Parasitism and Emergence of Tetrastichus howardi (Hymenoptera: Eulophidae) on Diatraea saccharalis (Lepidoptera: Crambidae) Larvae, Pupae and Adults

Authors: Pereira, Fabricio Fagundes, Kassab, Samir Oliveira, Calado, Vanessa Rodrigues Ferreira, Vargas, Elizangela Leite, Oliveira, Harley Nonato de, et. al.

Source: Florida Entomologist, 98(1) : 377-380

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.098.0164
Parasitism and emergence of *Tetrastichus howardi* (Hymenoptera: Eulophidae) on *Diatraea saccharalis* (Lepidoptera: Crambidae) larvae, pupae and adults

Fabricio Fagundes Pereira¹, Samir Oliveira Kassab¹,², Vanessa Rodrigues Ferreira Calado², Elizangela Leite Vargas², Harley Nonato de Oliveira³ and José Cola Zanuncio⁴

*Diatraea saccharalis* (Fabricius) (Lepidoptera: Crambidae), a major pest of sugarcane in the Americas (White & Wilson 2008; Dinardo-Miranda et al. 2012; Svedese et al. 2013) is capable of causing loss in biomass, death of the apical meristem and reduction in sugar and alcohol production (Simões et al. 2012; Rossato et al. 2013).

*Diatraea saccharalis* caterpillars develop inside the sugarcane stalks, which diminishes the efficacy of the insecticides used to control them (Pinto et al. 2009); hence the interest in the use of biological control to suppress *D. saccharalis* infestations (Cruz et al. 2011; Rodrigues et al. 2013). Hymenopteran parasitoids are frequently used as natural enemies in numerous applied biological control programs targeting *D. saccharalis* (Zanuncio et al. 2008; Mafi & Ohbayashi 2010; Tavares et al. 2011, 2013).

The parasitoid *Tetrastichus howardi* Olliff (Hymenoptera: Eulophidae) has been recorded from the pupae of several lepidopteran families, including: Crambidae, Noctuidae and Plutellidae (Kfir et al. 1993; Moore & Kfir 1995; Kfir 1997; Baithe et al. 2004; Hayat & Shahi 2004; Prutz et al. 2004; Silva-Torres et al. 2010; Duong et al. 2011; Costa et al. 2014), and it has been used to effectively control several lepidopteran pests. *Tetrastichus howardi* was also found parasitizing *D. saccharalis* larvae (Vargas et al. 2011), which motivated this study on the parasitism of *T. howardi* on various life stages of this important sugarcane pest. The aim of this study was to evaluate the biological characteristics of *T. howardi* parasitizing *D. saccharalis* eggs, larvae, pupae and adults stages.

Experiments were performed in the Laboratory of Entomology/Biological Control (LECOBIOL) of the “Faculdade de Ciências Agrárias” of the “Universidade Federal de Dourados (UFDF)” in Dourados, Mato Grosso do Sul State, Brazil. Life stages of *D. saccharalis* (eggs, larvae, pupae and adults) were obtained from *D. saccharalis* rearing of LECOBIOL (Parra 2007). *Tetrastichus howardi* females were reared on *D. saccharalis* caterpillars (Vargas et al. 2011).

Each experimental parcel contained 10 of the following stages of *D. saccharalis*: egg masses, larvae, pupae or adults, which were individualized with 7 *T. howardi* females. Each experiment was replicated 5 times (50 *D. saccharalis* individuals in total were used per treatment).

The parasitism intervals were as follows: 24 h for *D. saccharalis* eggs and pupae and 96 h for fifth instar caterpillar larvae and adults. Following parasitism, the *T. howardi* females were removed, *D. saccharalis* stages were placed in glass tubes (13-cm height and 8.5-cm diam.), and transferred to climatic chambers set at 25 ± 2 °C, 70 ± 10% RH and 14:10 h L:D.

Percent parasitism adjusting for natural host mortality (Abbott 1925), percentage of emergence, life cycle duration (from egg to adult), the number of parasitoids that emerged (progeny) from the different stages of *D. saccharalis*, and the sex ratio of *T. howardi* were evaluated. The sex of *T. howardi* was determined based on morphological characteristics (La Salle & Polaszek 2007) under a stereoscopic microscope.

*Tetrastichus howardi* did not parasitize *D. saccharalis* eggs. Parasitism by *T. howardi* was evident in fifth instar larvae (Figs. 1A, C and D), pupae (Fig. 1B, Figs. 2A, B and C) and adults of *D. saccharalis* (Fig. 2D) showing rates of parasitism of 2%, 56% and 68%, respectively. The emergence of *T. howardi* was 14%, 100% and 100% for fifth instar larvae, pupae, and adults of *D. saccharalis*, respectively.

The life cycle (egg-adult) durations of *T. howardi* in pupae, fifth instar larvae and adult stages of *D. saccharalis* were 20.00 ± 0.03, 27.00 ± 0.01 and, 33.00 ± 0.00 days, respectively. *Tetrastichus howardi* also showed a higher fecundity and sex ratio (females) with the *D. saccharalis* pupae at 70.44 ± 5.22 and 0.85 ± 0.41 individuals, respectively.

*Tetrastichus howardi* parasitized and developed within the larval, pupal and adults of *D. saccharalis*. The greatest number of offspring and greatest sex ratio (female based) for this parasitoid was observed in the pupal stage of the sugarcane borer, which suggests that this host stage is the most suitable for parasitism and development by this natural enemy. The low parasitism rates of *D. saccharalis* larvae and adult stages by *T. howardi* females suggests that these life stages may possess a stronger immune response against this parasitoid, as reported for *Cotesia flavipes* (Cameron) (Hymenoptera: Braconidae) parasitizing the sugarcane borer larvae (Mahmoud et al. 2012). Cellular defenses, encapsulation and melanization of the endoparasitoid eggs (Pennacchio & Strand 2006; Andrade et al. 2010) can be some of the mechanisms involved in this phenomenon.

*Tetrastichus howardi* parasitized the fifth instar *D. saccharalis* larvae and emerged in the pupal stage. Also *T. howardi* parasitized young *D. saccharalis* pupae and emerged from the adults. This is the first time that this pattern of behavior and development of *T. howardi* has been reported.

¹Faculdade de Ciências Biológicas e Ambientais, Universidade Federal da Grande Dourados, 79.804-970, Dourados, Mato Grosso do Sul State, Brazil
²Faculdade de Ciências Agrárias, Universidade Federal da Grande Dourados, 79.804-970, Dourados, Mato Grosso do Sul State, Brazil
³Embrapa Agropecuária Oeste, 79804-970, Dourados, Mato Grosso do Sul, Brazil
⁴Departamento de Biologia Animal, Universidade Federal de Viçosa, 36.570-000, Viçosa, Minas Gerais, Brazil
Corresponding author; E-mail: fabriciofagundes@ufgd.edu.br

2015 — Florida Entomologist — Volume 98, No. 1 377

Downloaded From: https://bioone.org/journals/Florida-Entomologist on 24 Mar 2020
Terms of Use: https://bioone.org/terms-of-use
Parasitism of the different biological stages of *D. saccharalis* by *T. howardi* revealed the ability of this natural enemy to regulate the development of various sugarcane borer life stages, and this can be attributed the longer life span of the adult stage of *T. howardi* (Vargas et al. 2011) compared with that of the egg parasitoids *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) (Pereira-Barros et al. 2005; Oliveira et al. 2013) and the larval parasitoid *C. flavipes* (Simões et al. 2012). Thus, in sugarcane fields, this eulophid has more time than other studied parasitoid species to locate and parasitize its host.

*Tetrastichus howardi* displays high plasticity by parasitizing larvae, pupae and adults of *D. saccharalis*. However, further studies on the cell biology, physiology and ecology of this parasitoid are necessary to better understand the parasitoid-host relationships and to increase the chances of success of this important natural enemy in biological control programs.

Thanks to “Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)” and “Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)” for financial support. Global Edico Services (www.globaledico.com) edited and proofread this manuscript.

Fig 1. *Tetrastichus howardi* (Hymenoptera: Eulophidae) female parasitizing fifth instar caterpillar and pupa of *Diatraea saccharalis* (Lepidoptera: Crambidae) (A and B) and hosts after parasitism (C and D).
Tetrastichus howardi Olliff (Hymenoptera: Eulophidae) parasitizes the larvae, pupae and adults of Diatraea saccharalis, and therefore seems to be a suitable candidate for the biological control of D. saccharalis in commercial sugarcane in Brazil and other industries where this stem borer is an important pest. The aim of our study was to analyze the biological characteristics of this natural enemy on sugarcane borer.

The research was conducted in the Laboratory of Entomology/Biological Control (LECOBIOL) at the “Faculdade de Ciências Agrárias” of the “Universidade da Grande Dourados (UFGD)” in Dourados, Mato Grosso do Sul State, Brazil. Ten of each of the following life stages: 24-h old egg masses, fifth instar larvae, pupae and adults of D. saccharalis were isolated and exposed to parasitism by seven T. howardi parasitoids females. Parasitism rates by T. howardi of the adult, fifth instar larva and pupal stages of D. saccharalis were 2%, 56% to 68%, respectively. Emergence rates of 14%, 100% and 100% were recorded for adult, fifth instar larvae, and adults, respectively. The duration of each life cycle (egg to adult) of T. howardi on the pupae, fifth instar larvae and adults of D. saccharalis were 20 ± 0.03, 27.00 ± 0.01, 33 ± 0.00 days, respectively. Fecundity and the female-based sex ratio of T. howardi were...
greatest in the pupae of *D. saccharalis*, at 70.44 ± 5.22 and 0.85 ± 0.41, respectively. Parasitism and the emergence of *T. howardi* from the fifth instar larvae, pupae and adults of *D. saccharalis* revealed the ability of this natural enemy to establish itself in culture, even in the absence of host pupae.

Key Words: biological control, larval and pupal parasitoid, sugarcane, sugarcane borer

**Sumário**

*Tetrastichus howardi* Olliff (Hymenoptera: Eulophidae) parasita larvas, pupas e adultos de *D. saccharalis* (Fabricius) (Lepidoptera: Crambidae), e, portanto, parece ser um candidato adequado para o controle biológico de *D. saccharalis* em plantios comerciais de cana-de-açúcar. A pesquisa foi realizada no Laboratório de Entomologia/Controle Biológico (LECO-BIO) na “Faculdade de Ciências Agrárias” da “Universidade da Grande Dourados (UFGD)”, em Dourados, Mato Grosso do Sul, Brasil. Dez de cada uma das seguintes fases da vida: massas de ovos com 24 horas de idade, larvas de quinto instar, pupas e adultos de *D. saccharalis* foram isoladas e expostas ao parasitismo por sete fêmeas de *T. howardi*. A taxa de parasitismo por *T. howardi* em adulto, a larva de quinto estádio e pupa de *D. saccharalis* foram de 2 %, 56 % e 68 %, respectivamente. As taxas de emergência foram de 14 %, 100 % e 100 % para adultos, larvas de quinto instar e pupas de *D. saccharalis*, respectivamente. A duração de cada ciclo de vida (ovo a adulto) de *T. howardi* em pupa, as larvas quinto instar e adultos de *D. saccharalis* foram de 20 ± 0,03, 27,00 ± 0,01, 33 ± 0,00 dias, respectivamente. A progênie e razão sexual de *T. howardi* foram maiores em pupas de *D. saccharalis* com 70,44 ± 5,22 e 0,85 ± 0,41, respectivamente. O parasitismo e a emergência de *T. howardi* em larvas de quinto instar, pupas e adultos de *D. saccharalis* revelam a capacidade, desse inimigo natural, em se estabelecer na cultura, mesmo com ausência as pupas hospedeiras.

Palavras-Chave: broca, controle biológico, cana-de-açúcar, parasitoide larval e pupal

**References Cited**

Abbott WS. 1925. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18: 265–266.

Andrade GS, Serrão JE, Zanuncio JC, Zanuncio TV, Leite GLD, Polançzyk RA. 2010. Immunity of an alternative host can be overcome by higher densities of its parasitoids *Palmistichus elaeisis* and *Trichogramma galloi* Zucchi (Hymenoptera: Trichogrammatidae). Bioscience Journal 29: 1267–1274.

Parra JRP. 2007. Técnicas de Criação de Insetos para Programa de Controle Biológico.134 pp. ed. Piracicaba: ESA/LQ/FEALQ, Brazil.

Penuccchio F, Strand MR. 2006. Evolution of developmental strategies in parasitic Hymenoptera. Annual Review of Entomology 51: 233-258.

Pereira-Barros JL, Broglio-Micheletti SMF, Santos AJT, Carvalho LWT, Carvalho AS, Oliveira CIT. 2007. Biological aspects of *Trichogramma galloi Zucchi* (Hymenoptera: Trichogrammatidae) reared on eggs of *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae). Ciência e Agrotecnologia 29: 714-718.

Pinto AS, Botelho PSM, Oliveira NH de. 2009. Guia ilustrado de pragas e insetos benéficos da cana-de-açúcar. 160 pp. Piracicaba: CP2, Brazil.

Prutz G, Brink A, Dettner K. 2004. Transgenic insect-resistant corn affects the fourth trophic level: effects of *Bacillus thuringiensis* corn on the facultative hyperparasitoid *Tetrastichus howardi*. Naturewissenschaften 91: 451-454.

Rodrigues MAT, Pereira FF, Kassab SO, Pastori PL, Glaeser DF, Oliveira NH, Zanuncio JC. 2013. Thermal requirements and generation estimates of *Trichoplistis diatraeae* (Hymenoptera: Eulophidae) in sugarcane producing regions of Brazil. Florida Entomologist 96: 643-648.

Simões RA, Letícia RG, Bento JMS, Solter LF, Delalibera Jr I. 2012. Biological and behavioral parameters of the parasitoid *Cotesia flavipes* (Hymenoptera: Braconidae) are altered by the pathogen *Nosema* sp. (Microsporidia: Nosematidae). Biological Control 63: 164-171.

Silva-Torres CSA, Pontes IVAF, Torres JB. 2010. New records of natural enemies of *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) in Pernambuco, Brazil. Neotropical Entomology 39: 835-838.

Swedse VM, Lima EAL, Porto ALF. 2013. Horizontal transmission and effect of the temperature in pathogenicity of *Beauveria bassiana* against *Diatraea saccharalis* (Lepidoptera: Crambidae). Brazilian Archives of Biology and Technology 56: 413-419.

Vargas EL, Pereira FF, Tavares MT, Pastori PL. 2011. Record of *Tetrastichus howardi* (Hymenoptera: Eulophidae) parasitizing *Diatraea* sp. (Lepidoptera: Crambidae) in sugarcane crop in Brazil. Entomotropica 26: 135-138.

Tavares WS, Hansson C, Serrão JE, Zanuncio JC. 2011. First report of *Trichoplistis diatraeae* (Hymenoptera: Eulophidae) parasitizing pupae of *Anti-caria gemmatalis* (Lepidoptera: Noctuidae). Entomologia Generalis 33: 281-282.

Tavares WS, Hansson C, Mielke OHM, Serrão JE, Zanuncio JC. 2013. Parasitism of *Palmistichus elaeisis* (Hymenoptera: Eulophidae) - a facultative hyperparasitoid of stem borers. Biological Control 63: 281-282.

White WH, Wilson LT. 2012. Feasibility of using an alternative larval host and host plants to establish *Cotesia flavipes* (Hymenoptera: Braconidae) in the temperate Louisiana sugarcane ecosystem. Environmental Entomology 41: 275-281.