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REFERÊNCIA

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Parasitoid associated with of *Helicoverpa armigera* in refuge areas of cotton, in Western Bahia, Brazil

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ABSTRACT: Natural biological control is one of the major causes responsible for reduction of pest population in agricultural ecosystem. However, natural biological control importance is usually minimized by not being estimated. This study reports the occurrence of *Campoletis sonorensis* (Cameron, 1886) (Hymenoptera: Ichneumonidae), *Archytas marmoratus* (Townsend, 1915) and *Archytas incertus* (Macquart, 1851) (Diptera: Tachinidae) associated with *Helicoverpa armigera* (Hübner, 1809) (Lepidoptera: Noctuidae). The rate of larval parasitism was up to 41% in structured refuge areas of cotton, without chemical control with insecticides. This study strengthens our knowledge relating to parasitoids associated with natural control of *H. armigera* in the American continent. In addition, it documents the rule that structured refuge areas could play as a source of natural enemies, besides their contribution to production of non-selective populations to Bt technology.

Key words: biological control, integrated pest management, natural enemies.

Parasitoides associados com *Helicoverpa armigera* em áreas de refúgio de algodão, no Oeste da Bahia, Brasil

RESUMO: O controle biológico natural é um dos principais componentes responsáveis pela redução populacional de pragas em agroecossistemas. Entretanto, a importância do controle biológico natural, usualmente, é minimizada devido não ser estimada. Este estudo documenta a ocorrência de *Campoletis sonorensis* (Cameron, 1886) (Hymenoptera: Ichneumonidae), *Archytas marmoratus* (Townsend, 1915) e *Archytas incertus* (Macquart, 1851) (Diptera: Tachinidae) associados a *Helicoverpa armigera* (Hübner, 1809) (Lepidoptera: Noctuidae). A taxa de parasitismo larval foi superior a 41% em áreas de refúgio estruturado de algodão, sem uso de inseticidas químicos. Este estudo fortalece o conhecimento relacionado com os parasitoides associados ao controle natural de *H. armigera* no Continente Americano. Adicionalmente, documenta o efeito que áreas de refúgio estruturado podem desempenhar como fonte de inimigos naturais, além da sua contribuição para produzir insetos não expostos à tecnologia Bt.

Palavras-chave: controle biológico, manejo integrado de pragas, inimigos naturais.

Helicoverpa armigera (Hübner, 1809) (Lepidoptera: Noctuidae: Heliiothinae) has great destructive potential with relevant economic impact world wide (MATTHEWS 1999). Although, *H. armigera* was first reported in Brazil in 2013 (CZEPAK et al. 2013), a subsequent study (SOSA-GÓMEZ et al. 2016) report that the specie was present in the country at least since 2008.

At least 35 parasitoid species were reported as natural enemies of Heliiothinae belonging Hymenoptera and Diptera (FATHIPOUR & SEDARATIAN 2013). Beyond the diversity,

parasitoid rates recorded in cotton range from 7% (SHEPARD & STERLING 1972) up to 76% (OBOPILE & MOSINKIE 2007).

Several natural enemies can be reported associated with insects in cotton, including some species of parasitoids. However, in the implementation of measures that favor the survival of these mortality agents in cotton demands documentation of the species associated with key pests (BASTOS & TORRES 2005). The present study reported the occurrence of larval-pupal parasitoids of *H. armigera* collected in

structured refuge areas of cotton in an intensive cotton cropping system in Correntina municipality, Western Bahia, Brazil.

Larvae were sampled in two structured refuge areas (non-*Bt* cultivar FM982GL), without chemical insecticide control during 2014/2015 and 2015/2016 crop seasons. The larvae were collected manually ($n = 301$) in a random transversal “zigzag” sampling as described by CORRÊA-FERREIRA et al. (2014) and were individually maintained in polyethylene cups (80 ml) with artificial diet (GREENE et al. 1976) until the emergence of moths or parasitoids. All emerged moths were identified as *H. armigera* comparing their genitalia (HARDWICK 1965, SPECHT et al. 2013). Likewise, the parasitized larvae or pupae were identified as *H. armigera* comparing the larval and pupal exuvia with reference material of *H. armigera* and *Helicoverpa zea* (Boddie, 1850) maintained in the Laboratório de Entomologia (Embrapa Cerrados).

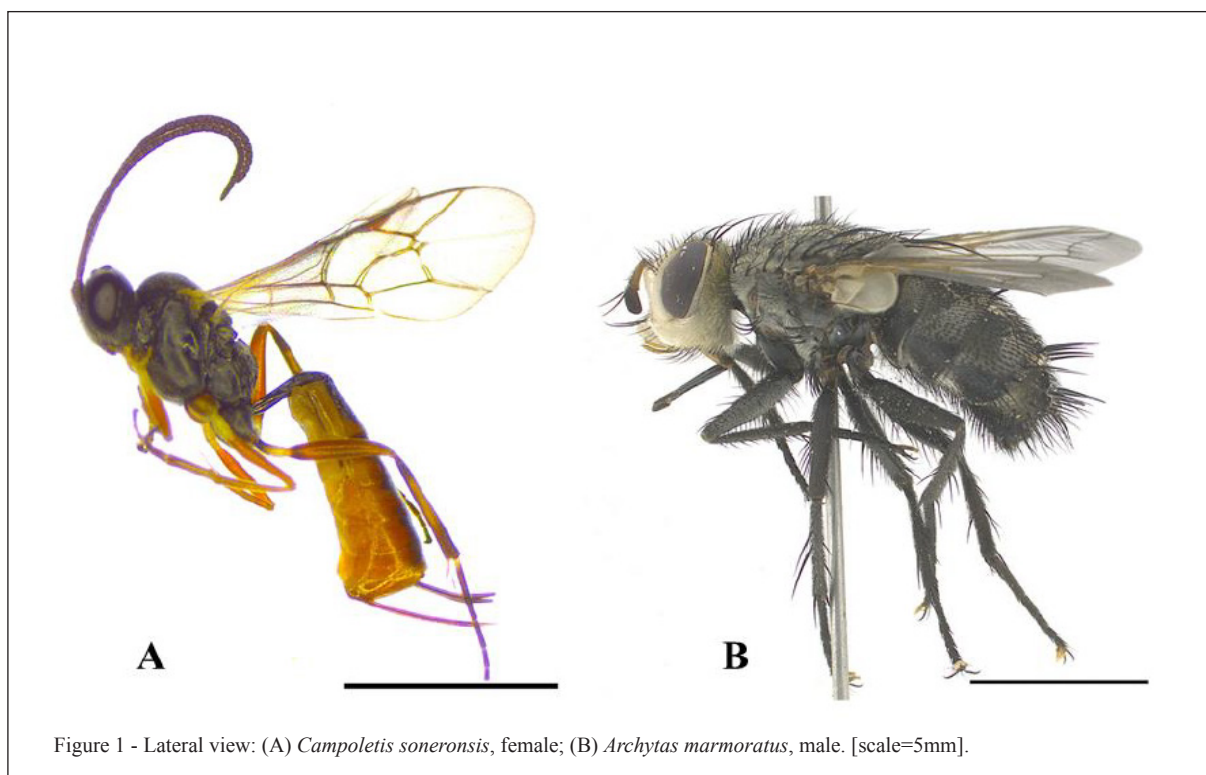
Dipterans were identified according to CURRAN (1928) and GUIMARÃES (1961), and wasps to AGUIRRE et al. (2015) and GOULET et al. (1993). Voucher specimens were housed in the

Department of Zoology - Universidade de Brasília (DZUB), and in the Department of Ecology and Evolutionary Biology - Universidade Federal de São Carlos (DCBU).

From the total of *H. armigera* larvae sampled, 125 (41.52%) insects were parasitized. The wasp *Campoletis sonorensis* (Cameron, 1886) (Hymenoptera: Ichneumonidae) (Figure.1A), was identified in 7,00% of the caterpillars; *Archytas marmoratus* (Townsend, 1915) and *Archytas incertus* (Macquart, 1851) (Diptera: Tachinidae) (Figure.1B), were detected in 34.52% of the larvae.

Campoletis sonorensis, obtained only during the first sampling (2014/2015), is a generalist endoparasitoid with high efficiency in the biological control of several moth pests, including the Americans Heliiothinae as *Chloridea virescens* (Fabricius, 1777) and *H. zea* (SHELBY et al. 2000). This wasp has been also mentioned parasitizing *H. armigera* in the Old World (FATHIPOUR & SEDARATIAN 2013).

Archytas marmoratus and *A. incertus* are morphologically inconspicuous, but had remarkable differences in their post abdomen structures (Figure.2 A-F), as shown by their male



genitalia structures (see Figure.2 B-C, and E-F, respectively), and also by their distribution patterns (GUIMARÃES 1961, 1971). *Archytas marmoratus* is distributed from the South of the United States to the North of Chile and Brazil (RAVLIN & STEHR 1984); *A. incertus* is recorded from Argentina, Brazil, Chile and Uruguay (GUIMARÃES 1961), parasitizing lepidopteran pests including: *C. virescens*, *H. zea*, and *Helicoverpa gelotopoeon* (Dyar 1921) (SANCHEZ & RAVEN 1989). This is the first register of *A. incertus* as parasitoid on *H. armigera* in Brazil.

The close relationship of the *Archytas* species with Heliiothinae (e.g. RAVLIN & STEHR 1984; CARPENTER & PROSHOLD 2000), includes its association with *H. armigera*, now present in the Americas. *Helicoverpa armigera* parasitism rate reached a 40%, which could be considered a high natural mortality factor amidst the intensive cropping system of cotton in West Bahia. Parasitoids' diversity and the high incidence of parasitism detected in structured refuge areas of cotton, without chemical control with insecticide, represents strategic information

for the management of *H. armigera*. These results agreed with OBOPILE & MOSINKIE (2007) who reported 76% parasitism of *H. armigera* on unsprayed crops in Botswana. Moreover, these results indicated the potential of refuge areas to promote non-selected populations of lepidopteran pests to *Bt* technology, as well as a way to promote a source of natural enemies in the agricultural landscape of intensive cropping system. Considering the pest pressure in refuge areas in tropical region, an eventual adoption of chemical control with insecticides in structured refuges should be based on selective products (SHEPARD & STERLING 1972; BASTOS & TORRES 2005).

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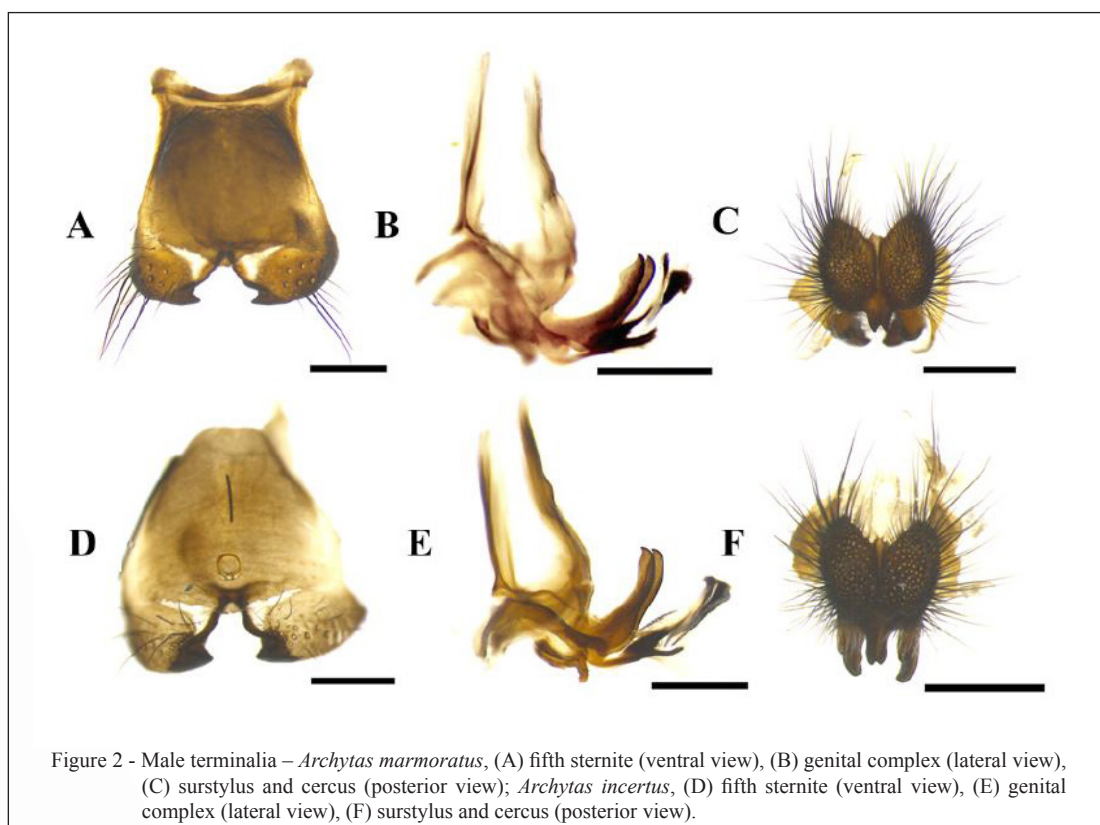


Figure 2 - Male terminalia – *Archytas marmoratus*, (A) fifth sternite (ventral view), (B) genital complex (lateral view), (C) surstylus and cercus (posterior view); *Archytas incertus*, (D) fifth sternite (ventral view), (E) genital complex (lateral view), (F) surstylus and cercus (posterior view).

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