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Scientific Note

First record of *Delphastus argentinicus* Nunenmacher (Coccinellidae: Serangiini) as a predator to whitefly in cassava crops

Greissi Tente Giraldi[1], Julio César Guerreiro[1]✉, João Paulo Francisco[1], Evandro Pereira Prado[2] & Pedro José Ferreira-Filho[3]

1. Universidade Estadual de Maringá – Campus de Umuarama: Umuarama, Paraná, Brazil. 2. Universidade Estadual Paulista - Campus de Dracena: Dracena, São Paulo, Brazil. 3. Universidade Federal de São Carlos – Campus Sorocaba: Sorocaba, São Paulo, Brazil.

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Abstract. Cassava crops hold high agricultural importance in Paraná State, Brazil. However, cassava root production is adversely impacted by pests. Aleyrodids, in particular, cause great damage to cassava fields, necessitating better knowledge of predators found in these agroecosystems and novel biological control strategies for integrated pest management. This study reports the first occurrence of the predatory lady beetle *Delphastus argentinicus* Nunenmacher, preying on all life stages of whiteflies in cassava fields. Given the economic and social importance of cassava crops in Brazil and the deleterious potential of aleyrodid species, it is recommended to conduct behavioral and bioecological studies assessing the application of *D. argentinicus* as a biocontrol agent in integrated pest management programs.

Keywords: Aleyrodidae; biological control; *Manihot esculenta* Crantz; ladybug; *Bemisia* sp.

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✉ **Corresponding author:**
Julio César Guerreiro
jcguerreiro@uem.br

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Cassava (*Manihot esculenta* Crantz) roots are known in Brazil and worldwide for their importance as a food crop and raw material for starch extraction (Saengchan *et al*. 2015; Pinto-Zevallos *et al*. 2016). Worldwide 27.52 million hectares of cassava are cultivated, and 303.57 million tons are produced, resulting in an average productivity of 11,030 tons/ha (Groxko & Pereira 2021). In Brazil, cassava production is 19.7 million tons, in an area of 1.32 million hectare, resulting in an average productivity of 15 thousand tons/ha (Groxko & Pereira 2021). Biotic factors such as pests can reduce the yield and quality of starch obtained from this tuberous root (Bellotti *et al*. 1999). Whiteflies, a group of sap-sucking insects belonging to the order Hemiptera and family Aleyrodidae, are a major cause of damage to cassava fields (Bellotti 2002) Six genera are noteworthy: *Aleurotrachelus*, *Trialeurodes*, *Aleurothrixus*, *Aleurodicus*, *Tetraleurodes*, and *Bemisia* (Bellotti *et al*. 2012).

Given their ample distribution and plant feeding behavior, whiteflies cause considerable losses in cassava starch production in the Neotropical region (Vásquez-Ordóñez *et al*. 2015). These sucking pests damage crops through direct and indirect mechanisms, which may occur simultaneously. Direct damage is inflicted by suction of plant sap, leading to chlorosis, apical wilting, and leaf abscission (Bellotti *et al*. 2012). Indirect damage results from the development of opportunistic fungi that feed on honeydew released from pierced plants (Carabalí *et al*. 2010). Furthermore, under certain conditions, aleyrodids may serve as vectors of plant diseases (Bellotti & Arias 2001; Bellotti *et al*. 2012).

The ability of whiteflies to feed on cassava crops during all stages of plant development, combined with faunal imbalance resulting from the use of conventional broad-spectrum insecticides, has made the control of this pest a great challenge for farmers (Silva *et al*. 2009; Sagrilo *et al*. 2010; Barilli *et al*. 2019). Adoption of natural biological control techniques as part of an integrated pest management strategy is recommended to mitigate the damage caused by whiteflies in cassava fields (Landis *et al.* 2000; Gurr *et al*. 2017).

Coccinellids, commonly known as ladybugs, are valuable pest control agents. These insects are natural predators of agricultural pests belonging to the most varied orders, including Hemiptera, Lepidoptera, Coleoptera, Diptera, and Thysanoptera (Burgio *et al.* 2002; Guerreiro *et al.* 2003; Ivana *et al*. 2020). Predatory coccinellids belonging to the subfamily Microweiseinae, tribe Serangiini (Escalona & Ślipiński 2011), which includes the genera *Serangium* and *Delphastus*, are particularly important for the biological control of aleyrodids (Legaspi *et al*. 1996; Obrycki & Kring 1998; Ellis *et al*. 2001; Al-Zyoud & Sengonca 2004; Simmons *et al*. 2008). Members of the genus *Delphastus* are oligophagous predators whose main prey species are whiteflies (Hoelmer & Pickett 2003), having the ability to feed on all life stages of these insect pests (Obrycki & Kring 1998; Liu & Stansly 1999; Heinz *et al*. 1999; Baldin *et al*. 2011; Giraldi *et al*. 2020).

Hoelmer *et al*. (1993) found that, under optimal conditions, lady beetle larvae can consume up to 1,000 whitefly eggs before pupating, and a single individual consumes about 10,000 eggs during its entire life span. In estimating the distribution of whitefly eggs and nymphs and the predation rate of *Delphastus catalinae* Horn in tomato by a mathematical model, Rincon *et al*. (2016) and Rincon *et al*. (2017) found that predators searched their prey in lower regions of the plant regardless of the location of whitefly nymphs and that *D. catalinae* adults were attracted to honeydew excreted by whitefly adults. It is possible to affirm that *Delphastus* spp. have a close relationship with whiteflies and can be an efficient predator for the control of whitefly populations. With this information, the present work aims to report a new predator in the cassava crop.

During assessment of the damage of whitefly species to cassava crops at the Santo Antônio farm (23°76'10.95"S 53°41'7.15"W), Umuarama, Paraná, Brazil (Figure 1), it was observed the presence of *Delphastus* larvae and adults associated with whitefly populations (Figure 2). The region where the coccinellids were found is delimited by the Caiuá sandstone formation, whose soil unit is classified as dystrophic Dark Red Latosol with sandy texture (Muzilli *et al*. 1990; Santos *et al.* 2018). The predominant climate is mesothermal humid subtropical (Cfa in the Köppen classification), the average annual rainfall is 1,500 mm, and the average temperature is 22 °C.

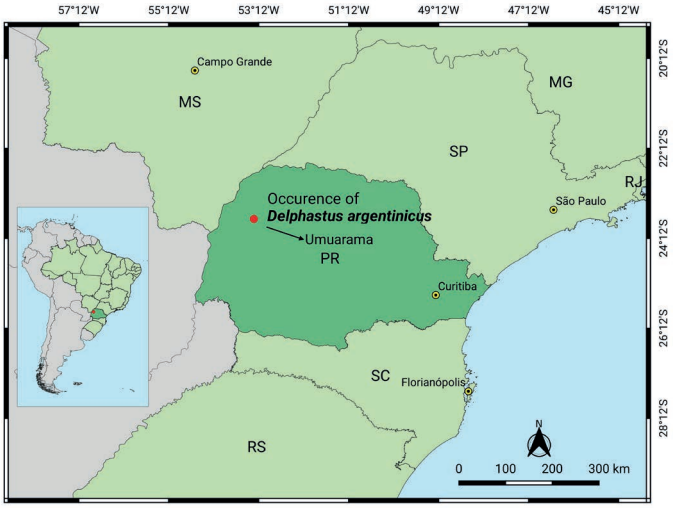

Figure 1. Location map of the occurrence of the ladybeetle *Delphastus argentinicus* Nunenmacher, Umuarama, Paraná, Brazil, 2021.

For taxonomic identification of lady beetle species occurring in cassava fields, insects were collected in the field, placed in tubes containing 70% alcohol, and sent to the Laboratory of Systematics and Bioecology of Coleoptera of the Universidade Federal do Paraná, Curitiba, Paraná, Brazil. Coccinellids were identified as *Delphastus argentinicus* Nunenmacher (Coccinellidae: Serangiini) (Gordon 1970).

The first description of *D. argentinicus*, carried out with specimens collected in Argentina, characterized the species as a minute coccinellid measuring 1.30 mm in length and 1.15 mm in width, with oblong oval shape slightly convex laterally, shiny black in color, without perforated elytra (Gordon 1977; Hodek & Honek 1996). This description was confirmed in the current study. *D. argentinicus* has been reported to prey on whiteflies in Argentina, Paraguay, and Brazil (Gordon 1970; Arioli & Link 1986).

In Brazil, the occurrence of *D. argentinicus* was reported only once, by Arioli & Link (1986) in the central region of Rio Grande do Sul State, in this research, the predator was observed feeding on *Bemisia tabaci* (Gennadius) on jurubeba (*Solanum paniculatum* L.). Up to now, there were no reports of *D. argentinicus* in Paraná State. Thus, this is the first record of the species in the region. *D. argentinicus* may play an important role in the predation of whiteflies in cassava crops.

Field sampling was performed weekly on February 5, 14, 20, and 28 and March 5, 12, 18, and 25, 2020. Collection was carried out at 87 points with a spacing of 10 × 10 m between points, in total area 8,700 m^2. Spatial points were delimited using Google Earth® and QGIS® 2.8.3 software. A Topcon HiPer II GNSS GPS receiver with a UTM projection system, Zone 22S, was used to locate and demarcate the points according to the position of sample nets. At each point, the number of whiteflies and coccinellids per cassava plant was counted.

Both predator and prey were observed in all samplings from the beginning of February to the end of March. *D. argentinicus* adults were always more abundant than larvae, whereas whitefly (*Bemisia* sp.) adults occurred in markedly smaller numbers than nymphs (Figure 2). The mean minimum and maximum numbers of lady beetles per plant were 1.92 ± 0.18 and 3.15 ± 0.29, respectively. Such a variation can be attributed to predator-prey interactions. A higher occurrence of predators naturally results from greater availability of food (prey).

Lady beetle occurrence and distribution patterns are governed by insects' choice of plants for feeding and oviposition, which is influenced by prey availability, suitability of oviposition sites, and competitive interactions between coccinellids (Hoogendoorn & Heimpel 2004; Park & Obrycki 2004). Rincon *et al*. (2016) showed that one of the main factors affecting predator-prey interactions is the structural complexity of the habitat, directly interfering with the spatial distribution and foraging behavior of predators.

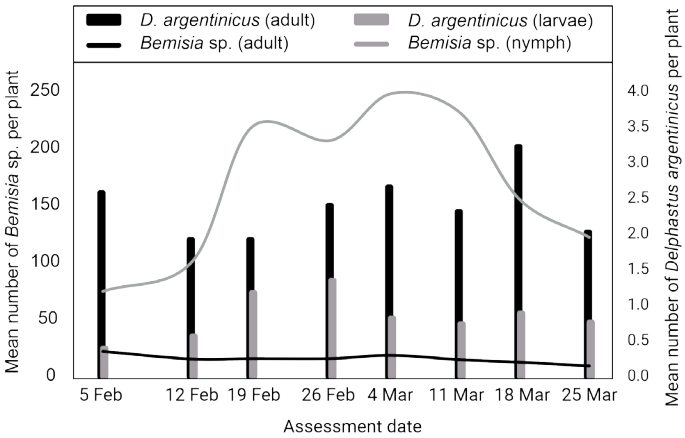

Figure 2. Mean number of *Bemisia* sp. and their predator *Delphastus argentinicus* Nunenmacher per plant in a commercial field of cassava (*Manihot esculenta*), Umuarama, Paraná State, Brazil.

Given the economic and social importance of cassava in Brazil and, more specifically, in Paraná State, as well as the increasing damage caused by whiteflies, more research is needed on *D. argentinicus* behavior and biology to assess this natural enemy's potential to reduce whitefly populations, whether by implementation of biological control or by improvement of techniques to stimulate natural predation on these pests.

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