5 \times$ the length of wing, with sparse short setae, basal infuscation in line with stigma. Fringe setae short, those on tornus longer, longest being about $0.25 \times$ the width of remigium (Fig. 30). Hind wing with fringe setae longer than those of fore wing. Genitalia narrow, width about $0.33 \times$ the length, with no perceptible dorsal connecting membrane. CS somewhat larger, of GF. MVP distinct, highly chitinized with distinct lateral tubercles. CR paired, running for a short distance (Figs. 43 & 43a). Aedeagus with shorter below the tips apedemes, both together $0.66 \times$ the length of hind tibia (Fig. 57).

Female: Length 0.4 to 0.5 mm; width 0.15 to 0.2 mm. Antennal flagellum $0.25 \times$ the scape, pedicel less than $0.5 \times$ the length and $0.75 \times$ the scape. Fore wing and hind wing as in male. Ovipositor slightly longer than hind tibia. Width of ovipositor plate slightly less than $0.5 \times$ of its length (Fig. 57).
Figs. 53-58. Relative lengths of aedeagus, hind tibia and ovipositor in: 53, T. armigera; 54, T. nana; 55, T. cryptophileiae; 56, T. fulva; 57, T. guamensis; and 58, T. b. fumata.

Holotype ♂, Guam: Barrigada, 'Lycaena boetica' eggs, vi.1936, 'O.H.S., Allotype ♀, same details as holotype. Paratypes: ♂♂ & ♀♀, ex Butterfly eggs on Cassia grandis, Piti x.1936, 'O.H.S.' coll. Holotype, allotype and paratypes deposited in USNM and paratype ♂ and ♀ in CIBC. Specimens of this species labelled as 'Trichogramma nana' were received from USNM.

*Lampides boeticus (L.)*
8. Trichogrammatoidea hypsipylae, sp. nov.

Male: Length 0.4 to 0.45 mm; width 0.18 to 0.2 mm. Fulvous with dark fuscous occiput, pronotum, mesoscutum and abdomen. Antenna with flagellum slightly less than 1.33× the scape. Pedicel slightly less than 0.5 of scape. Club segments somewhat enlarged. Flagellum with about 20 long hairs, longest being more than 3.0× the maximum width of flagellum (Fig. 19). Fore wing width slightly less than 0.5× the length; basal infuscation in line with stigma; remigium with sparse short setae, fringe setae moderately long, and those on tornus longer, longest of which more than 0.33× the width of remigium (Fig. 31). Hind wing with fringe setae slightly longer than those of fore wing. Genitalia some what wider, width slightly less than half the length, with dorsal connecting membrane not perceptible. Base not tapering, apex tapering. CS somewhat larger and almost reaching tips of GF. Median cleft slightly more than 0.25× the length of genitalia. MVP and lateral tubercles wanting; CR distinct, paired, extending to about 0.8 the genitalia (Figs. 44 & 44a). Aedeagus 0.6 the length of hind tibia (Fig. 59).

Female: Length 0.45 mm; width 0.2 mm. Colour same as in male but abdomen somewhat lighter. Antenna with flagellum slightly longer than scape, width of club 0.4× its length, about 0.8× the scape, pedicel about 0.4 the scape. Fringe setae length less than 0.33 the width of remigium. Hind wing fringe setae somewhat longer than those of fore wing. Ovipositor as long as hind tibia (Fig. 59). Width of ovipositor plate slightly less than 0.5× the length.


T. hypsipylae appears to have adapted to arboreal habitat.

9. Trichogrammatoidea lutea Girault


Male: Length 0.4 to 0.5 mm; width 0.15 to 0.18 mm. General body colour orange yellow. Head with light fuscous cheeks and antennae. Thorax with light fuscous pronotum, mesoscutum, pleurae and phragma. Abdomen dark fuscous anteriorly, light fuscous to yellow posteriorly. Legs yellow. Antenna with flagellum more than 1.5× the scape, pedicel slightly less than 0.5× the scape, club normal, flagellar hairs long, numbering about 30, longest being nearly 3.0× the maximum width of flagellum (Fig. 16). Fore wing wide, width nearly 0.5 the length; setae on remigium somewhat long, basal infuscation not reaching stigma, fringe setae short, those on tornus some-what longer, longest being

less than $0.33 \times$ the width of remigium (Fig. 29). *Hind wing* with fringe setae longer than in fore wing. *Male genitalia* narrow, width about $0.33 \times$ the length with a somewhat distinct dorsal connecting membrane. Apex tapering, base not tapering; CS slightly below GF, median cleft nearly $0.17 \times$ the length of genitalia. MVP distinct, tubercles indistinct, CR distinct and paired, extending to nearly $0.66 \times$ the length of genitalia (Figs. 45 & 45a). Aedeagus with apodemes of equal length, together more than $0.5 \times$ the length of hind tibia (Fig. 60).

*Female*: Length 0.42 mm; to 0.55 mm; width 0.15 mm to 0.2 mm. Yellow. Prothorax light fuscous. Anterior most abdominal terga dark fuscous and
abdominal tip light fuscous. Antenna with flagellum somewhat longer than scape, club shorter than scape, width 0.4 the length; pedicel; slightly more than 0.33✕ the scape. Fringe setae on torus of fore wing about 0.25✕ the width of remigium. Ovipositor as long as hind tibia, width of ovipositor plate 0.33✕ the length (Fig. 60).


Girault's syntypes were examined. Additionally, slides having specimens identified by Gahan (1925) as. "T. lutea Gir." were also examined. Both the series were obtained from the USNM. A culture was obtained through the courtesy of Miss C. J. Cilliers.

Specimens received from the USNM identified by Gahan were labelled as "Ex Aspidiotus hederæ, Claremont C.P., S. Africa". The host record is doubtful. No Trichogrammatid is known to be an adult scale insect parasite. Even if the host record refers to eggs of Aspidiotus, it still sounds untenable since the scale insect eggs are too small to accommodate the large specimens in question. T. lutea is obtained from terrestrial dry habitat.

10. Trichogrammatoidea nana (Zehntner)


Male: Length 0.4 to 0.45 mm; width 0.16 to 0.18 mm. General body orange yellow. Eyes and occelli bright red. Pronotum, mesoscutum and anterior part of abdomen light fuscous. Antenna with flagellum slightly more than 1.5✕ the scape; pedicel 0.33✕ the scape; flagellum with 22-26 long hairs, longest being 3.0✕ the maximum width of flagellum; flagellar segments slender, club segments normal (Fig. 12).

Fore wing: Somewhat broad, width slightly less than 0.5 the length, outer margin broadly rounded, setae on remigium somewhat sparse and long, basal infuscation in line with stigma. Fringe setae long, more than 0.33✕ the width of remigium, the setae on torus somewhat longer (Fig. 26). Hind wing with fringe setae as long as those of fore wing. Genitalia width a little more than 0.33✕ the length, with tapering base and a somewhat perceptible dorsal connecting membrane. CS far below GF. MVP distinct but short with indis-
tinct tubercles (Figs. 40 & 40a). Aedeagus apodemes, together nearly 0.75 ×
the length of hind tibia (Fig. 54).

Female: Length 0.45 to 0.5 mm; width 0.15 to 0.18 mm. Colour almost the
same as in male, the fuscous shades being lighter. Antennal flagellum 1.25 ×
the length of scape, club width slightly less than 0.5 the length and about
0.8 × the length of scape. Ovipositor as long as hind tibia; width of ovipositor
plate nearly 0.5 × the length (Fig. 54).

Specimens examined: INDIA: Bihar: Motipur, ♂ & ♀, ex Bactra venosana
Zeller on Cyperus rotundus, 1969, K. Ramachandran Nair & Sathyaprakash
coll. INDONESIA: JAVA, 1♂ & 1♀, ex Chilo sacchariphagus venosatus Walker
(Diatraea striatalis auct.) on sugar cane, 1896, Zehntner coll. PHILIPPINES:
NEGROS: Silay Occ., 1896, ♂ & ♀, Argyroplus schistaceana (Sn.) on sugar

There have been some confusion regarding true identity of T. nana in
literature. I have examined the slide of Zehntner obtained through the courtesy
of USNM. The slide has the following label: ‘Chaetosticha nana Zehntner, 7♀’s;
3♂’s. Aus Diatraea striatalis eierm (Java), 7375’. Girault (1911) examined the
specimen and erected the genus Trichogrammatoidea with nana as the geno-
type. He observed that ‘the slide bears in reality 2♂♂, 2♀♀ of nana and 1♂ and
5♀♀ of a larger species, an apparently undescribed species of Pentarthron Riley’.
But the slide contains 1♂ and 1♀ of T. nana, 2♂♂ and 1♀ of T. bactrae and 5♀♀
of an unidentified species of Trichogramma.

The identification of T. nana amongst the above specimens was based on
Zehntner’s description.

Considering the known host range of this species—all occurring on field
crops in humid habitat—the species referred to as nana by Beeson & Chatterjee
(1939), Beeson (1941) on teak defoliators, Tothill (1927) on coconut moth and
Wood (1968) on oil-palm moths must be altogether different ones adapted to an
arboreal habitat. That the species referred to as nana by Wood (loc. cit.) is in
fact T. thoseae, sp. nov. has been shown in this paper.

It is adapted to terrestrial humid habitat.

11. Trichogrammatoidea prabhakeri, sp. nov.

Male: Length 0.4 to 0.5 mm; width 0.15 to 0.18 mm. Colour same as in
lutea. Antenna, wings and genitalia same as in lutea (Figs. 24, 35, 48 & 48a).

Female: Same as in lutea (Figs. 62).

Holotype ♂, INDIA: KARNATAKA, Mandya, Achaea janata (L.) on castor, ix.
1971, H. Nagaraja coll. Allotype ♀, same details as the holotype. Paratypes: ♂♂
& ♀♀, same details as the holotype and allotype. Holotype and allotype deposi
ted in IARI and paratype ♂ and ♀ in USNM, CIE and CIBC.

This species is morphologically indistinguishable from lutea but biologically
distinct. Although it is capable of exchanging genes with lutea to a extremely
limited extent there are differences in certain other biological criteria. It was obtained only once from host eggs on castor which is usually grown in dry conditions.

12. Trichogrammatoidea rara Girault


**Male**: Length about 0.4 mm; width about 0.2 mm. The specimen on the slide was badly mutilated. The colour could not be determined as the specimens were very old. Antenna with flagellum having about 15 long hairs, longest being about 3.0× the maximum width of flagellum (Fig. 20). *Fore wing* width about 0.5× the length with moderately long and sparse setae on the remigium. Basal infuscation in line with stigma. Fringe setae moderately long, ones on tornus longer, longest being about 0.33 the width of wing (Fig. 37). *Hind wing* with fringe as long as those on fore wing. *Genitalia* width less than 0.33× the length with tapering ends. CS distinctly below the level of GF. Median cleft more than 0.25× the length of genitalia. MVP minute, CR could not be seen since the genitalia was not dissected out. Aedeagus with shorter apodemes, both together about 0.6 the length of hind tibia (Figs. 49, 49a & 63).

**Female**: Specimens badly mutilated. The characters observed from the fragments are: Pedicel slightly less than 0.5× the scape; club more than 0.75× the scape. Wings as in male. Ovipositor slightly shorter than hind tibia. Width of ovipositor plate about 0.33× the length (Fig. 63).

**Specimens examined**: 1♂, 2♀, Australia: Queensland: Mt. Gravatt, ex Eggs of *Cosmophilola* sp., No. Hy. 576 “3432” (QMB).

The type slide was obtained through the courtesy of Dr. E.C. Dahms, Curator of Entomology, the Queensland Museum, Fortitude Valley, Queensland, Australia. All the three specimens (2♀, 1♂) were badly mutilated. Antennal hairs are very sparse. If the combination of the following characters: (1) the sparse antennal hairs, (2) presence of a minute median ventral projection and (3) moderately long wing fringe hairs observed in the specimens on slide are not mere variations, then *T. rara* should be considered a distinct species.

The only other record of this species is that of Veitch (1927) who reared it from *Heliothis* in Australia.

13. Trichogrammatoidea robusta, sp. nov.

**Male**: Length 0.45 to 0.45 mm; width 0.15 to 0.2 mm. General body colour fulvous. Eyes and ocelli bright red. Occiput near neck genae, malar region and frons fuscos. Pronotum dark fuscos. Scutum light fuscos, mesopleura and femur moderately fuscos. Abdomen with anterior-most terga dark fuscos, hind rest light fuscos. Antenna with flagellum nearly 1.8× scape, pedicel slightly more than 0.33× the scape, club segments normal; 30-35× the flagellar hairs, longest hair measuring more than 2.5× the width of flagellum (Fig. 22). Fore
wing with remigium broad, width slightly less than half the length, basal infuscation light, in line with stigma, setae on remigium short, fringe setae moderately long, those on tornus slightly longer than the rest, measuring nearly 0.33 × the width of remigium (Fig. 36). Hind wing with fringe setae as long as in fore wing. Genitalia width less than 0.33 the length, with tapering base and broad apex. CS slightly below level of GF. Median cleft located at less than 0.17 × the length of genitalia. MVP minute, CR paired, extending to about 0.75 the length of genitalia (Figs. 50 & 50a). Aedeagus with shorter apodemes, both together about 0.6 the length of hind tibia (Fig. 64).

Female : Length 0.45 to 0.55 mm; width 0.15 to 0.2 mm. Colour same as in male. Antenna with flagellum 1.5 × the scape; club width 0.4 × its own length and slightly shorter than scape, pedicel 0.4 the length of scape. Wing fringe setae slightly shorter than in male. Ovipositor slightly longer than hind tibia. Width of ovipositor plate 0.33 × the length (Fig. 65).

Allotype ♀, same details as the holotype. Paratype: ♂♂ & ♀♀ same details as the holotype and the allotype. Holotype and allotype are deposited in IARI and paratypes ♂♂, and ♀♀ in the USNM, CIE, and CIBC.

This was identified by the Commonwealth Institute of Entomology as *T. nana* in absence of the type material there. It is an arboreal species.

14. Trichogrammatoidea simmondsi, sp. nov.

**Male**: Length 0.4 to 0.5 mm; width 0.15 to 0.18 mm. General body colour bright yellow. Head with fuscous genae and occiput near neck. Prothorax with light fuscous sides of pronotum. Mesothorax with light coloured scutum, legs yellow. Abdomen dark fuscous with lighter mid-region. Antennae with flagellum nearly 2.0× the scape; pedicel less than 0.4 the scape. Club segments normal, flagellum with 26-30 long hairs, longest being nearly 3.0× the maximum width of flagellum (Fig. 21). **Fore wing** with rounded outer margin, narrow, width about 0.4× the length, setae on remigium long, basal infuscation in line with stigma, fringe setae long, about 0.5 the width of remigium and uniform from tornus to apex (Fig. 34). Fringe setae on hind wing somewhat shorter than in fore wing. **Genitalia** apex tapering, base almost rounded, width about 0.4× the length. No perceptible dorsal connecting membrane. CS large with prominent digitus extending beyond GF. Median cleft located at about 0.17× the length of genitalia. MVP indistinct, lateral tubercles prominent, pointing apicad. CR paired, extending to base of genitalia, the region between the ridges chitini- zed (Figs. 51 & 51a). Aedeagus with apodemes of equal length, both together nearly 0.15× the length of hind tibia (Fig. 65).

**Female**: Length 0.5 mm to 0.6 mm; width 0.15 mm to 0.2 mm (across head). Yellow as in male with moderately fuscous prothorax, anterior three abdominal terga and tip of abdomen. Antenna with flagellum slightly longer than scape, pedicel 0.4× the scape, club width slightly less than 0.5× the length.

**Wings**: Fore wing fringe more than 0.33× the width of wing. Ovipositor slightly longer than hind tibia. Width of ovipositor plate 0.33 the length (Fig. 66). It is adapted to terrestrial humid condition.

**Holotype** ♂, **Ghana**: Dawhenya, ex *Chilo* sp. on paddy, 18.v.1972, G. Scheibelreiter coll. **Allotype** ♀, the same details as the holotype. **Paratype**: ♂♂ & ♀♀, **Ghana**: Kumasi, ex *Diopsis thoracica* Westw. on paddy; and Aunnase, ex *Chilo* sp. on paddy, 13.viii.1972, G. Scheibelreiter coll. Holotype and allotype in IARI, Paratypes ♂ & ♀, in the USNM, CIE and CIBC.

The protruding chelate structures and the highly chitinized, area in between central ridges make this species quite distinct. Judging from its hosts, the species appears to be adapted to humid conditions.
Fig. 67. Dendrogram showing the phenetic relationships between the species and a subspecies of *Trichogrammatoidea*.

15 *Trichogrammatoidea thoseae*, sp. nov.

*Male*: Length 0.33 mm to 0.45 mm; width 0.14 mm to 0.16 mm. General body colour light fulvous. Thorax with light fuscous shades on pronotum and mesoscutum; abdomen moderately fuscous, darker anteriorly. Antenna with stout segments, flagellum 1.25× the length of scape, pedicel less than half the scape. Club segments somewhat enlarged, club 0.66× the scape. Flagellum with about 20 short hairs, longest of which less than 2.0× the maximum width of flagellum (Fig. 23). *Fore wing* width of remigium slightly less than half the
length, basal infuscation light, in line with stigma. Setae on remigium sparse and short. Fringe setae of moderate length, ones on tornus slightly longer, longest of which is 0.4 times the width of remigium (Fig. 38). Hind wing: Fringe slightly longer than in fore wing. Genitalia broad, almost flask-shaped, width half the length with no perceptible dorsal connecting membrane. CS somewhat large, almost at level of GF. Median cleft more than 0.2 times the length of genitalia; MVP wanting, lateral tubercles indistinct. CR paired, running to the base of genitalia (Figs. 52 & 52a). Aedeagus 0.6 times the length of hind tibia (Fig. 66).

Female: Length 0.4 mm to 0.5 mm; width 0.15 mm to 0.18 mm. Colour somewhat lighter than in male. Antennal flagellum 1.25 times the scape, club width slightly less than 0.5 times the length, and 0.8 times the scape, pedicel 0.4 times the scape. Fringe setae less than 0.33 times the width of wing. Ovipositor as long as or slightly shorter than hind tibia, width of ovipositor plate slightly less than 0.5 times the length (Fig. 66).


This species is quite distinct in a number of characters, such as the male antenna and male genitalia. A few live specimens were obtained through the courtesy of Mr. B.J. Wood and Dr. R.A. Syed, Malaysia, but failed to oviposit in Corycyra eggs. Therefore a culture could not be built up to carry out biological studies. It is a arboreal species.

Species of Trichogrammatatoidea Not Examined

Doutt & Viggiani (1968) have provisionally placed 9 species under the genus Trichogrammatatoidea. These are: T. citri (Risbec), T. combretae (Risbec), T. flava, T. kayo (Risbec), T. lutea, T. nana, T. nodicornis (Westwood), T. rara, and T. stammeri Novicky. In addition, T. signiphoroides Breth and Trichogrammatatoidea sp. have been mentioned in the literature. T. flava, T. lutea, T. nana and T. rara have already been dealt with. The following comments pertain to species which were not available for my study.

16. Trichogrammatatoidea citri (Risbec)


Risbec’s illustrations of ♂ and ♀ antenna do not agree with the genus Trichogrammatatoidea. In both, the ring segments are missing while the female funicle is shown single-segmented. Hence the inclusion of this species under Trichogrammatatoidea is questionable.
17. Trichogrammatoidea combretae (Risbec)


The original descriptions and the illustration of fore wing agree with the genus _Trichogrammatoidea_.

18. Trichogrammatoidea kayo (Risbec)


Risbec based his description on females and apparently did not examine males. He stated that the females were clear yellow and gave a description of all parts. But the illustrations do not agree with _Trichogrammatoidea_ for the following reasons: The antennal club is shown to be bisegmented (unsegmented in _Trichogrammatoidea_), the fore wing is shown to have oblique setae below stigma (these setae being absent in _Trichogrammatoidea_) and the fringe setae are shown shorter than in _Trichogrammatoidea_.

Risbec mentioned the host as a larva of _Chrysomeles_ on rice. No Trichogrammatids are known to be larval parasites.

19. Trichogrammatoidea nodicornis (Westwood)


Host: Unknown; Locality: Colombo (Sri Lanka).


The original description and illustrations based on a single male agree with the genus _Trichogrammatoidea_ except for the following: The antenna as illustrated does not have a ring segment. A slight difference is also apparent in the marginal vein.

20. Trichogrammatoidea stammeri Novicky


I have not been able to obtain the original description of this species. No other particulars are available. From the key given by Peck (1964) the fore wing appears to have long fringe setae which are nearly as long as the width of the wing. None of the other species dealt with in this paper has such long fringe setae. The longest fringe setae encountered were in _T. simmondski_.
and *T. bactrae* in which the longest setae are only about half the width of wing.


I was unable to get any particulars of this species with regards to its author, year of publication, etc. The only record available is that of Barroetaena & Girola (1916) who reported that the species attacked the eggs of *Pseudaulacaspis pentagona* (Terg.) between April and November in Argentina.

22. *Trichogrammatoidea* sp.


Moutia & Courtois (1952) have given an account of the life history and immature stages of this species in Mauritius and observed that it was distinct from *T. nana* since it did not parasitize the eggs of *Chilo sacchariphagus venosatus* Walk.

**Numerical Taxonomy**

In recent years, numerical taxonomy has become an important method of classification of plants and animals. Sokal & Sneath (1963) in their treatise on numerical taxonomy have discussed the importance of phenetic relationships between taxa which are the prime criteria used in this method. This system is particularly helpful in classifying poorly known groups such as *Trichogrammatoidea*. In this system the proximity and distance between organisms is assessed by standardised mathematical process, not by mere mental logic and speculation which could often be biased.

In the present study 40 morphological and 5 biological characters were considered. These characters and codes are shown in Table 1. The members taken for the study are *T. armigera*, *T. bactrae*, *T. b. funata*, *T. cryptophlebiae*, *T. guamensis*, *T. hypsipylae*, *T. lutea*, *T. nana*, *T. prabhakeri*, *T. robusta*, *T. simmondsi*, and *T. thoseae*.

*T. fulva*, *T. flava* and *T. rara* were not included for reasons already explained.

**Table 1**

Characters and codes taken for members of *Trichogrammatoidea*.
(Roman numerals indicate characters while arabic ones codes.)

**Morphological characters**

**Colour**

I. *Colour ♂*: Yellow with fusco shades—1; fulvous with fusco shades—2; dark reddish brown with fusco shades—3; fulvous with black shades—4.

II. *Colour ♀*: Same as male—1, 2, 3 & 4.
ANTENNA ♂

III. Ratio of flagellum/scape: Less than $1\frac{1}{3}$ the scape—1; nearly or more than $1\frac{1}{3}$ time the scape—2.

IV. Ratio of scape/pedicel: Nearly 2 times the pedicel—1; more than 2 times the pedicel—2.

V. Club segments: Normal—1; somewhat enlarged—2.

VI. No. of hairs on the flagellum: Less than 25—1; more than 25—2.

VII. Length of flagellar hairs/width of flagellum: Length 2 times or less—1; more than 2 times—2.

ANTENNA ♀

VIII. Length of flagellum/scape: Slightly longer than scape—1; distinctly longer than scape—2.

IX. Length of scape/pedicel: Pedicel 2/5 the scape—1; pedicel more than 2/5 the scape—2.

X. Length of club/scape: Club distinctly shorter than scape—1; club slightly shorter than scape—2.

XI. Club width: Slightly less than or equal to $\frac{1}{2}$ the length—1; distinctly less than $\frac{1}{2}$ the length—2.

THORAX

XII. Shape: Normal—1; somewhat raised dorsally—2.

FORE WING ♂

XIII. Width/length: Width distinctly less than $\frac{1}{3}$ the length—1; width nearly $\frac{1}{3}$ the length—2.

XIV. Setae on remigium: Short—1; long—2.

XV. Basal infuscation: Behind stigma—1; in line with stigma—2.

XVI. Wing fringe: Setae uniform on outer margin—1; Setae on tornus longer—2.

XVII. Relative length of fringe/wing width: Length less than or about $1/3$ the width of wing—1; more than $1/3$ the width of wing—2.

XVIII. Relative lengths of hind wing fringe/fore wing fringe: Equal or fore wing fringe longer—1; hind wing fringe longer—2.

FORE WING ♀

XIX. Width/length: Width distinctly less than $\frac{1}{3}$ the length—1; width nearly $\frac{1}{3}$ the length—2.

XX. Relative length of wing fringe/wing width: Length less than or about $\frac{1}{3}$ the width of wing—1; length more than $1/3$ the width of wing—2.

XXI. Relative lengths of hind wing fringe/fore wing: Both of equal length—1; hind wing fringe longer—2.

XXII. Setae on fore wing remigium: Sparse—1; normal—2.

GENITALIA ♀

XXIII. Width/length: Width about $1/3$ the length—1; width more than $1/3$ the length—2.

XXIV. Shape of base: Tapering—1; rounded—2.

XXV. Shape of apex: Tapering—1; not tapering—2.
XXVI. Level of CS: Far below level of GF—1; Close to GF—2; extending beyond GF—3.

XXVII. Size of CS: Small—1; large—2.

XXVIII. Median cleft: Less than or equal to 1/6 the length of genitalia—1; more than 1/5 the length of genitalia—2.

XXIX. Size of MVP: Distinct—1; indistinct—0.

XXX. Median ventral tubercles: Indistinct—0; distinct—1; distinct and protruding caudad—2.

XXXI. Condition of central ridges: Indistinct—0; distinct—1.

XXXII. Region between CR: Normal—0; chitinized—1.

XXXIII. Relative length of aedeagus/apodemes: Both equal—1; aedeagus longer—2.

XXXIV. Dorsal Connecting membrane: Indistinct—0; distinct—1.

XXXV. Relative length of aedeagus/hind tibia: Aedeagus about 3/5 the hind tibia—1; more than 3/5 the hind tibia—2.

Genitalia ♀

XXXVI. Ovipositor plate length/width: Length less than 3 times the width—1; length 3 times the width—2.

XXXVII. Relative length of ovipositor/hind tibia: Both equal—1; ovipositor longer than hind tibia—2.

XXXVIII. Size of ♂: 0.5 mm or less—1; more than 0.5 mm—2.

XXXIX. Size of ♀: 0.5 mm or less—1; more than 0.5 mm—2.

XL. Relative length/width of body: Ratio 5:2—1; ratio less than 5:2—2.

Biological characters

XLI. % of females*: 60% or less—1; more than 60%—2.

XLII. Longevity of ♀/width food: Maximum 10 days—1; more than 10 days—2.

XLIII. Presence of apterous males: Present—1; absent—0.

XLIV. Acceptability of Corcyra as a host: Positive—1; negative—0.

XLV. Production of sterile males at 26°C (+1°): Present—1; not encountered—0.

In the first clustering cycle (Table 3), T. lutea and T. prabhakeri (r=.885), T. thoseae and T. hypsipyla (r=.460), T. cryptophlebiae and T. bactre (r=.234), and T. bactre bactreae and T. b. fumata (r=.511) form clusters. When a phenon line is drawn at 500 level in the dendrogram (Fig. 68) as suggested by Sokal & Sneath it is evident that there are two distinct groups, one comprising T. lutea, T. Prabhakeri, T. robusta, T. thoseae, T. hypsipyla, T. guamensis and T. armigera and another comprising T. cryptophlebiae, T. bactre, T. b. fumata, T. simmondsi and T. nana. These groups can be considered as: (1) lutea—group, comprising species having short to moderately long wing fringe and broad fore wing and (2) nana—group, having long wing fringe and narrow fore wing.

The characters and codes were then arranged under each species (OTU's) as shown in Table 2.

*Under laboratory conditions when reared on Corcyra cephalonica.
**Table 2—Characters and Codes of each Operational Taxonomic Unit**

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NC = Not included in Calculations.

Correlation coefficients for different combinations of OTU’s obtained from a computer are arranged in Table 3.
DISCUSSION AND CONCLUSIONS

The present study has shown that there are 18 known species and a subspecies of Trichogrammatoidea (of which I have been able to examine 15).

Based on present knowledge, the known species can be zoogeographically arranged as follows:

Australian: T. flava & T. rara.
Ethiopian: T. combretae, T. cryptophlebiae, T. lutea and T. simmondsi.
Neotropical: T. hypsipygae.
Palaeartic: T. stammeri.

Numerical taxonomic analysis has revealed that there are two distinct clusters of species having differences in length of wing fringe. T. fulva, T. rara and T. flava were not included in this study for reasons stated earlier. The systematic position of T. flava and T. rara, remains arbitrary since very few specimens were examined (1 ♀ in flava and 2 ♀♀ and 1 ♂ in rara) and no males of flava were seen.

Crossing experiments (Nagaraja, in press) showed that among T. lutea, T. prabhakeri, T. robusta and T. armigera, the lutea-group which form a cluster under the phenon level of −.500, there is a very limited gene exchange (except between prabhakeri and robusta) either in one direction or in both. No crosses could be conducted among nana-group because the only culture available was of T. bactrae. The species of the lutea-group have short to moderately long wing fringe, broad wing remigium with shorter setae. On the other hand, the species included in the nana-group have long wing fringe, a narrow remigium with longer setae. The genitalia characters, however do not conform to the clusters. The differences in male genitalia in Trichogrammatoidea are not as marked as in Trichogramma.

A study of T. lutea and T. prabhakeri, T. guamensis and T. fulva which resemble each other closely is interesting. T. lutea and T. prabhakeri exchange genes to a limited extent (Nagaraja, in press). Biologically also these two species differ markedly. They are therefore considered as semi-species with respect to each other. In the case of T. fulva and T. guamensis, there is however a slight difference in the length of male antennal hairs. But these could not be crossed since the culture of the latter was not available. How far their distribution extends is not known. It is possible that the insular T. guamensis was originally derived from a few founder individuals of T. fulva.

ACKNOWLEDGMENTS. I am highly grateful to Dr. F. J. Simmonds, former Director, Dr. V.P. Rao, former Entomologist-in-charge, Indian Station and Dr. T. Sankaran, Entomologist-in-charge, Indian Station, Commonwealth Institute of Biological Control for their kind encouragement and permission to use the laboratory facilities for the present studies on Trichogrammatoidea. I am equally grateful to Dr. Sankaran and Dr. Sudha Nagarkatti, Entomologist, Indian Station CIBC for having critically gone through the manuscript. I am
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First clustering cycle: A*—A↓B;
Coefficients of all Pairs of OTU's

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D' = D + E; G' = G + H; K' = K + L.
also indebted to the authorities of the U. S. National Museum, the Queensland Museum, and Commonwealth Institute of Entomology, and to other Entomologists (both of CIBC and of Institutions in other parts of the world) for having kindly loaned to me the type slides and supplied specimens of Trichogrammatoidea which enabled me to complete this study.

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