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On the identity of *Trichogramma demoraesi* Nagaraja (Hymenoptera: Trichogrammatidae), with a checklist and a key to *Trichogramma* species associated with *Erinnyis ello* (L.) (Lepidoptera, Sphingidae) in Brazil

JACI M. VIEIRA[1], RANYSE B. QUERINO[2] & ROBERTO A. ZUCCHI[1,3]

[1]*Departamento de Entomologia e Acarologia, Escola Superior de Agricultura Luiz de Queiroz, 13418-900 Piracicaba, São Paulo, Brazil. E-mail: jacimvieira@yahoo.com.br; razucchi@usp.br*
[2]*Empresa Brasileira de Pesquisa Agropecuária, Embrapa Meio-Norte, 64006-220 Teresina, Piauí, Brazil. E-mail: ranyse.silva@embrapa.br*
[3]*Corresponding author. E-mail: razucchi@usp.br*

Abstract

Specimens collected from eggs of the cassava hornworm *Erinnyis ello*, originally identified as *T. demoraesi*, were compared with the paratype of this species. Based on morphological analysis, the specimens from *E. ello* actually belong to *Trichogramma marandobai* Brun, Moraes and Soares, 1986. Therefore, *T. demoraesi* is not a parasitoid of the eggs of *E. ello,* a major pest of cassava. The main features separating the two species, and a checklist and key to the species of *Trichogramma* associated with *E. ello* are presented.

Key words: taxonomy, *Trichogramma marandobai*, checklist, identification, key

Introduction

Species of *Trichogramma* are egg parasitoids that have been used worldwide for biological control, mainly of lepidopteran pests. *Trichogramma* are micro-hymenopterans (usually ~0.7 mm in length), whose species identification is based mostly on characters of the male genitalia.

Our understanding of the taxonomy of *Trichogramma* in Brazil has improved significantly in recent decades (Querino & Zucchi 2003, 2005, 2011; Zucchi *et al*. 2010). However, some species of *Trichogramma* were inadequately described and illustrated. In addition, the male genitalia structures vary in some *Trichogramma* species, which may impede their identification. Among these species is *Trichogramma demoraesi*, whose identification is problematic, especially in specimens reared in the eggs of *Erinnyis ello*, a major pest of cassava in Brazil.

Trichogramma demoraesi was originally described based on specimens from eggs of *Glena bipennaria* Guenée on *Eucalyptus grandis* in Minas Gerais, Brazil (Nagaraja 1983). Later, several authors recorded this species in eggs of *E. ello* in cassava (see Querino & Zucchi 2008). However, parasitoids from *E. ello* eggs identified as *T. demoraesi* show features of the male genitalia that do not conform to the original species description.

In this study, these specimens were studied morphologically and compared with the paratype of *T. demoraesi*, in order to allow accurate recognition of the egg parasitoid of *E. ello* identified as *T. demoraesi.*

Material and methods

A comparative morphological analysis was performed among specimens previously identified as *T. demoraesi* in

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the *Trichogramma* collection at the Escola Superior de Agricultura Luiz de Queiroz (ESALQ), Piracicaba, Brazil, and a paratype of *T. demoraesi* held by the Natural History Museum (NMH), London, United Kingdom (UK).

The morphological characters and terminology are based on Pinto (1999) and Querino & Zucchi (2003, 2005).

Results

Trichogramma demoraesi Nagaraja, 1983

Diagnosis. Genital capsule elongate and narrow; dorsal lamina narrow at base, fork-shaped; intervolsellar process narrow and distinct, apex slightly pointed; ventral processes positioned anterior to base of intervolsellar process (Fig. 1A–C). Antennae with flagelliform setae moderately long, gradually tapering at apex (Fig. 1D).

FIGURE 1. *Trichogramma demorasei* (paratype) (40x). A, B. Genital capsule (male). (A, ventral view; B, dorsal view). C. Intervolsellar process (in detail). D. Antenna.

Type material. *Trichogramma demoraesi.* Paratype ♂, BRAZIL, Minas Gerais: Felixlândia, 11.v.1978 (Brun, Moraes, and Soares) (NHM) (examined). The holotype and "allotype" were deposited at the Institute of Biological Sciences, Federal University of Minas Gerais (ICB/UFMG), Brazil. Not found.

Distribution. Minas Gerais, Brazil.

Associated plant. *Eucalyptus grandis* Hill (ex Maiden) (Myrtaceae).

Habitat. Forest.

Host insect. *Glena bipennaria* (Guenée, [1858]).

Comments. Specimens reared from eggs of *E. ello*, previously identified as *T. demoraesi*, differ from the paratype as follows: i) flagelliform setae of specimens are shorter than in the paratype (ratio of the length and width

of setae is 1.52 and 2.05 respectively); ii) basiconic sensilla formula 1-2-2-0(1)-1-1 (specimens) and 1-1-2-0-1-1 (paratype), therefore, in the paratype there is only one sensillum in position 2 and none in position 4; iii) intervolsellar process broader in the specimens than in the paratype; iv) posterior extension of the dorsal lamina broader in the specimens than paratype, whose dorsal lamina is fork-shaped.

Trichogramma marandobai Brun, Moraes & Soares, 1986

Trichogramma demoraesi: Zucchi *et al*. 1991 (checklist); Zucchi & Monteiro 1994: 52 (record); Zucchi & Monteiro 1997: 53 (catalog); Querino & Zucchi 2005: 51 (key); Ronchi-Teles & Querino 2005: 515 (record); Zucchi *et al*. 2010: 222 (catalog); Querino & Zucchi 2011: 38 (identification guide).

FIGURE 2. Genital capsule (male). A, B. *Trichogramma manicobai*; C, D. *Trichogramma marandobai* (A, C ventral view; B, D dorsal view, 40x).

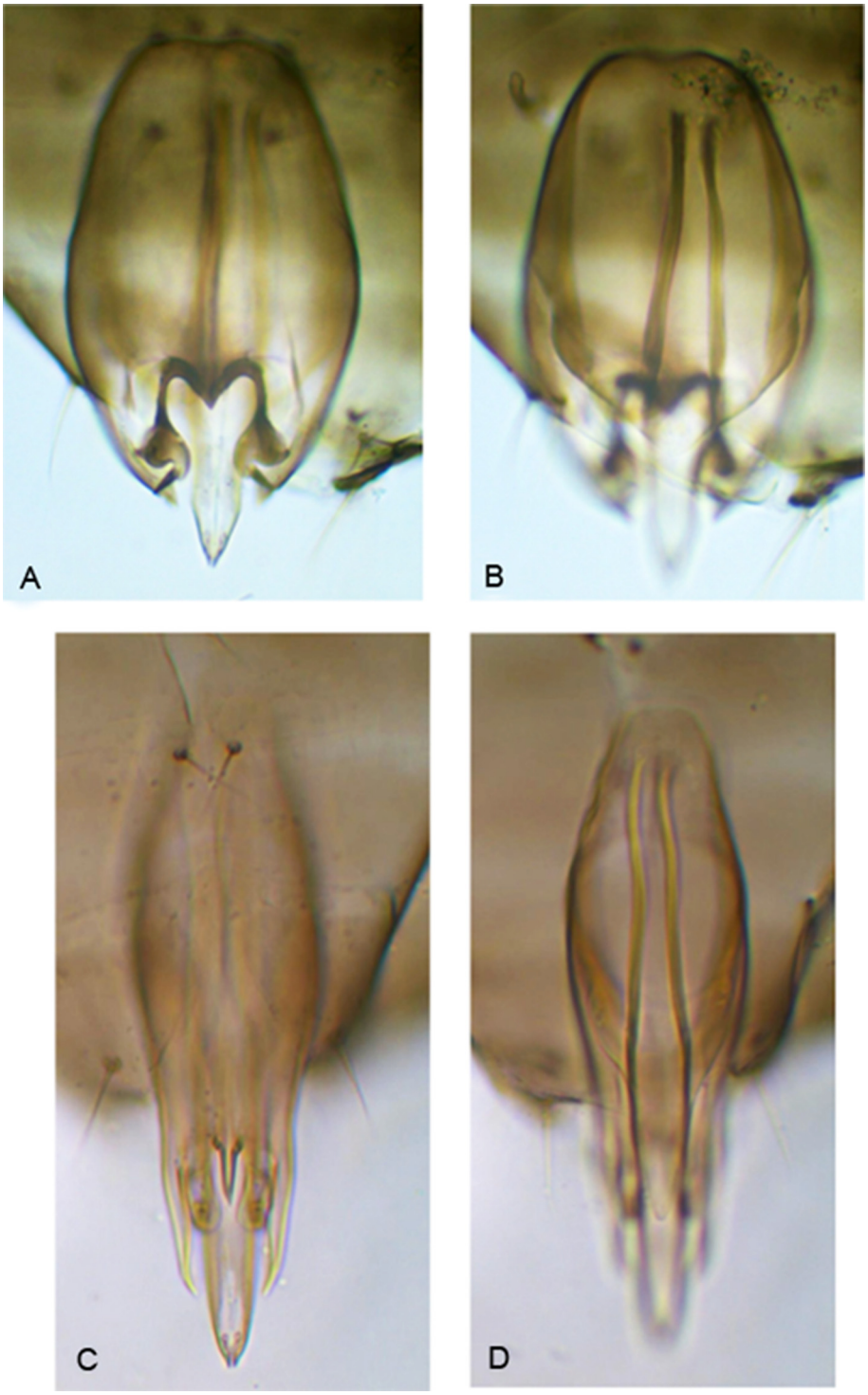

FIGURE 3. Genital capsule (male). A, B. *Trichogramma atopovirilia*; C, D. *Trichogramma pretiosum* (A,C ventral view; B,D, dorsal view, 40x)

Diagnosis. Genital capsule long; dorsal lamina tapering from apex to base, not extending beyond apex of volsellae; dorsal lamina with narrow posterior extension and rounded apex at same level as intervolsellar process; intervolsellar process long and stout; ventral carina not extending beyond midlength of genital capsule (Fig. 2 C, D). Antennae with flagelliform setae relatively short, tapering at apex (Fig. 4 B).

Type material. Holotype and paratype were deposited in the ICB/UFMG collection. However, these types are no longer at UFMG (Prof. Pedro M. Linardi, pers. comm.).

Examined material. BRAZIL, Minas Gerais: Janaúba, 9.iii.2010 15 ♂ (J.M. Vieira) (ESALQ). Espírito Santo:

Itapemirim, 1.vii.1985, 1 ♂, ex *Erinnyis ello* eggs (identified as *T. demoraesi*) (ESALQ). Minas Gerais: Lavras, 15.i.2001, 1 ♂, 20.xii.2000, 1 ♂, ex *Erinnyis ello* eggs (identified as *T. demoraesi*) (ESALQ). Paraná: Londrina, 18.iii.1986, 1 ♂, ex *Erinnyis ello* eggs (identified as *T. demoraesi*) (ESALQ). São Paulo: Atibaia (Experimental Station of the Biological Institute), 5 ♂; Piracicaba, 1.vii.1999, 15 ♂, ex *Erinnyis ello* eggs (identified as *T. demoraesi*) (ESALQ). PERU, locality unknown, 1.v.1999, 15 ♂, ex *Erinnyis ello* eggs (identified as *T. demoraesi*). Loreto: Estación Jenaro Herrera, 13.i.2011, 10 ♂, ex *Erinnyis ello* eggs (ESALQ).

Distribution. Brazil: Amazonas, Minas Gerais, Espírito Santo, Paraná, and São Paulo; Peru: Loreto.

Associated plant. *Manihot esculenta* Crantz.

Habitat. Farm.

Host insect. *Erinnyis ello* (L., 1758).

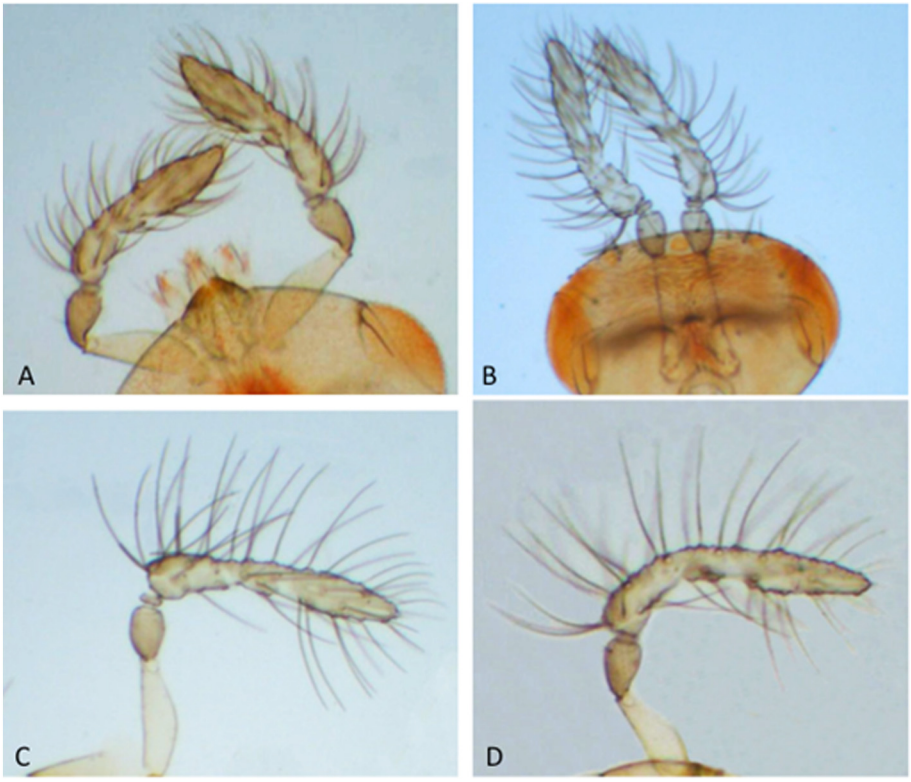

FIGURE 4. Antenna (male). A. *Trichogramma manicobai*; B. *Trichogramma marandobai*; C. *Trichogramma atopovirilia*; D. *Trichogramma pretiosum* (10x).

TABLE 1. Morphological distinction between *Trichogramma demoraesi* and *T. marandobai.*

Characters	***T. demoraesi*** (paratype)	***T. marandobai*** (ESALQ collection)
Flagelliform setae	Long (0.08 mm)	Short (0.05 mm)
Flagelliform setae length/width	2.05	1.4
Basiconic sensillae	1-1-2-0-1-1	1-2-2-0(1)-1-1
Ventral carina length/basal distance	0.39	0.39
Dorsal opening	Very deep	Not deep
Dorsal opening length/dorsal lamina length	2.18	1.43
Ventral processes	Close to the intervolsellar process base	Close to the intervolsellar process base
Length of the posterior row of the fore wing	Half of the wing length (9 setae)	Half of the wing length (6–11 setae)
Intervolsellar process	Narrow/slender	Robust
Width of the posterior extension of the dorsal lamina at base	Narrow (18 µm)	Wide (34 µm)

Comments. The comparative morphological analysis of the paratype and the specimens previously identified as *T. demoraesi* from eggs of *E. ello* in cassava, revealed that these specimens belong to *T. marandobai* (Table 1). *Trichogramma demoraesi* differs from *T. marandobai* by having longer flagelliform setae, narrower dorsal lamina at the base of the posterior extension (fork-shaped), a deeper dorsal opening, and a long stout intervolsellar process with the apex truncated or pointed (Table 1). Therefore, *T. demoraesi* is associated only with *G. bipennaria* in forest habitats in Brazil. *Trichogramma marandobai* has previously been recorded as a parasitoid of *E. ello* eggs.

Checklist of the species of *Trichogramma* parasitoids of *Erinnyis ello* in Brazil

Four species of *Trichogramma* are parasitoids of *E. ello* eggs in Brazil, namely *T. atopovirilia* (Oatman and Platner, 1983); *T. manicobai* Brun, Moraes & Soares, 1986; *T. marandobai*; and *T. pretiosum (*Riley, 1879) (Table 2). *Erinnyis ello* is the only known host of *T. manicobai* and *T. marandobai* Brun, Moraes & Soares, 1986. In South America, there are also records of *Trichogramma* parasitizing eggs of *E. ello* in Colombia (*T. colombiensis* Velasquez de Rios and Teran, 1995, Peru (*T. exiguum* and *T. marandobai*), and Venezuela (*T. colombiensis* and *T. exiguum* Pinto and Platner, 1983). In Peru, previous identifications of *T. demoraesi* are also misidentifications. A new record of *T. marandobai* from *E. ello* eggs collected in Loreto, Peru, is reported herein for the first time.

TABLE 2. Checklist to the species of *Trichogramma* parasitoid of *Erinnyis ello* in Brazil.

Trichogramma species	Municipalities	Geographic Coordinates	States	References
T. atopovirilia	Felixlândia	18° 45′ 28″ S 44° 53′ 56″ W	Minas Gerais	Brun *et al.* (1984)
T. manicobai	Felixlândia	18° 45′ 28″ S 44° 53′ 56″ W	Minas Gerais	Brun *et al.* (1984)
T . marandobai	Felixlândia	18° 45′ 28″ S 44° 53′ 56″ W	Minas Gerais	Brun *et al.* (1986)
T. pretiosum	Itapemirim	21° 0'38.57"S 40°50'1.98"W	Espírito Santo	Querino & Zucchi (2008)
T. pretiosum	Lavras	21°14'44.89"S 44°59'59.08"W	Minas Gerais	Querino & Zucchi (2008)
T. pretiosum	Londrina	23°17'33.83"S 51°10'23.55"W	Paraná	Querino & Zucchi (2008)
T. pretiosum	Atibaia	23° 7'1.16"S 46°33'21.74"W	São Paulo	Querino & Zucchi (2008)
T. pretiosum	Piracicaba	22°43'29.92"S 47°38'51.36"W	São Paulo	Querino & Zucchi (2008)

A key to the species of *Trichogramma* that parasitize *Erinnyis ello* in Brazil

1. Setae on flagellum of antenna short; length of longest setae less than 2.0x flagellar width 2
1'. Setae on flagellum of antenna longer; length of longest setae more than 3.0x flagellar width 3
2. Genital capsule dorsal lamina with distinct lateral lobes, extending beyond genital capsule margins; intervolsellar process distinct and short, generally with apical constriction (Figs 2A, B); flagellum setae short, tapering abruptly at apex, length of longest flagelliform seta < 1.5x width of flagellum (Fig. 4A) . . . . . ***T. manicobai***
2'. Genital capsule, dorsal lamina with no lateral lobes; intervolsellar process long and stout, with apex truncated or acute (Fig. 2C, D); flagellum setae short, tapering abruptly at apex, length of longest flagelliform seta < 1.7x width of flagellum (Fig. 4B) . . . . . ***T. marandobai***
3. Genital capsule broad, with broad dorsal lamina, not tapering distinctly from base to apex; posterior extension of dorsal lamina short, obsolescent; dorsal carina present; ventral carina distinct; parameres broad and arcuate laterally; volsella curved, with distinct lateral constriction, lateral surface broadly bulged; intervolsellar process short and triangular; ventral processes distinctly tubular on intervolsellar process (Figs 3A, B); flagellum setae elongate, length of longest flagelliform seta > 3.0x width of flagellum (Fig. 4C) . . . . . ***T. atopovirilia***
3'. Genital capsule not broad, dorsal lamina gradually narrowing from base to apex; posterior extension of dorsal lamina weakly sclerotized with apex of posterior extension difficult to distinguish under light microscopy; dorsal carina absent; ventral carina short, indistinct, not reaching midlength of genital capsule; parameres relatively straight; volsella slightly bowed; intervolsellar process long and slender with acute apex; ventral processes positioned near base of intervolsellar process (Figs 3C, D); flagellum setae elongate, gradually tapering to apex, length of longest flagelliform seta > 3.0x width of flagellum (Fig. 4D) . . . . . ***T. pretiosum***

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