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First record of *Helicoverpa armigera* (Lepidoptera: Noctuidae) feeding on *Plectranthus neochilus* (Lamiales: Lamiaceae) in Brazil

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Helicoverpa armigera Hübner (Lepidoptera: Noctuidae), the cotton bollworm, also known as the gram pod borer or the tomato fruit worm, is a polyphagous agricultural pest with a wide geographical distribution, recorded from Europe, Asia, Africa, Oceania, and recently South America (Czepak et al. 2013; Specht et al. 2013; Bueno & Sosa-Gómez 2014; Murúa et al. 2014). Larvae of *H. armigera* have been reported from over 67 host families, including Asteraceae, Fabaceae, Malvaceae, Poaceae, and Solanaceae (Pogue 2004), and this pest has caused losses to economically important crops such as cotton, legumes, sorghum, maize, tomato, soybean, ornamental plants, and fruit trees (Moral-Garcia 2006; Specht et al. 2013).

Helicoverpa armigera females lay eggs on host flowers and fruit, and larvae feed on various parts of the plants, although they prefer buds, inflorescences, fruits, and pods (Moral-Garcia 2006; Perkins et al. 2009; Specht et al. 2013) and thus cause damage to reproductive structures. This study reports the first occurrence of *H. armigera* feeding on *Plectranthus neochilus* Schltr. (Lamiales: Lamiaceae). Larvae were collected during Aug 2014, in Paraná State (Londrina, Embrapa Soybean; 23.190667°S, 51.184056°W; 630 m asl), Brazil, feeding on inflorescences of “boldo-rasteiro” (*P. neochilus*) (Fig. 1A).

The collected larvae were kept under laboratory conditions with natural diet (inflorescences) until pupation. Pupae were separated by sex and emerging adults identified by external (pattern and color of wings; Fig. 1B) and internal (morphology of male and female genital organs) characteristics (Pogue 2004). A pair of adults was allowed to mate in a cage, and the eggs used to confirm species identification (Kirkpatrick 1961). Male and female genitalia were cleared in a 10% potassium hydroxide solution and mounted on microscope slides (Specht et al. 2013). We performed the molecular characterization of *H. armigera* in the Laboratório de Entomologia da Embrapa Soja (Londrina/PR, Brazil). For DNA extraction, moth samples were obtained from 2 adults (heads and legs). The analyses followed the methods of Behere et al. (2008).

Specimens were diagnosed as *H. armigera* based on adult external and internal morphology, especially the genitalia. Other morphological characters used to identify specimens were the external structure

of the eggs, the shape of the base of abdominal sternite and of the valves, and the number of cornuti (= spines) inside the aedeagus (12 cornuti sets or less). Vouchers of genitalia slides and pinned specimens were deposited in the Laboratory of Biological Control of Caterpillars (Embrapa Soybean, Brazil).

For molecular characterization, we used polymerase chain reaction (PCR) amplification of partial *COI* (511 bp) and *Cyt b* (434 bp) genes for each specimen; DNA from all individuals was amplified successfully. The restriction endonuclease digest of the 511 bp *COI* PCR product resulted in 2 bands of 318 bp and 193 bp. Within the 434 bp of *Cyt b* sequences, the recognition site for *HphI* [GGTGA (N)8] was present, and the restriction digestion of the 434 bp *Cyt b* PCR product therefore resulted in 2 bands of 280 bp and 154 bp (Fig. 1C). These data are consistent with the molecular identification of *H. armigera* described in the literature (Behere et al. 2008).

Larvae of *H. armigera* prefer to feed on the reproductive structures of the host (Moral-Garcia 2006; Perkins et al. 2009), and this was observed in this study, with larvae on *P. neochilus* found only on the flowers (Fig. 1A). Growers should monitor other species of plants that may be temporary reservoirs during the period between harvests of economically important crops.

Furthermore, *P. neochilus* and other *Plectranthus* species are common throughout Brazil and associated with fruit orchards, home gardens, and vegetable gardens, because they have medicinal uses, especially in the treatment of digestive disorders (Lorenzi & Matos 2008). Because *P. neochilus* is widespread and is now a recorded host, this may be vital information in developing pest management strategies. The importance of plant-reservoirs is recognized for other species of insect pests and crops in Brazil (Krinski & Pelissari 2012; Krinski et al. 2012, 2015; Krinski 2013a,b, 2015). Furthermore, producers of commercial boldo crops should be aware of this pest and the damage potential it poses.

In Brazil, management of this pest is in the initial stages. Therefore, information about new host plants and correct identification and sampling techniques for adults, eggs, larvae, and pupae are essential for determining appropriate control tactics. Researchers in other coun-

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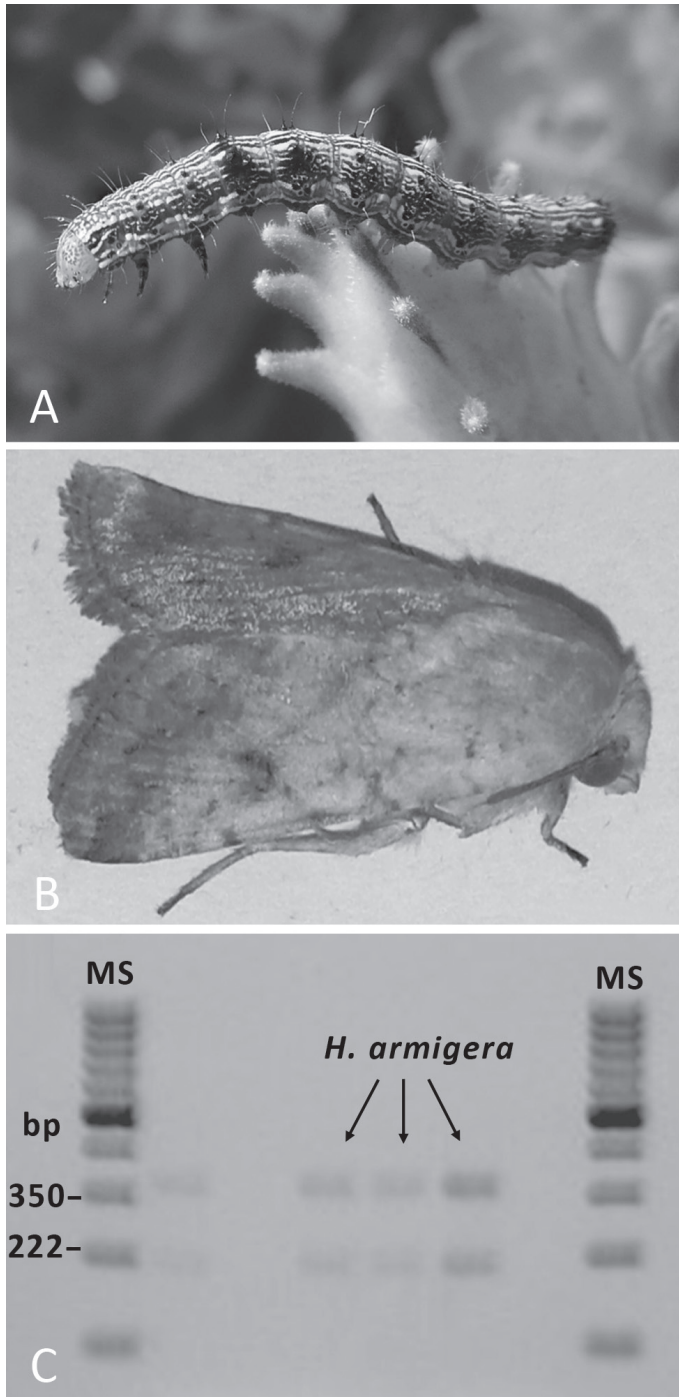


Fig. 1. *Helicoverpa armigera*. A) Larva; B) adult; and C) partial *COI* (511 bp) restriction fragment length polymorphism pattern (digested with *BstZ171*), with bands separated on a 6% polyacrylamide gel. Lanes labeled as MS are pGEM molecular weight standard DNA ladders. Photo credits: larva, D. K.; adult, Jhibran Ferral Piña.

tries have studied *H. armigera* on different host plants (e.g., Razmjou et al. 2014). Because this species is new to Brazil and its ecology, behavior, and host preferences may differ, studies with different host plants should be conducted to better understand the biology and development of this pest in Brazil.

According to Lammers & MacLeod (2007), the worldwide cost per year to control this pest, along with yield losses, reaches US\$ 5 billion. In India and China, 50% of pesticides in agriculture are used to control

this pest. In Spain, *H. armigera* is one of the most serious pests of tomato. In Brazil, losses in the 2012–2013 crop season were estimated at US\$ 0.8 billion (Bueno & Sosa-Gómez 2014). Considering this level of damage, it is essential that monitoring for this pest and natural enemies is established. Surveillance and monitoring of new host records and changes in distribution, and research on control methods, such as natural enemies and plant deterrents (extracts and essential oils) as previously reported in the literature (Favetti et al. 2013; Bueno & Sosa-Gómez 2014; Krinski et al. 2014), will help determine what control options will be chosen. The Brazilian Agricultural Research Corporation (Embrapa) has already emphasized that effective monitoring of eggs, larvae, pupae, and adults of *H. armigera* is critical to successfully implementing management strategies for this pest, because these factors determine what control tactics will be used (Bueno & Sosa-Gómez 2014).

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Summary

Helicoverpa armigera Hübner (Lepidoptera: Noctuidae) is a polyphagous agricultural pest recorded in Europe, Asia, Africa, Oceania, and recently South America. Larvae of *H. armigera* are recorded from over 67 host families, including Asteraceae, Fabaceae, Malvaceae, Poaceae, and Solanaceae. This study documents for the first time *H. armigera* larvae feeding on inflorescences of “boldo-rasteiro” *Plectranthus neochilus* Schltr. (Lamiales: Lamiaceae). The species was identified according to external and internal characteristics of adults, morphology of eggs, and by molecular characterization.

Key Words: identification; morphology; molecular characterization; new host record; boldo-rasteiro

Sumário

Helicoverpa armigera Hübner (Lepidoptera: Noctuidae) é uma praga agrícola polífaga com distribuição geográfica registrada na Europa, Ásia, África, Oceania e, recentemente, na América do Sul. Devido à sua distribuição mundial, suas larvas foram relatados em cerca de 67 famílias, incluindo Asteraceae, Fabaceae, Malvaceae, Poaceae e Solanaceae. Com o recente registro de sua ocorrência no Brasil, novas espécies de plantas hospedeiras tem sido registradas. Portanto, este estudo relata a primeira ocorrência de lagartas de *H. armigera* atacando inflorescências de “boldo-rasteiro” *Plectranthus neochilus* Schltr. (Lamiales: Lamiaceae). A espécie foi identificada de acordo com as características externas e internas, morfologia dos ovos e também por caracterização molecular.

Palavras Chave: identificação; morfologia; caracterização molecular; registro de novo hospedeiro; boldo-rasteiro

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