Aprostocetus (*Ootetrastichus*) *theioneurus* (Masi) (Hymenoptera: Eulophidae): a hyperparasitoid on the cereal stem borer *Chilo partellus* (Lepidoptera: Pyralidae) in Africa

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LaSalle, J. *Aprostocetus* (*Ootetrastichus*) *theioneurus* (Masi) (Hymenoptera: Eulophidae): a hyperparasitoid on the cereal stem borer *Chilo partellus* (Lepidoptera: Pyralidae) in Africa.

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Aprostocetus (*Ootetrastichus*) *theioneurus* (Masi) is recorded from Kenya as a hyperparasitoid on *Chilo partellus* through the braconid *Cotesia sesamiae*. This is the first known species of the subgenus *Ootetrastichus* which is not a primary endoparasitoid of eggs. Diagnostic characters are given for this species.

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Introduction

Cereal stem borers, comprising several species in the families Pyralidae and Noctuidae, are the most damaging pests of graminaceous crops in many parts of Africa. The larvae bore into the stems of maize, sorghum, millet and rice, and eventually kill the plant. Stem borers can cause extremely high levels of damage, and under certain conditions can cause up to 100% yield loss (Jepson, 1954). *Chilo* species, and in particular *C. partellus* (Swinhoe, 1885), are among the most destructive of the stem borers, and yield losses due solely to *Chilo* spp. have been reviewed by Seshu Reddy & Walker (1990), and have been as high as 88% in Africa.

Natural enemies of cereal stem borers have been listed by several authors (Harris, 1962; Mohyuddin & Greathead, 1970; Appert, 1973; Mohyuddin, 1990). Among the most important of these natural enemies are parasitoids in the braconid genus *Cotesia* Cameron, 1891. Members of this genus were previously treated under the name *Apanteles* Foerster, 1862, however this large genus has recently been split into several smaller and more meaningful genera (Mason, 1981; Walker et al., 1990). Within *Cotesia*, the most important parasitoids of cereal stem borers are the species *C. flavipes* (Cameron, 1891), *C. chilonis* (Matsumura, 1912) and *C. sesamiae* (Cameron, 1906). At the present time, only *C. sesamiae* is known to occur within Africa. In addition to being listed as one of the principle parasitoids of *Chilo partellus* in Africa (Greathead, 1990; Kfir, 1990), it attacks several other species of Lepidoptera including stem borers such as other *Chilo* spp., *Eldana saccharina* (Walker, 1865), *Busseola fusca* (Fuller, 1901) and *Sesamia* spp. (Polaszek & Walker, 1992).

Species of *Cotesia* have figured prominently in discussions on biological control of cereal stem borers (Mohyuddin & Greathead, 1970; Greathead, 1990; Mohyuddin, 1990). In 1962 *C. flavipes* was introduced from Japan to Pakistan, and it has since been introduced into Indonesia, Thailand, Madagascar, Central and South America (Cock,

1985; Mohyuddin, 1990; Polaszek & Walker, 1992). Several attempts to introduce this species into Africa have failed (Ingram, 1983; Skoroszewski & van Hamburg, 1987; Greathead, 1990), although Greathead (1990) considered its re-importation as a viable option for stem borer biological control.

Recent studies at the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya are reassessing the potential of *Cotesia flavipes* for classical biological control of *Chilo partellus* (Overholt, 1992). In close collaboration with these studies, a broader survey of all natural enemies of African stem borers is also underway (Polaszek, 1992). During this survey, a hyperparasitoid of *Cotesia sesamiae* was discovered, *Aprostocetus* (*Ootetrastichus*) *theioneurus* (Masi, 1917).

It is generally agreed that hyperparasitoids are to be avoided in biological control programmes (Bennett, 1981; Ehler, 1990; DeBach & Rosen, 1991). Negative aspects of hyperparasitoids include lowering efficiency levels of primary parasitoids in areas where biological control is established, and adversely affecting the chances of successful establishment of primary parasitoids in colonization attempts. Several hyperparasitoids of *C. sesamiae* have been recorded by Mohyuddin & Greathead (1970). Although quantitative information on the effect of these hyperparasitoids is generally not available, Kfir (1990) showed that the ceraphronid *Aphanogmus fijiensis* (Ferrière, 1933) could reduce parasitoid efficiency, and would at times infest up to 100% of *C. sesamiae* cocoons.

At present the only known host of *A. theioneurus* is *C. sesamiae*, however many hyperparasitoids have wide host ranges. Verma et al. (1976) reared the pteromalid *Catolaccus crassiceps* (Masi, 1911) as a hyperparasitoid of *Cotesia glomerata* (Linnaeus, 1758) on *Pieris rapae* (Linnaeus, 1758). Subsequent laboratory tests showed that *C. crassiceps* would oviposit into the cocoons of three related parasites, *Apanteles diatraeae* Muesebeck, 1921, *C. flavipes* and *C. sesamiae*, and completed its life-cycle in all of them. Kfir (1990) listed *Aphanogmus fijiensis* as occurring naturally on *C. sesamiae*, *C. flavipes*, *Apanteles tirathabae* Wilkinson, 1928, and probably *Microgaster curticornis* Granger, 1949, and it was reared in the laboratory on *Cotesia kazak* (Telenga, 1949). If *A. theioneurus* shows the same range of host acceptance, this could hinder further attempts to introduce *C. flavipes* into Africa, such as are currently being planned (Overholt, 1992).

Morphological terminology follows Graham (1987, 1991), and Boucek (1988), except that the term mesosoma is used rather than thorax. Abbreviations are as follows: CC, costal cell; F1-F4, funicular segments 1-4; MV, marginal vein; SMV, submarginal vein; SV, stigmal vein.

Acronyms for collections are as follows: BMNH, The Natural History Museum, London, UK; CNC, Canadian National Insect Collection, Ottawa, Ontario, Canada; NMK, National Museum of Kenya, Nairobi, Kenya; RMNH, Nationaal Natuurhistorisch Museum, Leiden, Netherlands; USNM, United States National Museum (Natural History), Washington, D.C., U.S.A.

Aprostocetus Westwood, 1833

Aprostocetus is the largest genus of Eulophidae, and one of the largest of all chalcidoid genera. It has a remarkably wide host range, and contains many of the species which were until recently included in *Tetrastichus*. For more complete accounts of the

complicated taxonomic history of this genus, as well as synonymy lists and biological information, see Graham (1987), Boucek (1988) and LaSalle (in press).

Graham (1987) redefined and characterized *Aprostocetus* and divided the genus into five subgenera; LaSalle (in press) described an additional subgenus. These works contain keys which will allow the recognition of *Aprostocetus*, as well as the constituent subgenera, and characters which will serve to distinguish the subgenus *Ootetrastichus* Perkins, 1906, from other Tetrastichinae are given below in the discussion. The subgenus *Aprostocetus* is by far the largest of the subgenera, however *Ootetrastichus* is the next largest and is found in all geographic realms. Although the subgenus *Aprostocetus* has a very wide host range, the other subgenera tend to show some restriction in their hosts. It had previously been assumed that all *Ootetrastichus* species were primary parasitoids of the eggs of other insects, particularly Hemiptera, Homoptera, Orthoptera, Odonata, and Coleoptera. *A. theioneurus* is the first known species of the subgenus *Ootetrastichus* which does not attack eggs.

Aprostocetus (Ootetrastichus) theioneurus (Masi, 1917) comb. nov.
(figs. 1-6)

Tetrastichus theioneurus Masi, 1917: 215-216.

Material.— Lectotype, ♀ (by present designation; BMNH, 5.1387), Seychelles, Silhouette Island. Paralectotypes, 5 ♀♀ BMNH: Seychelles, Mahé and Silhouette Islands. Other material: Kenya, Kilifi Dist., Mtwape, Coastal Res. Stn., 1.viii.1991 and 18.viii.1991, W.A. Overholt & K. Ogeda, ex. *Cotesia sesamiae* on *Chilo partellus* on maize (12 ♀♀, 3 ♂♂ BMNH; 4 ♀♀,1 ♂ NMK; 3 ♀♀ each: CNC, RMNH, USNM).

Diagnostic characters.— Masi (1917) gave a description of this species. Because it is potentially important to biological control programmes, the following diagnostic characters are given.

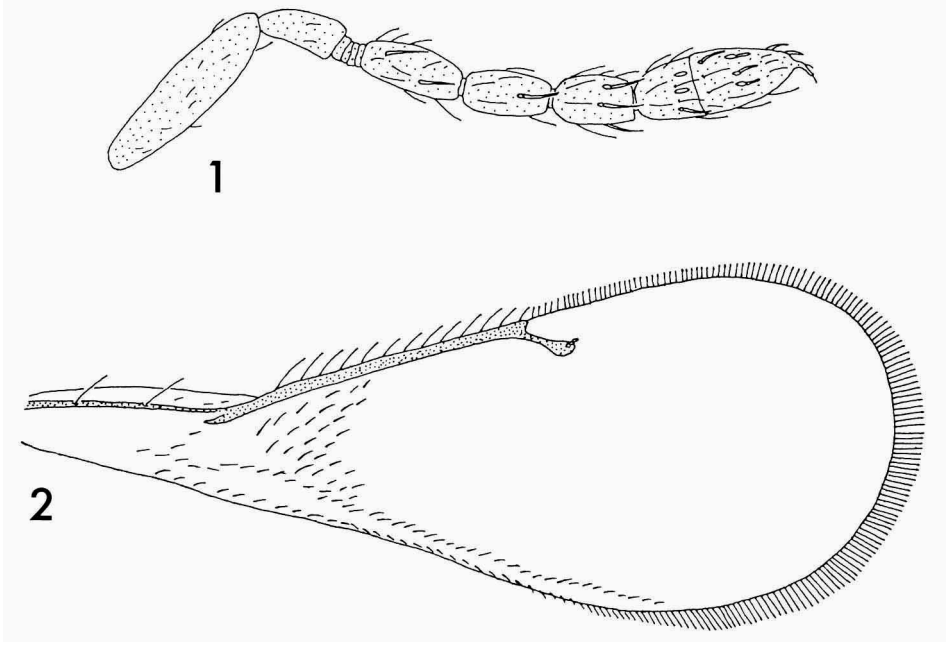
Female.— Length 1.25-1.70 mm. Head, mesosoma and metasoma bright metallic green to blue-green except tegula and upper angle of mesopleuron (just below tegula) bright yellow. Coxa and legs bright yellow, except hind coxa dorsally metallic green to blue-green. Antenna with scape yellow (slightly darkened dorso-apically), pedicel and flagellum brown. Wings hyaline, veins light brown.

Head. Frons with a fine median carina in its lower half. Malar sulcus curved, gena swollen. Toruli placed slightly above the ventral margin of eyes. Ocelli small, posterior ocellar length about 5 times greatest diameter of lateral ocellus.

Antenna (fig. 1). Club (both male and female) with downcurved apical spine. F1 about twice as long as wide, about 1.25 times as long as the pedicel. F2 and F3 subequal in length, both slightly shorter than F1. Club about as long as F2 and F3 taken together, about 3 times as long as wide; with only 2 distinct segments.

Mesosoma (figs 3-4). Midlobe of mesoscutum with 2 adnotaular setae; without a median line. Submedian lines of scutellum nearer to sublateral lines than to each other; anterior scutellar setae about at midlength. Propodeum without median line; callus with 2 setae; spiracle small, circular, separated from metanotum by twice its own diameter.

Forewing (fig. 2) about twice as long as wide. Dorsal surface of SMV with 2(-3)



Figs 1-2. *Aprostocetus* (*Ootetrastichus*) *theioneurus* ♀. 1, antenna. 2, forewing (setae on disc not drawn).

setae. MV about 3.3 times as long as SV.

Metasoma (figs 5-6) 1.3-1.8 times as long as mesosoma. Ovipositor sheaths slightly exserted (for a distance about as long as postcercale). Longest of cercal setae over twice as long as next longest.

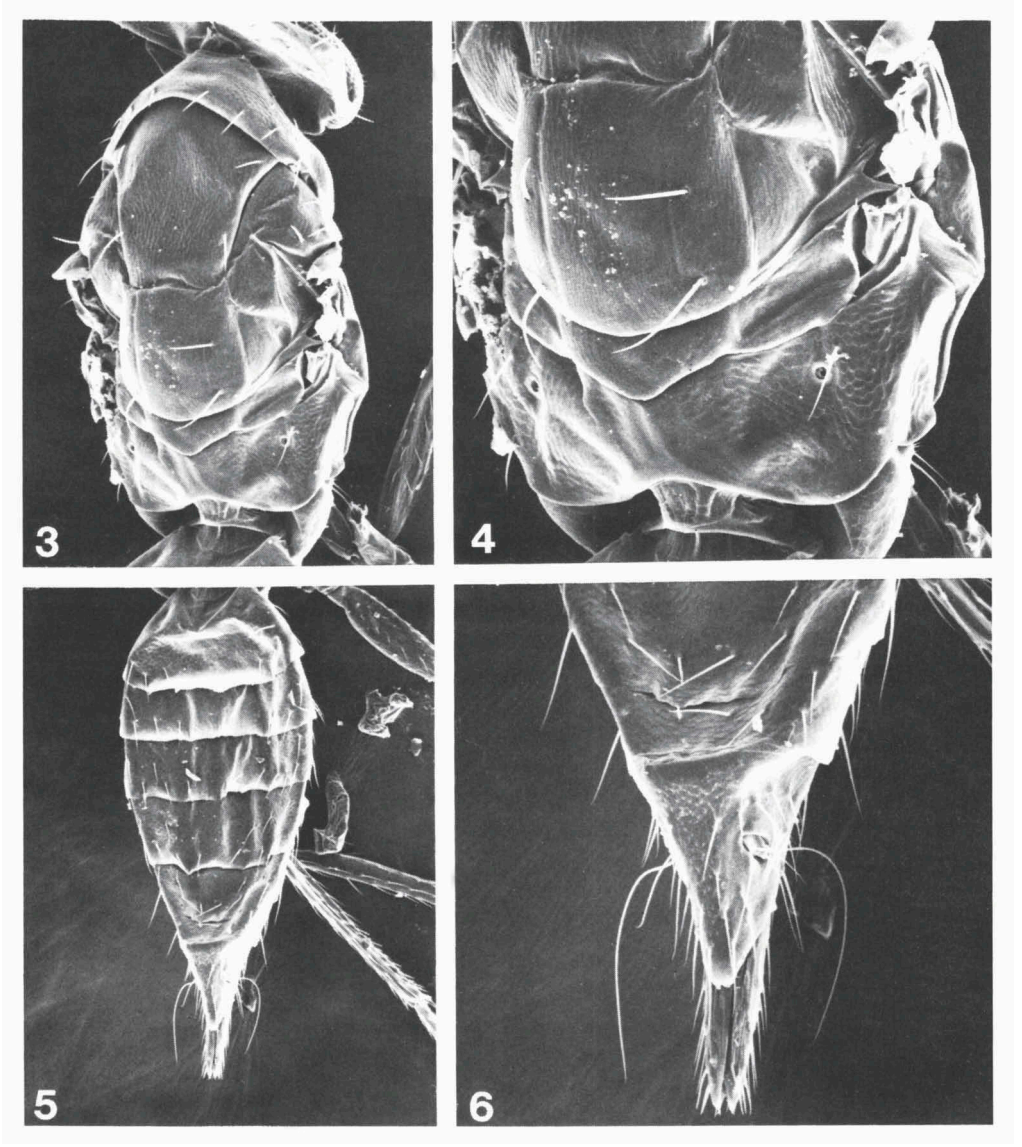
Male.— Length 0.9-1.05 mm. Similar to female except in antennal and gastral characters. Antenna with F1 over 2.5 times as long as wide; about 1.35 times as long as F2; F3 and F4 short, only slightly longer than wide, their combined length about equal to F1. Funicular segments without basal whorls of long, dark setae. Metasoma about as long as thorax (0.95-1.05).

Biology.— *A. theioneurus* is a hyperparasitoid of the cereal stem borer *Chilo partellus*, through the braconid parasitoid *Cotesia sesamiae*.

Masi described this species from 20 female specimens collected in the Seychelles on the islands of Silhouette and Mahé. There are presently six female specimens in the BMNH. I have designated one of these specimens as lectotype, the rest become paralectotypes.

Variation.— Specimens from the Seychelles differ from the Kenyan specimens in the shade and intensity of the metallic coloration on the head and body. In Seychelles specimens, the coloration is a bronze-green, without any blue; in Kenya specimens the coloration is distinctly blue-green. Further studies may indicate that these are indeed different species; however, as the differences are based solely on colour rather than any morphological characters, it seems advisable at this point to consider them as intraspecific variation rather than species level differences.

Discussion.— Graham (1987) provided a key to European species of the subgenus *Ootetrastichus*, however there are no keys to African species. *A. theioneurus* may be immediately distinguished from all European species, as well as all known



Figs 3-6. ***Aprostocetus*** **(*Ootetrastichus*)** ***theioneurus*** **♀. 3, mesosoma. 4, scutellum and propodeum. 5, metasoma. 6, apex of metasoma.**

African species, by the presence of the distinct, downcurved terminal spine on the club (fig. 1); this character is not found in any other species of *Ootetrastichus*.

It is interesting to note that the antennal club in *A. theioneurus* is similar to that seen in *A. gratus* (Giraud, 1863) and *apiculatus* Graham, 1987, two species which Graham (1987) placed in the subgenus *Aprostocetus*. These species were distinguished from other *Aprostocetus* by the "clava with a very long, at least slightly downcurved and tapering terminal spine" (Graham, 1987: 142).

In his discussion of *apiculatus*, Graham (1987: 282-283) mentioned that it bore a "remarkable superficial resemblance" to *theioneurus* Masi, which he considered to be

an aberrant member of the subgenus *Ootetrastichus*. The most apparent difference was the size and placement of the propodeal spiracles: in *theioneurus* they were small, circular, and separated by about 1.5 times their own diameter from the metanotum; in *apiculatus* they were oval and separated by about 0.5 times their own diameter from the metanotum.

A. apiculatus and *gratus* are similar to *Ootetrastichus* in other characters. Graham (1987) used the following characters to define *Ootetrastichus*: body either distinctly metallic, or more or less yellow; thorax long, 1.5-2.0 times as long as broad, pronotum in dorsal view usually 0.25 times or more the length of mesoscutum; midlobe of mesoscutum normally without a median line; propodeal spiracles very small to minute, circular or virtually so, with their outer rim usually more or less covered by a raised flap of the callus; forewing with subcubital line of setae on upper surface reaching or virtually reaching level of basal vein; submarginal vein usually with 2, sometimes with 1 or 3 setae; speculum small to very small, occasionally nearly absent; ovipositor sheaths slightly to very far exserted, sometimes as long as or longer than the body; one seta of each cercus nearly always about twice the length of the next longest.

A. apiculatus and *A. gratus* agree with all the above characters except that in these two species: the propodeal spiracle is larger, oval, and within about 0.5 its own diameter of the metanotum; the SMV has more dorsal setae (3-4 in *apiculatus*, 4-7 in *gratus*). In *apiculatus* the median line on the mesoscutum is present, although it is missing in *gratus*. These two species may represent intermediate forms between the subgenera *Aprostocetus* and *Ootetrastichus*.

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