

***Telenomus* species (Hymenoptera: Scelionidae) attacking eggs of pyralid pests (Lepidoptera) in Africa: a review and guide to identification**

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Abstract

The taxonomy and host-records of 11 *Telenomus* species recorded from eggs of ten species of pyralid pests in Africa are reviewed. Three species, *T. bini*, *T. creusa* and *T. nemesis*, are described as new. Primary type material of nine previously described species was examined: *T. applanatus* Bin & Johnson, *T. etieliphaga* (Risbec) (comb. n.), *T. nephele* Nixon, *T. procas* Nixon, *T. soudanensis* (Risbec), *T. thestor* Nixon, *T. tolli* Risbec, *T. ullyetti* Nixon and *T. versicolor* Bin & Johnson. A lectotype is designated for *T. etieliphaga* (Risbec), which is transferred to *Telenomus* from *Micromymar*. Lectotypes are also designated for *T. soudanensis* and *T. tolli*. The monotypic genus *Micromymar* Risbec is synonymized with *Telenomus*. A method for the preparation, mounting and identification of *Telenomus* specimens reared from eggs of African pyralid pests is given. Host-records based on previously misidentified *Telenomus* spp. are corrected, and records in which the host has been apparently misidentified are commented upon. The relevance of *Telenomus* spp. to biological control and integrated pest management of African pyralid pests is discussed.

Introduction

Telenomus spp. are small wasps, often black, and exclusively parasitoids in the eggs of other insects. The genus currently contains about 500 described species. The hosts of *Telenomus* spp. are mostly Lepidoptera and Hemiptera, but they are also known from Diptera and Neuroptera. As Johnson (1984) has stated, although the host range for the genus is rather broad, the degree of host-specificity varies between the species, with some species attacking the eggs of many different genera within an order, and others apparently restricted to a single host species.

The genus is important economically because many species are naturally-occurring regulating factors of pest species. Although the number of current and past successes in classical biological control using *Telenomus* spp.

is relatively small, this has a great deal to do with the difficulties of correct identification and the confusion which has often arisen due to the perpetuation of erroneous host associations through the applied entomological literature. The potential of *Telenomus* and closely related genera as biological control agents is reviewed by Bin & Johnson (1982b), and that of Scelionidae as a whole by Orr (1988).

The best approach to dealing with the many taxonomic difficulties associated with the genus would be a complete revision, at species-level, based on the world fauna. Such a work would constitute an almost overwhelming task for a single taxonomist, but sound foundations have been laid by Johnson (1984), who divided the genus into holophyletic species-groups, which are more easily manageable. Johnson's division of the genus into these species-groups is based on female morphology, but many of the groups are also strongly host-associated; thus, the *laricis*-group are all parasitoids of

Miridae, the *floridanus*-group of Lygaeidae. This species-group/host association appears to be particularly true for the species-groups with hemipterous hosts, but the majority of *Telenomus* spp., the hosts of which are Lepidoptera, belong to the *californicus*-group. This remains a rather large and unmanageable group. While we endorse a broad approach to solving the taxonomic difficulties of the genus, a degree of pragmatism has been necessary in the present study as these difficulties are of a particularly pressing nature. We have dealt only with the African species associated with pyralid pests, mostly of cereal crops. From the systematist's point of view, the *Telenomus* spp. attacking pyralids are largely a mere paraphyletic assemblage, and therefore of little interest. The purpose of this paper is, however, to facilitate the correct identification of those *Telenomus* spp. which attack the eggs of this economically important group of moths, and to clear some of the confusion surrounding those species. For example, of the 12 published records of previously described *Telenomus* spp. attacking pyralids in Africa 11 are based on misidentifications.

An attempt has been made in this paper to provide reliable host information for the species dealt with. However, the difficulties in making a correct identification of a parasitized pyralid egg-mass are obvious. This is particularly a problem with the numerous *Chilo* and *Scirpophaga* species whose host-plant associations and geographical distributions often overlap. Some of the ways in which reliable host data can be obtained in such cases are given below in the section on identification.

The geographical area covered in this paper is the Afrotropical Biogeographical Realm *sensu* Udvardy (1975), which includes the entire continent south of the Sahara, plus Madagascar and the Mascarene Islands.

Material & abbreviations

The majority of the material examined was from the collections at the British Museum (Natural History), most of which had been previously sent to the CAB International Institute of Entomology (formerly the Commonwealth Institute of Entomology) for identification. Other material was borrowed from: Muséum National d'Histoire Naturelle, Paris; Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Montpellier, France; Instituut voor Taxonomische Zoölogie, Amsterdam, and Dr H.R. Feijen, Leiden, Netherlands. The following abbreviations are used in the text for these institutes or persons and for type depositories: BMNH: British Museum (Natural History), London, UK; CIRAD: Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Montpellier, France; HRF: Dr H.R. Feijen, c/o Rijksmuseum voor Natuurlijke Historie, Leiden, Netherlands; ITZ: Instituut voor Taxonomische Zoölogie, Amsterdam, Netherlands; MNHN: Muséum National d'Histoire Naturelle, Paris, France; NMK: National Museums of Kenya, Nairobi, Kenya; USNM: United States National Museum of Natural History, Washington, D.C., USA.

Identification

From the introduction, it is apparent that the correct identification of *Telenomus* spp. from African pyralids

has been hitherto extremely problematical. Of the previously published records only one (*T. busseolae*) appears to have been based upon a correct identification. The only keys available until now were those of Nixon (1935) and Risbec (1950). These are based on external morphology of females, and most key characters are either variable or very difficult to assess without access to a reference collection and therefore of no use for identifications. Nixon (1937) stressed the importance of male genitalia in this group with the following statement: 'Several [*Telenomus* spp.] are alike in all characters save the genitalia of the males. This structure, as I discovered while working on the African species of *Telenomus*, continues to show excellent and easily appreciated specific differences; to examine it is really the only satisfactory way of separating critical species'. However, bound by tradition, he based his keys and species descriptions on female external morphology.

While we concede that the patterns shown by many aspects of the external morphology may be of great importance in assessing the phylogenetic relationships between taxa, the male genitalia provide unquestionably the best means of species-level identification. Furthermore, with a few exceptions, differences in the external morphology of the species dealt with herein are so slight compared with differences in male genitalia that we have based both our key and our species descriptions on genitalia characters. However, we have stressed differences in external morphology where these provide a more convenient alternative (as with males of *T. etielliphaga*, *T. nephele* and *T. versicolor*).

Preparation of specimens

For reliable species-level identifications of *Telenomus* we recommend that a reasonably long series (10–20 individuals) of specimens, containing both sexes and reared from a reliably identified host, is used. In a number of cases, closely related hosts are found sympatrically, often with two or more closely related parasitoid species, and for this reason it is extremely important that egg-masses collected should be kept individually, separate from other egg-masses. Surveys of pyralid species present in the area studied should also be carried out by rearing of larvae. If possible, freshly laid host egg-masses should be divided, part allowed to develop into adults and part left to permit possible parasitization.

All emergent specimens should be carefully examined for the possible occurrence of two or more species emerging from a single egg-mass. We have seen a number of samples containing more than one species, *apparently* reared from the same host egg-mass. However, it is not always clear from collectors' data whether this was actually the case. In some instances a few individuals of a second species, sometimes of only one sex, are present in samples consisting otherwise of a single species.

For identification, the following procedure, requiring card-mounting followed by slide-mounting of the male genitalia, should be followed:

Card-mounting

Select at least five individuals of each sex. The sexes can be distinguished easily, males having 12-segmented

moniliform antennae in which all the flagellar segments are of approximately equal diameter, whereas females have 11-segmented clavate antennae, in which the last four or five segments are much larger than the preceding ones. Specimens will normally have been collected into alcohol and should be first carefully dried on porous white card, before being mounted individually on small card rectangles. Each specimen should be mounted longitudinally, tilted on its side at about a 45° angle, as recommended by Noyes (1982) for chalcid wasps. Each specimen should, at this stage, be labelled with all the relevant data.

Slide-mounting of male genitalia

We strongly recommend using Canada balsam mounting medium in preference to any of the water soluble mountants.

- i. Remove the metasoma (gaster) from some or all of the card-mounted male specimens. It is important at this stage to keep the metasomata separate from each other, giving each a reference number so it can be associated with the original specimens. This is particularly important if the series turns out to be a mixture of two or more species.
- ii. Macerate the metasoma in hot KOH for 5–10 minutes, then transfer to a glass cavity block. Remove the KOH and add a few drops of glacial acetic acid.
- iii. After a few minutes, remove glacial acetic acid, add distilled water, leave for 10 minutes.
- iv. Add an equal volume of 70% alcohol, leave for 10 minutes.
- v. Remove liquid, add 70% alcohol, leave for 10 minutes.
- vi. Add an equal volume of absolute alcohol, leave for 10 minutes.
- vii. Remove liquid, add absolute alcohol, leave for 10 minutes.
- viii. Add 5–10 drops clove oil. Leave until most alcohol has evaporated.
- ix. Transfer the metasoma from the cavity block to a small drop of fresh Canada Balsam on a slide.
- x. Carefully dissect out male genitalia, including the basal ring (see fig. 1). This can be done in a number of ways, most of which usually result in the metasoma itself being destroyed. With practice, however, it is possible to remove all the genitalia intact simply by using the viscosity of the balsam to draw the genitalia carefully out of the metasoma without damaging them. The undamaged metasoma can then be washed in alcohol and remounted with the original specimen.
- xi. Arrange the genitalia in the balsam, trying to keep the basal ring attached, and add a small, clean coverslip.
- xii. Label slide with all relevant data.

Identification

The general structure of male *Telenomus* genitalia is given in fig. 1. Descriptive terms used both for the male genitalia, and for the male and female morphology in later sections of this paper, follow Johnson (1984). In many cases comparison with figs 2–11, followed by careful checking against the full species accounts will give the correct answer. However, the key is provided in order to draw

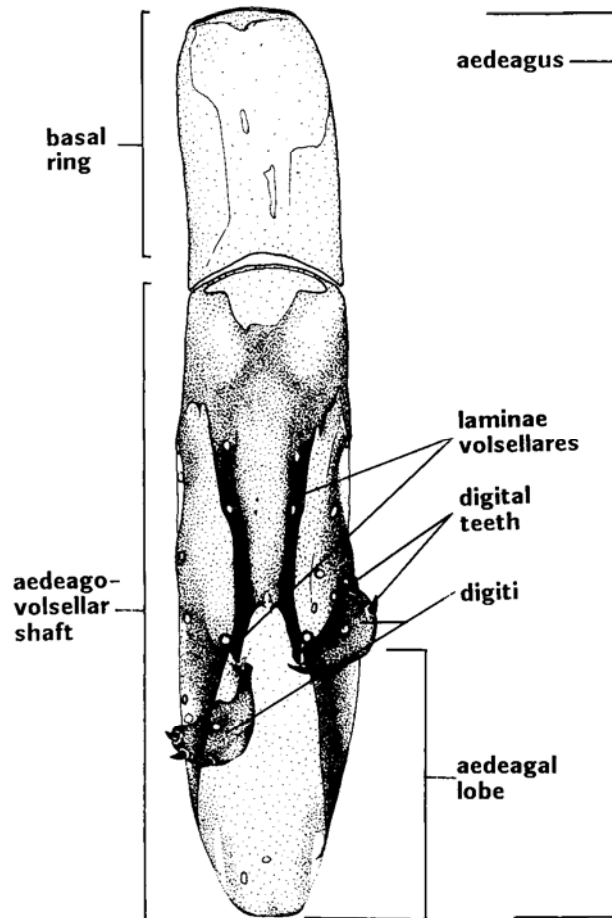


Fig. 1. Male genitalia of *Telenomus* (nomenclature follows that of Johnson, 1984).

attention to the most useful characters in each case. The following characters in particular are subject to variation within a species: position of digiti (either one or both digiti may be in either the raised or the lowered position, see fig. 1), degree of pigmentation, length of the basal ring. Also, the aedeagal lobe, which is often very weakly sclerotized, may undergo distortion during slide preparation.

Slides should preferably be examined with phase-contrast illumination at a magnification of 200–300×.

Telenomus species attacking pyralids in Africa

Telenomus Haliday, 1833:271. Type species *Telenomus brachialis* Haliday. Designated by Ashmead (1893:142).

Micromymar Risbec, 1950:622. Type species *Micromymar etielliphaga* Risbec by monotypy **syn. n.** (see *T. etielliphaga*).

Platytelenomus Dodd, 1914:126. Type species *Platytelenomus planus* Dodd by monotypy. Synonymized by Johnson (1988).

Diagnosis. All species belonging to the *californicus*, *tabanivorus* (*sensu* Johnson, 1984) or *dignus* (*sensu* Nixon, 1937) groups can be characterized by the following; antennal clava of female 5-segmented; frons smooth medially; eyes hairy; notauli absent; forewings clear. Parasitoids of Lepidoptera or Diptera.

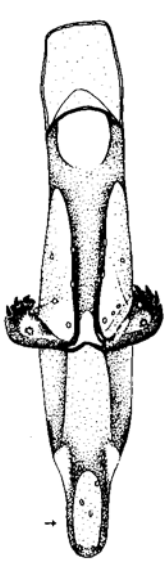


Fig. 2
T. procas

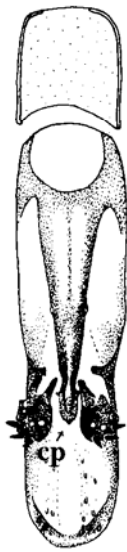


Fig. 3
T. nemesis

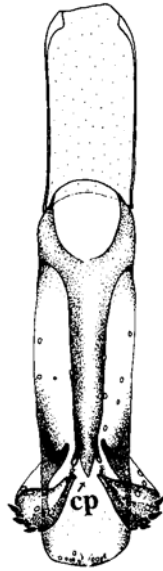


Fig. 4
T. busseolae

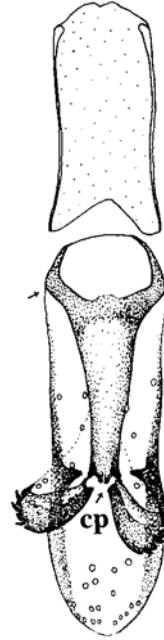
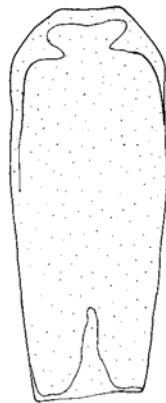


Fig. 5
T. creusa

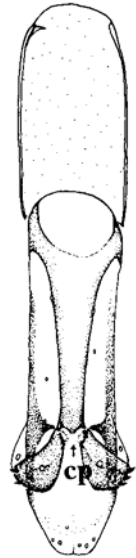


Fig. 6
T. bini

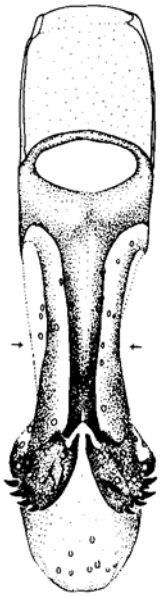


Fig. 7
T. thestor

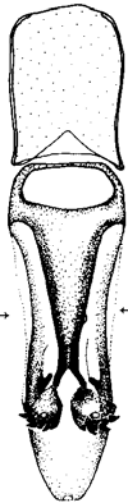


Fig. 8
T. soudanensis

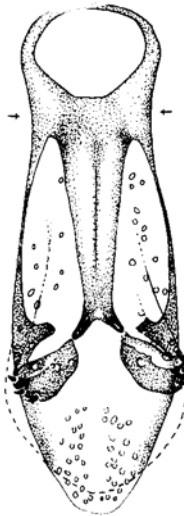


Fig. 9
T. nephele /
(T. versicolor
=dotted line)

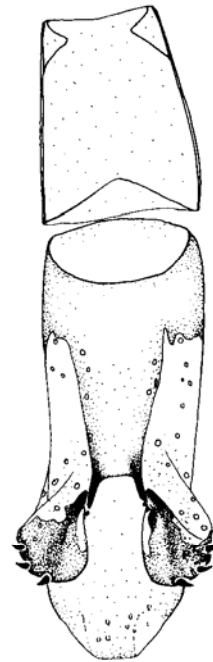


Fig. 10
T. etielliphaga

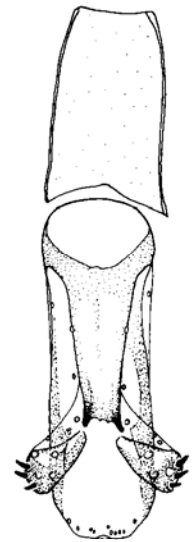


Fig. 11
T. applanatus

Figs 2–11. Male genitalia of *Telenomus* species attacking pyralid pests in Africa (all drawn to same scale).

For a full generic diagnosis and synonymy of *Telenomus* see Johnson (1984).

To avoid repetition under the descriptive part for each species, the following characters are shared by all the *Telenomus* species recorded so far from African Pyralidae:

1. Male genitalia: aedeago-volsellar shaft longer than aedeagal lobe (e.g. fig. 1). Digits with three to five teeth.
2. Colour: never metallic; always brown, black, yellow or bicoloured.
3. Head: eyes hairy (sometimes with very short hairs); hyperoccipital carina absent; post ocellar furrows absent; preocellar pit absent; antennae 12-segmented (males), 11-segmented (females); antennal clava (females) 5-segmented, A9, A10 transverse.
4. Mesosoma: notauli absent; wings hyaline, unpigmented; postmarginal vein longer than stigmal.

Key to *Telenomus* species

1. Aedeagal lobe with a sclerotized ring (fig. 2, arrowed)..... *procas*
– Aedeagal lobe without such a ring (figs 3–11) 2
2. Ends of laminae volsellares with a projection centrally ('cp' in figs 3–6)..... 3
– Ends of laminae volsellares without such a projection centrally (figs 7–11)..... 6
3. Digits small relative to aedeagal lobe, each digitus 0.4–0.45× the length of the aedeagal lobe (fig. 3) *nemesis*
– Digits larger relative to aedeagal lobe, each digitus at least 0.5× the length of the aedeagal lobe (figs 4, 5 & 6) 4
4. Aedeagal lobe almost entirely truncate, digits very large in relation to it (when digits are in the 'lowered' position they nearly reach the tip of the aedeagal lobe (fig. 4) *busseolae*
– Aedeagal lobe either pointed (fig. 5) or truncate only at the tip, which is slightly bilobed (fig. 6). Digits smaller in relation to aedeagal lobe 5
5. Aedeagal lobe pointed, more than 0.33× the total length of the aedeago-volsellar shaft (fig. 5) *creusa*
– Aedeagal lobe truncate at the tip, about 0.33× the total length of the aedeago-volsellar shaft (fig. 6) *bini*
6. Aedeago-volsellar shaft constricted at a point approximately half-way along its length (figs 7 & 8, arrowed)..... 7
– Aedeago-volsellar shaft either with sides parallel-sided (figs 10 & 11), or if constricted, then not at a point approximately half-way along its length (fig. 9, arrowed)..... 8
7. Digits large, one half or more as long as the aedeagal lobe, with 3–5 teeth (fig. 7)..... *thektor*
– Digits small, rounded, a third as long as the aedeagal lobe, with 3 teeth (fig. 8)..... *soudanensis*
8. Aedeago-volsellar shaft with sides bowed, its distal half wider (maximum width) than its proximal half, digits small in relation to aedeagal lobe (fig. 9) 9
– Aedeago-volsellar shaft parallel-sided, digits large in relation to aedeagal lobe (figs 10 & 11) 10
9. Aedeagal lobe usually broadly rounded (fig. 9, dotted line). Head and mesosoma of male largely pale brown, contrasting with dark metasoma. Hind femur of female largely dark. 2nd metasomal tergite of female less than 1.5× its maximum width, and with hind margin straight..... *versicolor*
– Aedeagal lobe tapering, triangular, but often with a flattened tip (fig. 9). Head, mesosoma and metasoma of male black. Hind femur of female largely yellow with a slight brown infuscation. 2nd metasomal tergite of female more than 1.7× its maximum width, and with hind margin curved *nephele*
10. Digits short and broad, forming an approximately equilateral triangle (fig. 10) males of this species are rather distinctive: yellow, with antennomeres strongly transverse and eyes reduced) *etielliphaga*
– Digits elongate (fig. 11) males dark, with antennomeres and eyes as is usual for the genus) ... 11
11. Aedeagal lobe with a pointed tip (fig. 5). Mesosoma not flattened dorso-ventrally *creusa*
– Aedeagal lobe truncate at the tip (fig. 11). Mesosoma dorso-ventrally flattened *applanatus*

Telenomus applanatus Bin & Johnson

(fig. 11)

Telenomus applanatus Bin & Johnson, 1982a:231

Male. Genitalia (fig. 11): aedeagus parallel-sided, digits large, with elongate digital teeth.

Female. Mesosoma compressed dorso-ventrally, dorsellum almost smooth, with very little sculpture; otherwise without any distinctive characters.

Material examined. Holotype ♀, [IVORY COAST] Côte d'Ivoire, Bouaké, ix.1978. (P. Cochereau.) *Ex Eldana saccharina* (BMNH). Paratypes 2 ♀♀, 2 ♂♂, same data as holotype (BMNH). Other material: 5 ♀♀, 7 ♂♂, [GHANA] Gold Coast, Kumasi, 1943 (G.S. Cotterell) CIE 1530 *ex* corn stalk borer (BMNH). 2 ♀♀, 1 ♂, GHANA, Kumasi, 11.i.1971. (G.K. Scheibelreiter) (BMNH). Material from GABON, recorded by Bin & Johnson (1982a), was not examined.

Hosts. Pyralidae, Crambinae: *Eldana saccharina* (Walker). A stem-borer, primarily of maize (*Zea mays*) but also attacking sorghum (*Sorghum bicolor*), rice (*Oryza sativa*) and sugarcane (*Saccharum officinarum*). Widely distributed south of the Sahara (CIE, 1971; Kranz *et al.*, 1977). According to Hill (1983) the eggs are oval, yellow and laid in batches of variable size, but often of ten to 15, on the soil surface, the leaf bases or in cracks on mature stalks.

Distribution. Gabon, Ghana, Ivory Coast.

Remarks. This species was dealt with thoroughly by Bin & Johnson (1982a) in the original description, which should be consulted for details of morphology. However, under the name *T. applanatus* they included material reared from both *Eldana saccharina* Walker and from *Maliarpha separattella* Ragonot. Whilst recognizing some morphological differences between the two 'forms', Bin & Johnson

considered these differences to be correlated with the smaller size of *Maliarpha*-reared specimens. Having seen material reared from both hosts from a range of localities we conclude that two species are present. The male genitalia are consistently different irrespective of the size of the adult, and we have found no intermediates. The *Maliarpha*-'form' is treated under *T. bini*, below.

This is the species recorded as *Telenomus* sp. by Scheibelreiter (1980), and presumably that recorded as *Telenomus* sp. nr *dignus* by Cochereau (1980a, 1980b). Carnegie *et al.* (1985) record the importation of *T. applanatus* from Ivory Coast into South Africa in 1980. Despite the release of over a million parasitoids, over a two and a half year period, the rate of recovery in the field was extremely poor. Carnegie *et al.* (1985) also list five species of Lepidoptera whose eggs were not acceptable to *T. applanatus* under laboratory conditions.

Telenomus bini sp. n.

(figs 6, 12)

Male. Genitalia (fig. 6): central projection present; digiti large relative to aedeagal lobe; aedeagal lobe about a third the total length of the aedeago-volsellar shaft and truncate at the tip, which is bilobed. Mesosoma depressed dorso-ventrally, but this character rather variable.

Female. Mesosoma depressed dorso-ventrally (variable), otherwise without any distinctive characters; sculpture and setation as in fig. 12.

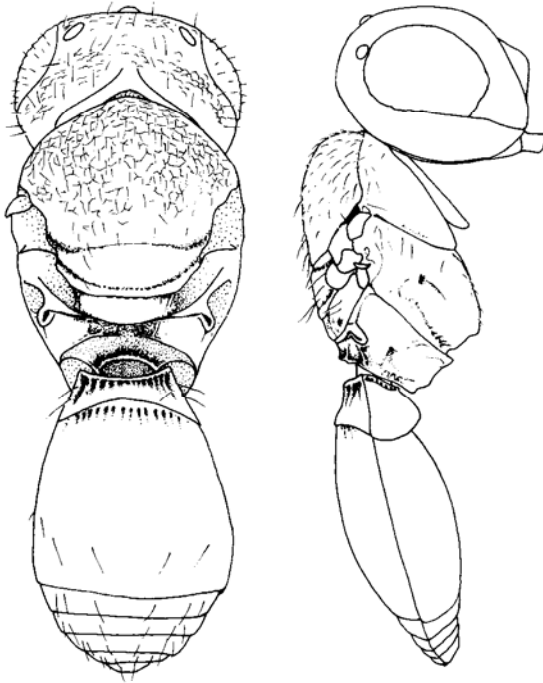


Fig. 12 *T. bini*

Fig. 12. *T. bini*.

Material examined (all ex *M. separatella* unless stated otherwise). Holotype ♂, MADAGASCAR, Lac Alaotra, Stn 'Cala', 2.iii.1983 (P. Bousses) ('LB7') (MNHN). Genitalia mounted on a slide. Paratypes, 1 ♂, 19 ♀♀. Same data as holotype (BMNH, MNHN, NMK, USNM). Other material: 4 ♀♀, MADAGASCAR, Lac Alaotra, 1983 (BMNH), 1 ♀, 1 ♂, [IVORY COAST] Côte d'Ivoire, Bouaké, OB 13.80.2. 1954 (Ouayogodé) (MNHN). 1 ♀, 1 ♂, Bouaké, x.1980. OBV 80.2 Boite G FL.II 1776 (Ouayogodé) (BMNH). 4 ♂♂, GHANA, Dawhenya, 12.xii.1972. (G.K. Scheibelreiter) (BMNH). 2 ♂♂, MALAWI, Lake Chilwa, 5.iv.1972, ex ?*Chilo*; 7 ♀♀, 6 ♂♂, MALAWI, Khanda, 31.i.75 (H.R. Feijen) ex ?*Scirpophaga subumbrosa* (A.P. det.) (BMNH, ITZ); 3 ♀♀, 2 ♂♂, SENEGAL, Djibelor, 4.xii.1979 1601 (sp. 61) 1603 (sp. 70) (MNHN). >100 ♀♀, ♂♂, TANZANIA, Zanzibar, Bumbwi, vii.1987 (H.R. Feijen); Zanzibar, Unguja, Mtwango, 1983. (H.R. Feijen) (BMNH, ITZ).

Hosts. Pyralidae, Phycitinae: *Maliarpha separatella*; Schoenobiinae: *Scirpophaga ?subumbrosa* Meyrick; Crambinae: ?*Chilo* sp. (majority of records from *Maliarpha*).

Maliarpha separatella is known commonly as the white rice borer, is widespread south of the Sahara, and is an important pest in Madagascar and in the rice-growing areas of West Africa. Egg-masses are laid on the upper surface of the leaf, each containing usually between 20 and 30 eggs. They are attached to the leaf by a cement which, upon drying, causes the leaf to fold in a characteristic way, concealing the egg-mass (Brenière *et al.*, 1962).

The genus *Maliarpha* currently contains only one valid species, *M. separatella*. However, specimens from West Africa (Sierra Leone) differ morphologically in some characters from Madagascan specimens, and may constitute a different species (*M. Shaffer*, pers. comm.). Furthermore, studies on the pheromones of Madagascan and West African specimens suggest that a pre-mating isolating mechanism would operate should the two populations be found in sympatry, further evidence for separate species status (*A. Cork*, pers. comm.).

The single record of *T. bini* from *S. ?subumbrosa* is from Lake Chilwa, Malawi. The host egg-mass from which the parasitoids emerged is that of a *Scirpophaga* species. Adult specimens of *S. subumbrosa* (det. A.P.), previously misidentified as *Thopeutis* sp., were collected simultaneously from the same locality. The pest status of this species in that region is unknown to us.

Distribution. Ghana, Ivory Coast, Madagascar, Malawi, Senegal, Tanzania.

Remarks. This species was described originally as *T. applanatus* (see above) by Bin & Johnson (1982a). For the reasons given above under that species, we consider *T. bini* to be distinct from it. However, the morphological diagnosis given by Bin & Johnson for the *Maliarpha*-reared *T. applanatus* applies to *T. bini*, and should also be consulted.

This is the species recorded as '*Telenomus* sp.1, groupe *lemoleae* Nixon' by Etienne (1987). It is very probably also the Madagascan species referred to by Brenière *et al.* (1962), although that material was not seen by us. According to these authors, the species could be easily reared on *Maliarpha* in the laboratory, but would not ac-

cept eggs of the pyralids *Ephestia kuehniella* Zeller or those of *Corcyra cephalonica* Stainton.

***Telenomus busseolae* Gahan**

(fig. 4)

Telenomus busseolae Gahan, 1922:23

Platytenomus hylas Nixon, 1935:74 (synonymized by Fergusson, 1983).

Male. Genitalia (fig. 4): central projection present, digiti large, much longer than half the length of the aedeagal lobe, which is truncate. A distinctive species, being strongly flattened dorso-ventrally, including the head. This species and some other dorso-ventrally flattened species were placed until recently in the genus *Platytenomus*, synonymized with *Telenomus* by Johnson (1988). However, the strong dorso-ventral flattening of *T. busseolae* easily distinguishes it from most other *Telenomus* species. It can be further distinguished from the other *Telenomus* species that have a flattened body by the shape of the head, which is markedly transverse in dorsal view and about three times broader than long. The above characters (except genitalia characters) are applicable also to the female.

Material examined. Paratypes (*Telenomus busseolae* Gahan), 2 ♀♀, 1 ♂, SOUTH AFRICA, Cedare, Natal, 1.iii.1919. (C.W. Mally) ex *B. fusca* (BMNH). Holotype ♀ (*P. hylas* (Nixon)), SUDAN, Shendi, xii.1929–i.1930 (J.W. Cowland) ex *S. cretica* (as *S. 'arctica'* in the original description) (BMNH). Paratypes 21 ♀♀, 11 ♂♂, same data as holotype. Over 50 other specimens examined from all of the countries listed below under 'Distribution' all from either *Sesamia* or *Busseola* spp. except the following: 2 ♀♀, 1 ♂, SENEGAL, Bambey, 18.x.1943. (J. Risbec), ex *Chilo* sp. on millet (BMNH). 7 ♀♀, 1 ♂, NO LOCALITY [?Senegal, Bambey], ex '*Chilo pyrocaustalis*' (MNHN).

Hosts. Noctuidae: *Busseola fusca* (Fuller), *Chrysodeixis chalcites* (Esper), *Sesamia botanophaga* Tams & Bowden, *S. calamistis* Hampson, *S. cretica* Lederer, *S. inferens* (Walker), *S. nonagrioides* (Lefevre), *Sesamia* sp.; Pyralidae, Crambinae: *Coniesta* (= *Donacoscaptes*) *ignefusalis* (Hampson).

C. ignefusalis is a pest primarily of bulrush millet, maize and sorghum. The eggs (unparasitized) are yellowish white, and are oblong/oval in shape, although distorted from being closely pressed against each other (Harris, 1962).

Distribution. Africa: Cameroon, Egypt, Ghana, Kenya, Mauritius, Nigeria, Réunion, Senegal, South Africa, Sudan, Uganda. Elsewhere: Bangladesh, Greece, Iraq, Iran, Israel.

Remarks. This species is well known as a parasitoid of the stem-borers *Busseola* and *Sesamia* (Noctuidae), and has a wide distribution.

T. busseolae has been included here on the strength of a single record from the pyralid *Coniesta ignefusalis* (= *Chilo pyrocaustalis*). We have examined the material (2 ♀♀, 1 ♂, BMNH) on which (in all probability) this record is based, which was identified originally by G.E.J. Nixon.

Furthermore, a slide in MNHN labelled '*Platytenomus hylas* Nixon ex *Chilo pyrocaustalis*' contains 7 ♀♀ and 1 ♂, and the remains of the host eggs from which they emerged. All these specimens are *T. busseolae*, and the host eggs clearly do not belong to any *Busseola* or *Sesamia* species. The appearance of the eggs approximates to that of *C. ignefusalis* eggs, described above.

***Telenomus creusa* sp. n.**

(figs 5, 13)

Male. Genitalia (fig. 5): aedeagal lobe large, length greater than one third of the total length of the aedeago-volsellar shaft, broadly pointed. Digits large, about half the maximum length of the aedeagal lobe, usually with three digital teeth per digitus. Central projection present between distal ends of laminae volsellares, though this is often indistinct or unpigmented (best viewed with phase-contrast illumination).

Female. Head, mesosoma and metasoma without any distinctive characters; sculpture and setation as in fig. 13.

Material examined. Holotype ♂: MALAWI, Lake Chilwa, Veld 1, Hill 9, 15.iv.75 (H.R. Feijen) ex eggs *C. diffusilineus* on rice (ITZ). Paratypes: 35 ♀♀, 10 ♂♂. 13 ♀♀, same data as holotype; 1 ♀, 4 ♂♂, data as holotype except: Veld 1/0, Hill 6, 8.iii.1973; 21 ♀♀, 6 ♂♂, same data as holotype except: 8.iv.1974 (BMNH, ITZ, NMK, USNM). All specimens were originally mounted on cavity slides in Hoyer's medium and have had to be remounted. They are, therefore, in rather poor condition.

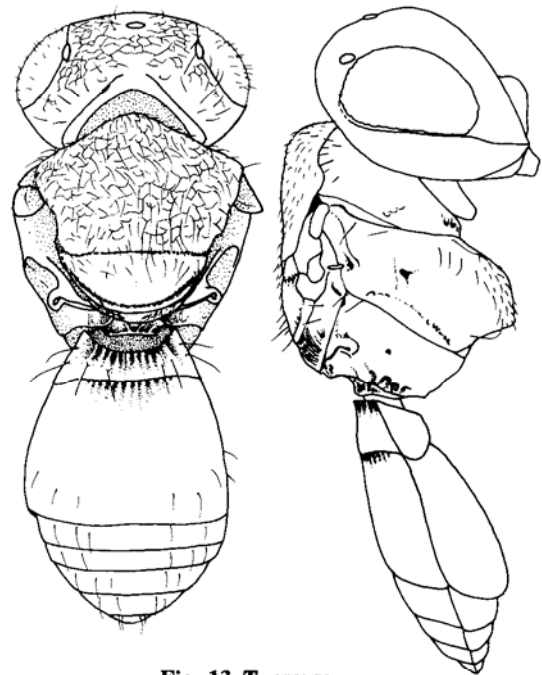


Fig. 13 *T. creusa*

Fig. 13. *T. creusa*.

Hosts. Pyralidae, Crambinae: *Chilo diffusilineus* (J. de Joannis). This species attacks rice, and has been recorded as a pest in Malawi (Feijen & Schulten, 1981).

Distribution. Malawi.

Remarks. The species was recorded as *T. ullyetti* (Feijen & Schulten, 1981) and later as *Telenomus* sp. (Schulten & Feijen, 1982).

***Telenomus etielliphaga* (Risbec) comb. n.**

(fig. 10)

Micromymar etielliphaga Risbec, 1950:622.

Male. Genitalia (fig. 10): digital teeth large, three per digitus. Digiti large, about half the length of the aedeagal lobe. Aedeagal lobe rounded, not pointed, slightly truncate. Aedeago-volsellar shaft about twice the length of the aedeagal lobe. Antennae unusual for the genus, having transverse antennomeres. Clypeus centrally produced into a prominent spine, extending to the point where the mandibles meet. Eyes reduced, ocelli absent/vestigial. Wings strongly reduced. Legs short, with femur, tibia and basitarsus strongly broadened. Colour orange/yellow except second metasomal segment and subsequent segments brown.

Female. Bearing a superficial resemblance to the females of *T. nephele* and *T. versicolor*, but with the hind margin of the second metasomal tergite straight (curved in *T. nephele*), and with the mesosoma longer than in either of those species and quite strongly flattened dorso-ventrally.

Material examined. Lectotype ♂: (no original data except: '*Telenomus nephele* Nixon ex *Etiella zinckenella*' [SENEGAL: Bambey col. J. Risbec] (MNHN). Paralectotypes: 2 ♂♂ on slide with lectotype, same data (MNHN). Other material: 6 ♀♀, same data as lectotype. 3 ♀♀, 2 ♂♂, SENEGAL, Bambey, (J. Risbec) CIE 384 ex ?*Etiella zinckenella*. '*Micromymar etielliphaga* Risbec, G. Nixon det. 1950' (BMNH).

Hosts. Pyralidae, Phycitinae: *Etiella zinckenella* Treitschke. A pod-borer, important in Africa as a pest of legumes, including cowpea (*Vigna unguiculata*). The species is widely distributed in Africa and elsewhere (CIE, 1974). According to Hill (1983) the eggs are oval, shiny white, 0.6 × 0.3 mm, laid singly, or in groups of up to six, on immature pods.

Distribution. Senegal.

Remarks. The unusual males of this species were described originally in the chalcidoid family Mymaridae. The original description was based on three specimens reared from *Etiella zinckenella* Treitschke. We have not found any specimen in the MNHN collections labelled *Micromymar etielliphaga*. However, a slide labelled '*Telenomus nephele* Nixon ex *Etiella zinckenella*' contains three males of *Telenomus* fitting exactly the description of '*Micromymar etielliphaga*', an extremely distinctive species.

The central male of the three on this slide is hereby designated the lectotype. A second slide, labelled in the same way, contains six females. On both slides the specimens have been rather badly crushed under the coverslip. In the BMNH accessions material (Scelionidae) we have located a series of five specimens, three females and two males (somewhat damaged), labelled 'SENEGAL, Bambey, J. Risbec, ex eggs of *Etiella zinckenella* *Micromymar etielliphaga* Risbec G. Nixon det. 1950'. These are conspecific with the MNHN material. The females from the BMNH material have the mesosoma intact; the dorso-ventral flattening mentioned above is not therefore, an artifact due to slide-mounting.

The unusual males of this species share a number of characters with the micropterous morph of *T. polymorphus* (Costa Lima, 1943), i.e. the overall yellow coloration, reduced eyes, absent/vestigial ocelli, enlarged mandibles and reduced wings. However, whether *T. etielliphaga* is also a polymorphic species remains to be discovered.

***Telenomus nemesis* sp. n.**

(figs 3, 14)

Male. Genitalia (fig. 3): distal ends of laminae volsellares with a very characteristically shaped central projection extending towards the distal end of the aedeagal lobe between the digiti. Digiti small (less than half the length of the aedeagal lobe) equipped with large teeth; aedeagal lobe smoothly rounded at its distal end.

Female. Head, mesosoma and metasoma without any distinctive characters; sculpture and setation as in fig. 14.

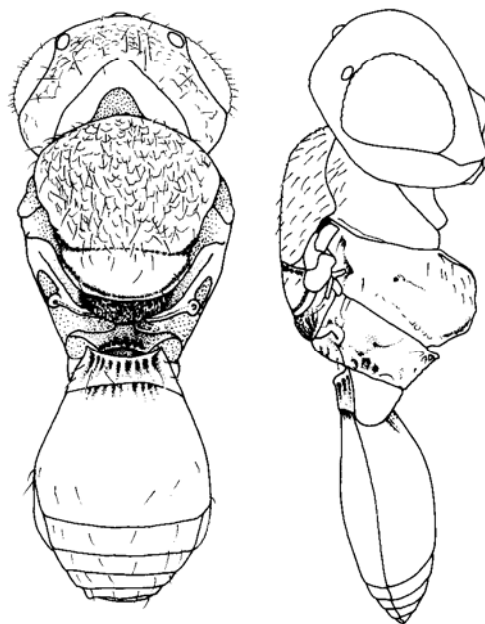


Fig. 14 *T. nemesis*

Fig. 14. *T. nemesis*.

Material examined. Holotype ♂: KENYA, Mombasa–Mtwapa Kilifi Coastal Research Station (ICIPE) vii. 1986 (J.O. Ochieng) ex *Chilo orichalcociliellus* on maize (NMK). Paratypes: 14 ♀♀, 2 ♂♂, same data as holotype (BMNH, NMK, USNM). Other material: 2 ♀♀, 4 ♂♂, GHANA, Kwadaso viii.1972 (G.K. Scheibelreiter) CIE 6064 ex *Chilo* sp. on rice (BMNH). 1 ♀, 1 ♂, SENEGAL, Djibelor 23.x.1980 (J. Etienne) sp. 178 1839 ex *Chilo* (MNHN). 6 ♀♀, 2 ♂♂, MOZAMBIQUE, Marraquene 3.i.1979 (H.R. Feijen) ex *Chilo* sp. on rice (HRF).

Hosts. Pyralidae, Crambinae: *Chilo orichalcociliellus* (Strand), *Chilo* sp.

In East Africa, *C. orichalcociliellus* is known as the ‘coastal stalk borer’, and is a pest of maize (K.V. Seshu Reddy, pers. comm.). It is known also from Zaire, Madagascar and South Africa.

Distribution. Ghana, Kenya, Mozambique, Senegal.

Remarks. This species was recorded as ‘*Telenomus* sp. 2, groupe *lemoleae* Nixon’ by Etienne (1987).

Telenomus nephele Nixon

(fig. 9)

Telenomus nephele Nixon, 1935:88.

Male. Genitalia (fig. 9): aedeagal lobe tapering, often truncate at the tip. Black with yellow legs. Genitalia very similar to, and sometimes indistinguishable from, those of *T. versicolor*, with which it is often found in sympatry.

Female. Black with yellow legs, the hind femora slightly infuscated. Body elongate, length of second metasomal tergite more than 1.7 times its maximum width and with a distinctly curved hind margin.

Material examined. Holotype ♀: [MALAWI] Nyasaland, Maiwale Em[erged] 2.i.1932 (W.A. Lamborn) ex ?moth egg mass on grass [CIE]1209 (BMNH). Paratypes: 1 ♂, 6 ♀♀, same data as holotype (BMNH). Other material: 25 ♀♀, 1 ♂, [Cameroon] Garoua 8.55. ‘ex...pyrale indet... Riz (Descamps) 281. *Telenomus tolli* R’ (MNHN). 2 ♀♀, 3 ♂♂, [IVORY COAST] Côte d’Ivoire, Bouaké 12.xii.1979 (P. Cochereau) ex *Scirpophaga melanoclista* on rice. Paratypes (part) *Telenomus versicolor* Bin & Johnson [with *T. versicolor*] (BMNH). 1 ♀, 1 ♂, Bouaké ex ponte *Scirpophaga* A [?occidentella] OB 16.80.2 (Ouayogodé) 1958 No 5 (MNHN). 1 ♀, Bouaké iv. 1977 (M. Lor Sun Ly). ex *Scirpophaga* [with *T. versicolor*] (BMNH). 94 ♀♀, 26 ♂♂, GHANA, Dawhenya [nr Accra] 8.iii.1972 (G. Scheibelreiter) ex [*Scirpophaga* (=)*Tryporyza*(?)] Nos 2,5 (BMNH). 3 ♀♀, 5 ♂♂, MALAWI, Lake Chilwa 9.xii.1971 (H.R. Feijen) ex Lep. eggs on rice (ITZ). 7 ♀♀, 5 ♂♂, L. Chilwa veld 2 9.iii.1975 (H.R. Feijen) [ex *Scirpophaga* ?*subumbrosa*, A.P. det.] [slide no.] 37 ‘*Telenomus tolli*?’ [with *T. versicolor*] (ITZ). 16 ♀♀, 1 ♂, L. Chilwa, Khanda 10.ii.1975 [H.R. Feijen ex *Scirpophaga*] ‘*Telenomus tolli* Risbec’ [slide no.] 34 (ITZ). 1 ♀, MALI, Mopti 21.ix.1977 (Dembélé) 1287 no. 2 [ex] *Scirpophaga subumbrosa* (MNHN). 9 ♀♀, 7 ♂♂, [SENEGAL], Lower Senegal Valley, Richard Toll 17.ix.1957 (A. Wane) [ex] eggs..no. 15 [*Scirpophaga* sp. on] rice CIE

15707 (BMNH). 1 ♀, 1 ♂, SENEGAL, Djibelor 26.xi.1979 1606 sp. 52 [ex *Scirpophaga*] (MNHN). 4 ♀♀, 2 ♂♂, Djibelor, 4.xii.1979 1608 sp. 55 [with *T. versicolor*] 1609 sp. 59, 1610 sp. 62, 1611 sp. 69 [all ex *Scirpophaga*] (MNHN).

Hosts. Pyralidae, Schoenobiinae: *Scirpophaga melanoclista* Meyrick, *S. occidentella* (Walker), *S. subumbrosa* Meyrick, *Scirpophaga* spp.

In Africa, these species are minor pests, boring stems of rice. The eggs are laid in small masses, with a covering of golden-brown hairs deposited from the anal region of the moth.

Distribution. Cameroon, Ghana, Ivory Coast, Malawi, Mali, Senegal.

Remarks. In Nixon’s original description, the male genitalia are not figured. We have since mounted the genitalia of the allotype (fig. 9) and they are almost indistinguishable from those of *T. versicolor* (fig. 9, dotted line). This similarity, coupled with the fact that these two species attack the same hosts and often occur mixed in samples, caused Bin & Johnson (1982a) to include both males and females of *T. nephele* in the type series of *T. versicolor*. For a detailed discussion of this problem see *T. versicolor*.

This species was recorded as *T. tolli* by Descamps (1956), and was present among the material recorded as ‘*Telenomus* sp. 2, groupe *benefactor* Nixon’ (sic, *T. benefactor* was described by Crawford) by Etienne (1987), and ‘*T. tolli*’ by Feijen & Schulten (1981).

T. nephele was introduced from Ghana into India in 1972 against cereal stem borers, but failed, apparently, to become established (Sankaran, 1974).

Telenomus procas Nixon

(fig. 2)

Telenomus procas Nixon, 1935:78

Male. Genitalia (fig. 2): very distinctive, with a sclerotized ring on the aedeagal lobe. Otherwise very similar morphologically to *T. thestor*.

Female. Without any distinctive characters.

Material examined. Holotype ♀: [SUDAN]: British Sudan, Wad Medani 29.xii.1927 (H.B. Johnston) Well. T.R. Labs. ex [*Utetheisa*=] *Deiopoieia pulchella* CIE 4309 (BMNH). Paratypes (9 ♀♀, 5 ♂♂): 4 ♀♀, same data as holotype; 5 ♀♀, 5 ♂♂, same data as holotype except coll. 29.xii.1927 (BMNH). Other material: 7 ♀♀, 9 ♂♂, INDONESIA: [Java] Bogor viii.1956 (M. Sutardi) ex *Argina cribraria* CIE 15769 (BMNH). 4 ♀♀, 1 ♂, SENEGAL, Bambey ex [*Antigastra*] ‘*Anticarsia*’ *catalaunalis* (MNHN). 3 ♀♀, 2 ♂♂, SENEGAL, Richard Toll 24.ix.1951 (J. Appert) ex eggs on rice CIEA 12376/071 (BMNH).

Hosts. Arctiidae: *Utetheisa* (= *Deiopoieia*) *pulchella* L., *Argina astrea* (Drury) (= *A. cribraria* (Clerck)); Pyralidae, Pyraustinae: *Antigastra catalaunalis* (Duponchel).

Both the host records and the distribution of this species are somewhat unusual. The records from the arctiids *Utetheisa* and *Argina* are from Sudan and Java,

respectively. These two host genera are very closely related, and were it not for the pyralid host record *T. procas* would appear to be genus-group specific. It may be that Risbec's (1950) record from *A. catalaunalis* is based on a misidentification, but if genuine then *T. procas*, like the (apparently) closely related *T. thestor*, appears to be not very host-specific.

A. catalaunalis is primarily a pest of sesame (*Sesamum indicum*), and has a broad distribution, occurring throughout Africa and in Europe and Asia. The eggs are elongate, oval, and are laid singly on terminal shoots and leaves, though several eggs may be found close together (Kranz, Schmutterer & Koch, 1977).

Distribution. Africa: Senegal, Sudan. Asia: Indonesia.

Remarks. This species was misidentified as *T. thestor* 'variété' by Risbec (1950) and the record perpetuated by Balachowsky (1972) as '*T. testor* Aixon' (*sic*).

Telenomus soudanensis (Risbec)

(figs 8, 15)

Trissolcus soudanensis Risbec, 1950:555.

Telenomus soudanensis (Risbec) Masner, 1976:78.

Male. Head and body brownish-yellow (?discoloured). Genitalia (fig. 8): digital teeth large, laminae volsellares most strongly pigmented laterally such that aedeago-volsellar shaft appears to have two rods converging towards the digiti before diverging for a short distance. Central projection absent. Genitalia indistinguishable from those of *T. remus* Nixon or *T. nawai* Ashmead. Antenna with segment A5 with a strong projection apically, equipped with a large, blunt sensillum (fig. 15).

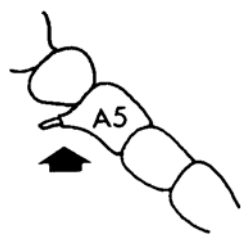


Fig. 15. *T. soudanensis* ♂ antenna (part).

Female. Material examined without any characters to distinguish the species from the related species *T. remus* and *T. nawai*.

Material examined. Lectotype ♀ (here designated): [NIGER] Kayo Riz [rice] [?1943] 'ex. *Proceras africana*, *Trissolcus soudanensis* Risbec'. Circled on a slide in canada balsam with 2 ♀♀, 2 ♂♂ (paralectotypes) (MNHN). 1 ♀, 1 ♂ (badly damaged) card-mounted from same slide, genitalia on a separate slide (paralectotypes, BMNH). 3 ♂♂ on another slide (crushed remains) '*Trissolcus soudanensis* Risb. ex w. *Proceras africana*' (MNHN).

Host. Recorded from *Chilo zacconius* Bleszynski only (det. A.P.). A stem-borer, attacking rice in West Africa.

Distribution. Niger.

Remarks. We have examined male paratypes of *T. remus* and paralectotypes of *T. nawai* and their genitalia are indistinguishable from those of *T. soudanensis*. However, the conspicuous projection on the fifth antennal segment, at the base of the large sensillum, is absent in *T. remus* and *T. nawai*. Johnson *et al.* (1987) have demonstrated intraspecific host-related variation in the shape of female antennomeres, but data on intraspecific variation in sensilla and associated structures are lacking. We conjecture that such a specialized sensillar arrangement may be involved in mate-recognition, and if such is the case could therefore be a good indicator of separate species status.

The host was given by Risbec (1950) as '*Proceras africana*', and later as '*Chilo nr phaeosoma* Martin' (Risbec, 1960). There are specimens in the BMNH collection with the following data: 'Sudan: Kayo . 18.x.43 J. Risbec. ex Rice. *Proceras nr africana* Auriv. det T.H.C. Taylor 1945. *Chilo agamemnon* Bleszynski det Bleszynski 1964'. These specimens are, in fact, *C. zacconius* Bleszynski (det A.P.), as was reported previously by Trân vinh Liêm (1977).

Telenomus thestor Nixon

(fig. 7)

Telenomus thestor Nixon, 1935:79.

Male. Genitalia (fig. 7): central projection absent, aedeagus with sides concave, digiti large, usually with four or five teeth.

Female. Head, mesosoma and metasoma black, legs and antennae also almost entirely black. Head strongly transverse and appearing very low in side view, giving this species a 'humpbacked' appearance. Otherwise without any distinctive characters.

Material examined. Holotype ♀: UGANDA, Kampala 16.vi.1930 (H. Hargreaves) ex Lepid. eggs on 'Mukasa' (BMNH). Paratypes: 8 ♀♀, 28 ♂♂, same data as holotype (BMNH). Other material: 2 ♀♀, 2 ♂♂, [IVORY COAST] Côte d'Ivoire, Abengourou, Dagatiguy, ex oeufs sur taro' (MNHN). 7 ♀♀, 2 ♂♂, KENYA, Mtwapa Coast, vi.1987 (Lu Qing Guang) CIE A19224/CM 1-a-58 (ICIPE) ex *Chilo orichalcociliellus* on maize (BMNH). 8 ♀♀, ZAIRE, Shaba Region, Mufuempa 27.i.1987 (R. Hennessey) CIE A19122/H2 ex eggs of Lepidoptera on maize (BMNH).

Hosts. Arctiidae: *Amsacta moloneyi* (Druce); Pyralidae, Crambinae: *Chilo orichalcociliellus* (Strand) (see *T. nemesi*, above, for comments on the pyralid host).

Distribution. Ivory Coast, Kenya, Senegal, Uganda, Zaire.

Remarks. The species appears to be widespread and polyphagous. It was recorded originally from lepidopterous eggs on 'mukasa', a local (Luganda) name for *Senecio* sp. probably *S. abyssinicus*—or possibly *S. discifolius* (A.W.R. McCrae, pers. comm.). Interestingly, Le Pelley (1959) lists four arctiids on *S. abyssinicus* in Uganda.

***Telenomus versicolor* Bin & Johnson**

(fig. 9, dotted line)

Telenomus versicolor Bin & Johnson, 1982a:236.

Male. Genitalia (fig. 9, dotted line): almost indistinguishable from those of *T. nephele*, but aedeagal lobe usually broadly rounded. Head and thorax largely pale brown, mesoscutum usually darker centrally than at the sides, metasoma black.

Female. Black with legs infuscated, length of second metasomal tergite less than 1.5 times its maximum width and with the hind margin straight.

Material examined. Holotype ♀: [IVORY COAST] Côte d'Ivoire, Bouaké 12.xii.1979 (P. Cochereau) ex *Scirpophaga melanoclista* on rice [with *T. nephele*] (BMNH). Paratypes: 1 ♀, 3 ♂♂, same data as holotype (BMNH). Other material: 2 ♀♀, 2 ♂♂, [IVORY COAST] Côte d'Ivoire, Man xi.1979 Bordat 1846 [ex *Scirpophaga* (MNHN)]. 1 ♂, [IVORY COAST] Bouaké, iv.1977 (M. Lor Sun Ly) ex *Scirpophaga* [with *T. nephele*] (BMNH). 96 ♀♀, 42 ♂♂, GHANA, Dawhenya [nr Accra] 8.iii.1972 (G. Scheibelreiter) ex [*Scirpophaga*] (= *Tryporyza*) Nos 3,4 (BMNH). 16 ♀♀, 2 ♂♂, MALAWI, Lake Chilwa 9.xii.1971 (H.R. Feijen) ex Lep. eggs on rice (ITZ). 48 ♀♀, 11 ♂♂, L. Chilwa veld 2 9.iii.1975 (H.R. Feijen) [?ex *Scirpophaga subumbrosa* slide no.] 37 '*Telenomus tolli*' [with *T. nephele*] (ITZ). 16 ♀♀, 1 ♂, L. Chilwa, Khandu 10.ii.1975 [H.R. Feijen ex *Scirpophaga*] '*Telenomus tolli*' Risbec [slide no] 34 (ITZ). 1 ♀, SENEGAL, Djibelor, 4.xii.1979 1608 sp.55 ex *Scirpophaga* sp. [with *T. nephele*] (MNHN).

Hosts. Pyralidae, Schoenobiinae: *Scirpophaga melanoclista* Meyrick, *S. ?subumbrosa* Meyrick, *Scirpophaga* spp. (for notes on hosts, see *T. nephele*). The record from *S. subumbrosa* is based on the occurrence of adults (det. A.P.) on the crop at the same locality. The possibility exists, however, that the egg-mass from which the parasitoids emerged was actually from a different *Scirpophaga* species.

Distribution. Ghana, Ivory Coast, Malawi, Senegal.

Remarks. The type series of *T. versicolor* contains two species: *T. versicolor* and *T. nephele*. The two species are rather similar, especially the males, and often occur in sympatry. However, they can be distinguished readily by using the characters given in the key. Whilst recognizing the occurrence of two types of males, Bin & Johnson considered this to be a case of dimorphism. The description was based on a single very large sample, which may well have contained specimens reared from more than one host egg-mass (345 specimens). Having studied material of both species, from a wide range of localities, we have found that the characters given in the key couplet are stable for all specimens, and there are no intermediates.

Together with *T. nephele*, this is the species referred to as *T. tolli* by Feijen & Schulten (1981).

Host records for all of the above species are summarized in table 1.

A summary of the published records of *Telenomus* species attacking pyralid pests in Africa

The following summary contains corrections and notes on the validity of previously published records of

Table 1. *Telenomus* species attacking African pyralid pests

Species	Host(s)	Previously recorded as:
<i>T. applanatus</i>	<i>Eldana saccharina</i>	<i>Telenomus</i> sp. (Scheibelreiter, 1980)
<i>T. bini</i>	<i>Maliarpha separata</i> <i>Scirpophaga</i> sp. ? <i>Chilo</i> sp.	<i>T. applanatus</i> (part) (Bin & Johnson, 1982a) <i>Telenomus</i> sp. 1 groupe <i>lemolae</i> Nixon (Etienne, 1987)
<i>T. busseolae</i>	<i>Coniesta ignefusalis</i>	<i>Platytenomus hylas</i> (Risbec, 1950)
<i>T. creusa</i>	<i>Chilo diffusilineus</i>	<i>T. ullyetti</i> (Feijen & Schulten, 1981)
<i>T. etielliphaga</i>	<i>Etiella zinckenella</i>	<i>Micromymar etielliphaga</i> (Risbec, 1950) <i>T. nephele</i> (Risbec, 1950)
<i>T. nemesi</i>	<i>Chilo orichalcociliellus</i>	<i>Telenomus</i> sp. 2 groupe <i>lemoleae</i> Nixon (Etienne, 1987)
<i>T. nephele</i>	<i>Scirpophaga melanoclista</i> , <i>S. occidentella</i> , <i>S. subumbrosa</i>	<i>T. tolli</i> (Descamps, 1956; Feijen & Schulten, 1981). <i>T. versicolor</i> (part) Bin & Johnson, 1982a). <i>Telenomus</i> sp. 2 groupe <i>benefactor</i> (Etienne, 1987).
<i>T. procas</i>	<i>Antigastra catalaunalis</i>	<i>T. thestor</i> (Risbec, 1950)
<i>T. soudanensis</i>	<i>Chilo zacconius</i>	<i>Trissolcus soudanensis</i> (Risbec, 1950)
<i>T. thestor</i>	<i>Chilo orichalcociliellus</i>	—
<i>T. versicolor</i>	<i>Scirpophaga melanoclista</i>	—

putative hosts of *Telenomus* species from Africa. These corrections are based, in almost all cases, on examination of the original specimens on which the record was based. Where these were not available, the reason for any decision made by us regarding the validity of a record has been explained.

T. alecto (Crawford)

Prophanurus alecto Crawford, 1914:85.

Chilo sacchariphagus (Bojer): Mauritius (van Dine, 1929).

This record is based on a misinterpretation by van Dine (Moutia & Courtois, 1952). *T. alecto* was also imported from Trinidad into Mauritius in the early 1950s against *C. sacchariphagus* (Greathead, 1971) but without success (CIBC, BIOCAT databank). As far as we know, *T. alecto* is not found in Africa.

T. applanatus Bin & Johnson

Eldana saccharina Walker, *Maliarpha separatella* Ragonot: Gabon, Ivory Coast, South Africa (Bin & Johnson, 1982a; Carnegie *et al.*, 1985).

Bin & Johnson (1982a) drew attention to morphological differences between specimens reared from *E. saccharina* and those from *M. separatella*, while considering them conspecific.

Having studied material from many other localities, we consider these two 'forms' to constitute separate species (see above under *T. applanatus* and *T. bini*).

T. busseolae Gahan

Coniesta ignefusalis (Hampson): Senegal (Risbec, 1950 as *Chilo ?pyrocaustalis*; 1960 as *Coniesta ignefusalis*; Ferguson, 1983 as *Chilo* sp.).

This species is well known as a widespread parasitoid of the noctuid stem-borers *Sesamia* and *Busseola*. This single record from a pyralid appears, however, to be genuine.

T. etielliphaga (Risbec)

Etiella zinckenella Treitschke: Senegal (Risbec, 1950).

This appears to be a valid record. The species was described, from males only, originally in the family Myrmaridae (Chalcidoidea). What are almost certainly the females of the species were misidentified by Risbec (1950) as *T. nephele* (see below).

T. nephele Nixon

E. zinckenella: Senegal (Risbec, 1950).

This record is based on a misidentification of what are almost certainly females of *T. etielliphaga* (above). However, *T. nephele* is a widespread parasitoid of *Scirpophaga* spp.

T. soudanensis (Risbec)

Chilo zacconius Bleszynski: Niger [Risbec, 1950, as *Parerupa (=Proceras) africana* (Aurivillius): (misidentification);

also 1960 as *Chilo* sp. nr *phaeosema* Martin]; also as *Chilo 'zacconi'* (Brenière, 1969).

C. zacconius appears to be the host of this species.

T. thestor Nixon

Scirpophaga sp.: Ivory Coast (Trần vinh Liêm, 1977).

Misidentification of either *T. nephele* or *T. versicolor*, probably the former (Bin & Johnson, 1982a [as *T. versicolor*]).

Antigastra catalaunalis (Duponchel): Senegal (Risbec, 1950:328; 1960); also: Risbec (1950:560) as *T. thestor* 'variété' ex '*Anticarsia*' *catalaunalis*.

Misidentification of *T. procas* Nixon (see above). This record is also repeated by Balachowsky (1972:1176) misspelt as '*T. testor* Aixon'.

Despite this confusion, *T. thestor* is a parasitoid of the pyralid *Chilo ?orichalcociliellus*.

T. tolli Risbec

Scirpophaga sp.: Cameroon (Descamps, 1956).

This record is almost certainly based upon a misidentification of *T. nephele*. A slide in MNHN bears a label '*Telenomus tolli* R ex pyrale . . sur Riz. Descamps 281 Garoua 8.55'. This slide contains *T. nephele*. Furthermore, a syntypic slide of *T. tolli* (MNHN) bears the host remains which appear to be two tabanid egg-masses, each containing a different species of *Telenomus*!

The two species differ greatly in size (also noted by Risbec in his description), morphology and male genitalia characters. The larger species is almost certainly *T. benefactor* Crawford, and the smaller one is near *T. kingi* Crawford. Other material in Paris identified by Risbec as *T. tolli* has later been labelled '*?benefactor*' by Dr J. Bruneau de Miré. Any taxonomic decision to synonymize *T. tolli* with *T. benefactor* is probably best deferred pending a thorough review of the *Telenomus* spp. attacking Tabanidae. To facilitate future study we have designated a lectotype male for *T. tolli* (MNHN) from the syntypic series.

Thopeutis sp.: Malawi (Feijen & Schulten, 1981).

This record is based on a misidentification of both the host and the parasitoid. The host in this case is a *Scirpophaga* sp., possibly *S. subumbrosa* Meyrick, and two parasitoids are present in the samples on which this record is based: *T. nephele* and *T. versicolor* (see under this species).

T. ullyetti Nixon

Scirpophaga sp.: Cameroon (Descamps, 1956).

This is almost certainly a misidentification. A slide in MNHN bears a label '*Telenomus ullyetti*. Nixon ex . . Lepid indet Garoua 8.55 Descamps 356'. This slide contains the remains of a badly crushed male, which is not *T. ullyetti*.

Chilo diffusilineus (J. de Joannis): Malawi (Feijen & Schulten, 1981).

This record is based on a misidentification of the species described herein as *T. creusa*.

Thopeutis sp.: Malawi (Feijen & Schulten, 1981). This

record is based on a misidentification of both the host and the parasitoid. The host is *Scirpophaga* sp., possibly *S. subumbrosa* Meyrick, and the parasitoid is the species described herein as *T. bini* (= *T. applanatus* Bin & Johnson, part).

The above host records also appear in van den Berg *et al.* (1988). However, all reliable host records for *T. ullyetti* indicate that it is exclusively a parasitoid of *Helioverpa* (= *Heliothis*) *armigera*, the cotton bollworm, one of Africa's major agricultural pests.

T. versicolor Bin & Johnson

Scirpophaga melanoclista Meyrick: Ivory Coast (Bin & Johnson, 1982a).

The type series, on which the original description was based, consists of two species, *T. versicolor* and *T. nephele*, both of which are genuinely parasitoids of *Scirpophaga* spp. For a detailed discussion see above under those species.

In addition to the above, there are in the literature various records of *Telenomus* spp. attacking pyralids, but with no species name given for the parasitoid. Some of these have been recognized in the current study, and are dealt with under the appropriate species.

Discussion

The usefulness of *Telenomus* spp. for biological control (in the broad sense) of pyralid pests in Africa is still largely unknown. For 'classical' biological control of African pyralids, the single documented case of the importation of *T. applanatus* from Ivory Coast into South Africa against *Eldana saccharina* appears to have been a failure, despite the release of over a million parasitoids over two and a half years (Carnegie *et al.*, 1985). The importation of *T. nephele* into India from Ghana, against 'Chilo, *Scirpophaga* (as 'Tryporyza') and other stem borers' appears also to have failed (Sankaran, 1974; CIBC, BIOCAT data-bank).

Notwithstanding these failures, *Telenomus* spp. possess many characteristics which make them particularly suitable as biological control agents. Some of these attributes, e.g. searching ability, reproductive potential and phoresy, are discussed by Orr (1988) and Bin & Johnson (1982b), and there are also examples of *Telenomus* spp. acting very successfully in classical biological control programmes; e.g. *T. alsophilae* against *Oxydia trychiata* (Bustillo & Drooz, 1977), and *T. remus/nawai* against *Spodoptera* (Cock, 1985).

A high degree of host-specificity is a further positive attribute of any prospective agent for importation, particularly from an environmentalist's point of view, and one of the most common objections to classical biological control concerns lack of information on this subject. This is particularly true for weed control programmes, and thus host-specificity screening is an essential, though expensive and time-consuming, component of such programmes (Harris, 1979). Such screening, or host-range testing, is rarely carried out for insect control programmes for the following reasons: firstly, it is usually not considered necessary, supposedly because very few insects are of direct benefit to man (Waage & Greathead, 1988); this argument overlooks any consideration of the

consequences, upon the ecology of a particular region, of native species being attacked by the introduced agent. Secondly, the time and effort involved in rearing and screening potential alternative hosts, presumably in the quarantining country, would far exceed those in a weed control programme, and would be beyond the resources of the majority of insect control programmes. We should add that the 'new associations' approach to classical biological control (Hokkanen & Pimentel, 1984) rejects the idea that host-specificity is a desirable characteristic in a control agent.

Host-range testing was carried out for *T. remus* subsequent to its importation for control of *Spodoptera*, and shows that *T. remus* was capable of parasitizing eggs of 17 other lepidopterous species (Wojcik *et al.*, 1976; Dass & Parshad, 1984), showing an apparent lack of host-specificity in a successful control agent. These studies were laboratory-based, and field studies may have yielded different results. A possible source of field data on host ranges might result from post-release investigations which assess whether an agent has become established, but such studies invariably concentrate on the target host, and other possible hosts, which may be of no apparent economic importance, are seldom investigated. Thus any unfortunate long-term consequences upon the ecology of the region are unlikely to be noticed. Host-range data are also essential for the planning of natural enemy augmentation components of IPM programmes. The complex decision-making process when planning such programmes can be greatly affected by information on possible hosts other than the target host. There is, therefore, a necessity for the accumulation of reliable data on host ranges of *Telenomus* spp. However desirable that may be, these data are almost useless unless specimens can be identified correctly.

Misidentification has previously occurred in all but one of the published records of African *Telenomus* attacking pyralids (other than those included with descriptions of new species). The relatively simple procedure for examining male genitalia, as outlined in this paper, should alleviate this problem to a large degree. There are numerous instances where two or more species are extremely difficult to distinguish using external morphology, but can be easily separated by a study of the male genitalia. However, there are also examples where male genitalia alone do not provide sufficient characters for species separation, and some of these cases suggest the occurrence of sibling species, e.g. *T. nawai*, *T. remus*, *T. soudanensis*. Also, limited studies of male genitalia in the closely related *Trissolcus* suggest that genitalia may be of little taxonomic use in that genus.

In summary, we would recommend that in future studies of *Telenomus*, special emphasis should be placed on male genitalia characters, supplemented where appropriate by examinations of external morphology, and more especially by careful field observations and collection of host data.

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