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Scientific Note

Lepidoptera larvae (Insecta) responsible for herbivory on *Vanilla* spp. (Orchidaceae) in the Federal District, Brazil

Alexandre Specht[1]✉, Ranyse Barbosa Querino[2], Willian Rogers Ferreira de Camargo[2], Amabílio José Aires de Camargo[2], Wanderlei Antonio Alves de Lima[2] & Zenilton de Jesus Gayoso Miranda Brasil[2]

1. Embrapa Recursos Genéticos e Biotecnologia, Brasília, DF, Brazil. 2. Embrapa Cerrados, Planaltina, DF, Brazil.

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Abstract. Given its culinary importance and high market value, the cultivation of *Vanilla* (Orchidaceae) has been expanding annually in Brazil. As observed in many crops, the increase in cultivated areas leads to a greater incidence of insects associated with species of this genus. This study reports the herbivory of larvae from *Cremna thasus* (Stoll, 1780) (Papilionoidea: Riodinidae: Riodininae), *Hypercompe cunigunda* (Stoll, 1781) (Noctuoidea: Erebidae: Arctiinae), and *Spodoptera cosmioides* Walker, 1858 (Noctuoidea: Noctuidae: Noctuinae) on *Vanilla bahiana* Hoehne and *V. planifolia* Andrews in the Federal District, Brazil. A list of 19 Lepidoptera species from six families associated with *Vanilla* spp. worldwide is provided based on a literature review. Most (n=15) of them exhibit polyphagous larvae. Given reports of exotic larvae spreading with orchids worldwide and the discussed larval polyphagy, we address precautions that producers of *Vanilla* and other orchids should take to reduce the incidence of insect pests in crops, especially in areas with intensive cropping systems involving annual commodities such as maize and soybean.

Keywords: Insect pests; larval polyphagia; pest management; quarantine.

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✉**Corresponding author:**
Alexandre Specht
alexandre.specht@embrapa.br

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Vanilla beans are among the most economically valuable agricultural products and play a significant role in the food industry supply chain (Gallage & Møller 2018; Havkin-Frenkel & Belanger 2019). Vanilla orchids belong to the genus *Vanilla* Mill. (Orchidaceae), which has a pantropical distribution. The genus comprises approximately 120 species distributed across three centers of diversity: Tropical America (n=62) (Karremans *et al*. 2020), Southeast Asia-New Guinea (n=28), and Africa-Madagascar (n=24) (Cameron 2011). From the perspective of biodiversity and the use of this natural resource, Tropical America is critical, not only because it harbors about half of the species but also because around 35 of them produce aromatic fruits (Cameron 2003, 2011).

Brazil hosts the greatest diversity of vanilla species (n=38), 20 of which are endemic (Flora e Funga do Brasil 2024). Among the main species economically exploited in this country, *Vanilla bahiana* Hoehne and *V. pompona* Schiede stand out. According to Ferreira *et al*. (2017), *V. bahiana* is endemic to Brazil, originally described from the state of Bahia, and later reported in other states of the Northeast (Sergipe, Alagoas, Pernambuco, Paraíba, and Rio Grande do Norte), Central-West (Federal District), and Southeast regions (Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo). It is phylogenetically related to *V. planifolia* (Nascimento *et al*. 2019; Bianchetti *et al*. 2023).

Various phytophagous insects, including Lepidoptera from different families, are associated with different Orchidaceae species, exhibiting different forms of herbivory (Swezey 1945; Capps 1952; Silva *et al*. 1968; Light & Macconaill 2011; Robinson *et al*. 2023). However, the entomofauna associated with *Vanilla* species in Brazil is not well known, particularly for native species in environments such as the Cerrado. To date, only *Cremna thasus* (Stoll, 1780) (Lepidoptera: Riodinidae) and *Spodoptera* sp. (Lepidoptera: Noctuidae) have been associated with *Vanilla* in the state of São Paulo (Costa *et al*. 2022).

The present study aims to document lepidopterans associated with *Vanilla* spp., with a particular focus on larvae collected feeding on vanilla plants in the field, especially on *V. bahiana* and *V. planifolia*.

The larvae were collected while feeding on seedlings or plants in Cerrado areas at Embrapa Cerrados, in Planaltina, Federal District, through visual inspection of the plants. These areas include preserved woodland (*cerradão*) represented by seminal seedlings of *V. bahiana* and *V. planifolia*, as well as in other locations within the Federal District.

The collected specimens were brought to the laboratory and kept in rearing cages with *Vanilla* spp. plants under ambient conditions until they have completed their biological cycle. The adults sampled were dry-mounted for subsequent species identification. Taxonomists identified the species using specialized literature, genitalia examination and comparison, and/or comparison with specimens from the Entomological Collection of Embrapa Cerrados, Federal District. Voucher specimens were deposited in the Entomological Collection of

Embrapa Cerrados.

To better characterize and understand the main associations between Lepidoptera and *Vanilla*, a review was conducted on lepidopteran species whose larvae feed on *Vanilla* worldwide. This involved surveying major databases on Lepidoptera host plants (Janzen & Hallwachs 2009; Robinson *et al*. 2023) and searching for publications on various search engines using the keywords "Lepidoptera", "*Vanilla*," and "Orchidaceae." Only technical-scientific publications or information related to educational and research institutions were considered. When relevant, the nomenclature and taxonomy of the lepidopterans were updated.

Between 2021 and 2024, larvae were collected and reared until they reached adulthood. The adults were identified as *Cremna thasus* (Stoll, 1780) (Papilionoidea: Riodinidae: Riodininae), *Hypercompe cunigunda* (Stoll, 1781) (Noctuoidea: Erebidae: Arctiinae), and *Spodoptera cosmioides* Walker, 1858 (Noctuoidea: Noctuidae: Noctuinae). The larvae of all species were found to cause significant defoliation, severely reducing leaf area and potentially compromising plant development.

The literature review identified 19 lepidopteran species associated with *Vanilla* spp. worldwide (Table 1), including representatives from Tortricidae (n= 4), Crambidae (n= 1), Pyralidae (n= 1), Erebidae (n= 9), Noctuidae (n= 3), and Riodinidae (n= 1). Most of them exhibit polyphagous larvae.

Lepidoptera larvae responsible for herbivory on *Vanilla* spp. in the Federal District, Brazil:

***Cremna thasus* (Stoll, 1780) (Figure 1 A-F)**. Larvae of *C. thasus* were collected on *V. bahiana* during the rainy seasons of 2022 and 2023. The larvae were fed with leaves from the same plant until reaching adulthood for species identification. Six larvae were reared, with the larval stage lasting 14 days - during which approximately ten leaves were consumed - and the pupal stage lasting nine days. The butterflies have a wingspan ranging from 2 to 2.5 cm, with tiger-striped black wings and a background color varying from white to reddish.

Crema thasus has been observed associating with *Vanilla planifolia* in Costa Rica (Janzen & Hallwachs 2009) and in experimental vanilla cultivation (*V. planifolia*) within agroforestry systems (AFS) and commercial areas in São José do Rio Preto, São Paulo, Brazil, in small groups and feeding on the leaves from December to March, the period of highest

Table 1. Lepidopterans associated with herbivory of *Vanilla* (Orchidaceae) according to superfamily, family, subfamily, world regions of its occurrence, and feeding patterns or botanical families consumed by their larvae, with references in parenthesis.

Taxa	World region	Feeding pattern
Tortricoidea: Tortricidae: Olethreutinae		
Archips micaceana (Walker, 1863)	Oriental (8, 9)	Polyphagous (13)
Lobesia vanillana (de Joannis, 1900)	Afrotropical (2, 13)	Anacardiaceae and Orchidaceae (13)
Tortricoidea: Tortricidae: Tortricinae		
Platynota flavedana Clemens, 1860	Puerto Rico (13)	Polyphagous (13)
Platynota rostrana (Walker, 1863)	New World (1, 13)	Polyphagous (13)
Pyraloidea: Crambidae: Pyraustinae		
Terastia meticulosalis Guenée, 1854	Pantropical (1, 13)	Polyphagous (13)
Pyraloidea: Pyralidae: Phycitinae		
Cryptoblabes gnidiella (Millière, 1867)	Cosmopolita (5)	Polyphagous (13)
Noctuoidea: Erebidae: Arctiinae		
Creatonotos transiens (Walker, 1855)	West Malaysia, Indonesia (3, 13)	Polyphagous (3, 13)
Hypercompe eridanus (Cramer, [1775])	[Neotropical] (13)	Polyphagous (13)
Hypercompe icasia (Cramer, [1777])	Puerto Rico, Neotropical (1, 13)	Polyphagous (7, 13)
Hypercompe trinitatis (Rothschild, 1910)	[Neotropical] (10)	Polyphagous (10)
Olepa ricini (Fabricius, 1775)	Oriental (8, 9)	Polyphagous (13)
Spilarctia multiguttata (Walker, 1855)	Oriental (13)	Verbenaceae and Orchidaceae (13)
Noctuoidea: Erebidae: Lymantriinae		
Euproctis bigutta (Holland, 1893)	West Malaysia (8, 9)	Loranthaceae, Melastomataceae, Orchidaceae (13)
Somena scintillans Walker, 1856	West Malaysia (8, 9, 13)	Polyphagous (13)
Noctuoidea: Erebidae: Herminiinae		
Simplicia extinctalis (Zeller, 1852)	indian Ocean Islands (13)	Polyphagous (13)
Noctuoidea: Noctuidae: Plusiinae		
Thysanoplusia orichalcea (Fabricius, 1775)*	Old World (2, 11, 13)	Polyphagous (13)
Noctuoidea: Noctuidae: Xyleninae		
Spodoptera sp.	Neotropical (11, 12)	Polyphagous (4, 13)
Noctuoidea: Noctuidae: Noctuinae		
Agrotis sp.	Cosmopolita (11)	Polyphagous (13)
Papilionoidea: Riodinidae: Riodininae		
Cremna thasus (Stoll, [1780])	New World (6, 12)	Orchidaceae (6, 7, 12, 14)

* *Sin: Plusia aurifera* (Hübner, [1813])
References: 1 - Childers 1948; 2 - Correl 1953; 3 - Holloway 1988; 4 - Pogue 2002; 5 - Guillermet 2009; 6 - Janzen & Hallwachs 2009; 7 - Rech *et al*. 2009; 8 - Vanitha *et al*. 2011; 9 - Vanitha *et al*. 2012; 10 - Cock *et al*. 2019; 11 - Havkin-Frenkel & Belanger 2019; 12 - Costa *et al*. 2022; 13 - Robinson *et al*. 2023; 14 - FUNET 2024.

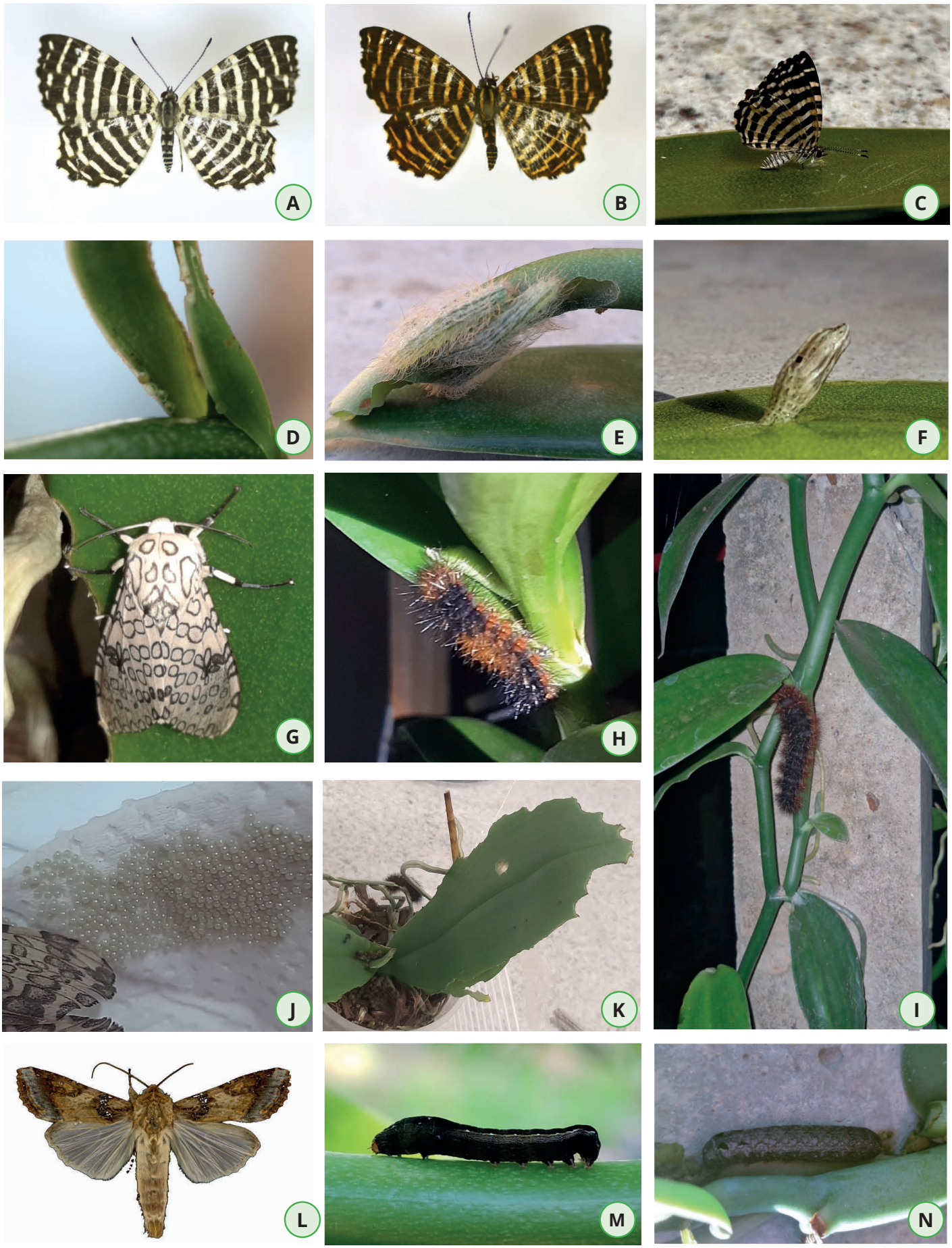

Figure 1. Lepidoptera responsible for herbivory on *Vanilla* spp.: A-F. *Cremna thasus*: A - female; B and C - male; d - eggs; e - caterpillars and f - pupa; G-K. *Hypercompe conigunda*: G - adult; H and I - caterpillars, J - adult and egg mass and K - caterpillar and damage on Orchidaceae; L-N: *Spodoptera cosmioides*: L - adult male; M caterpillar (black form) and N - caterpillar (gray form).

rainfall (Costa *et al*. 2022). Additionally, larvae of *C. thasus* have been reported feeding on other orchids such as *Catasetum virdiflavum* Hook., *Caularthron bilamellatum* (Rchb.f.) R.E. Schult., *Dendrobium* sp., *Dimerandra emarginata* (G.Mey.) Hoehne, *Oncidium* sp. (DeVries 1997; Zotz 1998; Murgas & Jaen 2020; FUNET 2024), as well as on fruits and seeds of *Brassavola cebolleta* Rchb. f. and *Oncidium jonesianum* Rchb. f. (Rech *et al*. 2009).

***Hypercompe cunigunda* (Stoll, 1781) (Figure 1 G-K).** Larvae of *H. cunigunda* were collected from *V. bahiana* plants throughout the rainy season (November-April) in 2021, 2022, 2023, and 2024.

Hypercompe cunigunda occurs in Ecuador, Venezuela, Suriname, French Guiana, Brazil, and Bolivia (De Toulgoët & Navatte 2000).

The adults display pronounced sexual dimorphism and significant morphological variation (Oberthür 1881). The female body is nearly twice the size of the male, with nearly circular spots on the forewings (which is why they are referred to as "leopard moth") filled with gray. The hindwings have a dark spot that covers the basal and disc areas, except for the costal margin, and small, almost circular spots along the line dividing the post-disc and submarginal areas. In contrast, the forewing spots of the male collected are filled with the same white as the background color, and the hindwings are white.

The larvae have many protective setae and exhibit solitary behavior. They are usually found exposed on the host plant's leaves and, when disturbed, curl into a circle to protect their anterior and posterior ends. Information on the biology of this species was retrieved from studies conducted in Suriname (Gernaat *et al*. 2016), and details about natural enemies were obtained from research in Paraná, southern Brazil (Salgado-Neto *et al*. 2020).

Larvae of the genus *Hypercompe* Hübner, [1819] are considered polyphagous as they associate with a variety of native and cultivated plants (Nava *et al*. 2008; Janzen & Hallwachs 2009; Salgado-Neto *et al*. 2020; Robinson *et al*. 2023). Several records of this genus have been associated with Orchidaceae, including *Vanilla* in the Neotropics (Robinson *et al*. 2023).

***Spodoptera cosmioides* Walker, 1858 (Figure 1 L-N).** Larvae of *S. cosmioides* were collected feeding on *V. planifolia* leaves during the 2023 rainy season.

Spodoptera cosmioides is distributed from mainland Central America, including Costa Rica, to southern South America, excluding Chile (Brito *et al*. 2024). Its larvae are polyphagous, feeding on over a hundred native, exotic, cultivated, or spontaneous plants (Specht & Roque-Specht 2016; Borges Jr *et al*. 2020; Santos Júnior *et al*. 2024). While definitive identification was not possible, the larval images provided by Costa *et al*. (2022) strongly suggest that the *Spodoptera* species reported by those authors feeding on *V. planifolia* is *S. cosmioides.*

Regarding *Spodoptera* species, it is noteworthy that the moths oviposit in masses in elevated locations. After hatching, the larvae secrete a silk thread and disperse it through air currents in a process known as ballooning (Bell *et al.* 2005). Consequently, they can end up in various locations carried by the wind and must be capable of feeding on plants from different families, including Orchidaceae. Indeed, different *Spodoptera* species have been associated with this family (Montezano *et al*. 2018; Brito *et al*. 2019; Candano *et al*. 2020). This includes *S. cosmioides*, for which Takahashi *et al*. (2003) documented the interception of *S. cosmioides* (sic. *S. latifascia*) larvae in Japan, originating from *Oncidium* spp. from Brazil.

The observation of larvae from these three lepidopteran species causing significant herbivory on *Vanilla* spp., with recurring incidences over the years in a relatively small cultivation area in the Federal District, raises concerns about the potential for larger infestations and damage, particularly in the context of extensive cultivation for large-scale production (Bianchetti *et al*. 2023). Their importance is underscored by the report of 19 lepidopteran species whose larvae can feed on *Vanilla* (Table 1) worldwide. Our findings, coupled with the knowledge of a large number of endemic *Vanilla* species with broad distribution across the American continent (Karremans *et al*. 2020), suggest that many other lepidopteran species could potentially associate with and even cause significant damage to commercial plantings.

Based on Table 1, it is anticipated that herbivory will predominantly be carried out by lepidopteran species whose larvae are polyphagous and may occasionally use *Vanilla* as an "accidental" host, as well as species that feed on various Orchidaceae species, such as *C. thasus*.

An increase in occurrences is anticipated for polyphagous species, including those feeding on *Vanilla* spp. (Table 1) and *Spodoptera* species that feed on various Orchidaceae (Takahashi *et al*. 2003; Montezano *et al*. 2018; Brito *et al*. 2019; Candano *et al*. 2020). This risk is heightened when *Vanilla* cultivation is established near areas with intensive agricultural production. During the production of annual crops like soy, maize, or other commodities, large numbers of moths are generated. These moths take refuge or feed on nectar in areas with permanent vegetation, such as those where Vanilla is cultivated. Consequently, these areas become sites for oviposition, with larvae potentially dispersing into *Vanilla* crops.

Given that many records of herbivorous species associated with Orchidaceae originate from airport interceptions (*e.g.*, Swezey 1945; Capps 1952; Takahashi *et al*. 2003; Candano *et al*. 2020), it is crucial for producers - many of whom are orchid enthusiasts - to exercise the utmost caution when importing, exporting, or purchasing seedlings from other growers. This caution is necessary to prevent contamination of their properties not only by lepidopterans but also by other organisms.

Regarding management, there are currently no insecticides registered with the Ministry of Agriculture and Livestock (Ministério da Agricultura e Pecuária - MAPA) for these caterpillars in this crop. However, alternative control methods are generally recommended for caterpillars, especially in agroecological production systems (*e.g.*, Aquino & Assis 2012). These recommendations include good management practices, particularly regular monitoring through periodic visual inspections of plants to detect insect presence. During the rainy season, when these caterpillars are more prevalent, physical control methods, such as hand-picking and removal, should be conducted more frequently.

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AUTHORS CONTRIBUTIONS

AS and RBQ conceptualized the study and wrote the first draft of the manuscript. RBQ, WRFC, and AJAC reared the specimens. AS, WRFC, and AJAC identified the species. RBQ, WRFC, AJAC, WAAL, and ZJGMB produced the photographs. All authors commented on previous versions and read and approved the final version of the manuscript.

CONFLICTS OF INTEREST STATMENT

The authors declare no conflicts of interest.

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