

Scientific Note

Mites (Acari) threaten *ex situ* conservation actions of *Ipomoea cavalcantei* D.F. Austin (Convolvulaceae), an endemic species from Carajás National Forest, Pará, Brazil

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Abstract. *Ipomoea cavalcantei* D.F. Austin (Convolvulaceae) is a Highly Restricted Endemic species only found in Canga vegetation in conservation areas in the Carajás region, Parauapebas, State of Pará, in the Brazilian Amazon. Due to edaphic endemism and the increase in mineral exploration in the Carajás, it is necessary to cultivate *I. cavalcantei* outside of its habitat in order to preserve the species. On plants cultivated in a greenhouse covered with shade, at the Parauapebas Campus of the Universidade Federal Rural da Amazônia (UFRA), symptoms of pest attack were observed. The aim of this study was to characterize the damage and confirm the identification of the mite species causing injuries to the leaves of *I. cavalcantei* when cultivated outside its natural environment. The leaves of the plant had light green spots, which initially appeared as small dots. As the symptoms intensified, these spots coalesced, evolving into larger, yellowish spots, later necrosis and leaf fall at the slightest mechanical action. Mites were found on the abaxial surface of leaves, in abundant colonies, surrounded by a dense layer of webs, used for dispersion and oviposition of mites. This behavior, added to the shape of the eggs (spherical and hyaline) is characteristics of the mites of the genus *Tetranychus* Dufour, 1832 (Acari: Tetranychidae). Some female and male specimens were preserved for later identification. This is the first occurrence of *Tetranychus ludeni* Zacher, 1913 on *I. cavalcantei* and represents an important issue for conservation programs aimed at protecting *I. cavalcantei*.

Keywords: Amazon, Endangered species, Flor-de-Carajás, Potential plague, Tetranychidae.

Parauapebas is a municipality located in the Carajás mineral province, in the northern region of Brazil. The mineral province comprises a large territory in the central part of the southeast region of the Pará state, in the Eastern Amazon (Fig. 1). Carajás has been recognized for its giant deposits of enriched iron, manganese, copper, and gold (Grainger et al. 2008).

Ipomoea cavalcantei D.F. Austin (Convolvulaceae) is a symbol of the municipality of Parauapebas and the Carajás region. Commonly known as the "flor-de-Carajás" (flower of Carajás), this plant is characterized by its intense red flowering. It is classified as Highly Restricted Endemic (Giulietti et al. 2019) species exclusively found in a unique vegetation area known as Canga (Babychuk et al. 2017) (Fig. 1). Cangas are plant ecosystems associated with areas where the outcrop of ferruginous rocks, also known as ferruginous fields, are exposed. These ecosystems can be found in at least three regions in Brazil, including the conservation areas in the Carajás region, the Iron Quadrangle and the lateritic banks at Corumbá (Souza-Filho et al. 2019; Fonseca-da-Silva et al. 2020; Rodrigues et al. 2020). The natural habitat of this species in the "Serra dos Carajás" has been reduced by over 50% due to increase mineral exploration in the last three decades (Rodrigues et al. 2020). This reduction may continue as the demand for iron remains high. While some parts of "Canga" will be protected from mining, through agreements between environmental agencies and the mining company, the area of occurrence of the species is not fully considered (Skirycz et al. 2014).

In order to protect the species, studies have been carried out to cultivate *I. cavalcantei* outside of its natural habitat. However, this can lead to certain issues, such as the risk of pest attacking the plant without

the plant having developed its own endogenous defense mechanisms (Baldin et al. 2019). To date, no pests or diseases have been associated with the endangered species *I. cavalcantei*. The aim of this study was to characterize the damage and confirm the identification of the mite species causing injuries to the leaves of *I. cavalcantei* when cultivated outside its natural environment.

Plants of *I. cavalcantei* were cultivated in a shade-covered greenhouse to explore their vegetative propagation and study their vegetative and reproductive development in a non-native environment. The experiment was conducted at the university campus of Parauapebas (06° 04' 03" S and 49° 54' 08" W), Universidade Federal Rural da Amazônia (UFRA). Parauapebas has an Aw climate (Köppen & Geiger 1928), with average temperatures above 26 °C and annual precipitation around 1,800 mm (INMET 2022). It also experiences a distinct dry period in addition to the high temperatures typical of the Amazon region (Alvares et al. 2013). The aforementioned greenhouse, which is close to the UFRA entomology laboratory, had 27 individuals of *I. cavalcantei* cultivated in pots and in the campus gardens there were three individuals as ornamental plants. Pest attack symptoms were observed on all this plants, widespread in all fully expanded leaves, throughout the dry season in this region of the Amazon (April to October) in two consecutive years (2020 and 2021). From the beginning of the rainy season, when the plant releases new leaves and branches, the symptoms disappear.

Mites were found on the abaxial surface of leaves in abundant colonies, surrounded by a dense layer of webs used for dispersion and oviposition in addition to other functions. This behavior, long with the shape of the eggs (spherical and hyaline), is characteristic

of mites belonging to the genus *Tetranychus* Dufour, 1832 (Acari: Tetranychidae). Some specimens, both females and males, were mounted in Hoyer's medium and identified using a phase contrast microscope. The identification was carried out with dichotomous key to identify the spider mite genera worldwide (Bolland et al. 1998), as well as the species within the *Tetranychus* genus (Pritchard & Baker 1955; Tuttle et al. 1977). Additionally, photographic records were taken of the symptoms and individuals found on the plants leave. Additionally, photographic records were taken of the symptoms and individuals found on the plants leave.

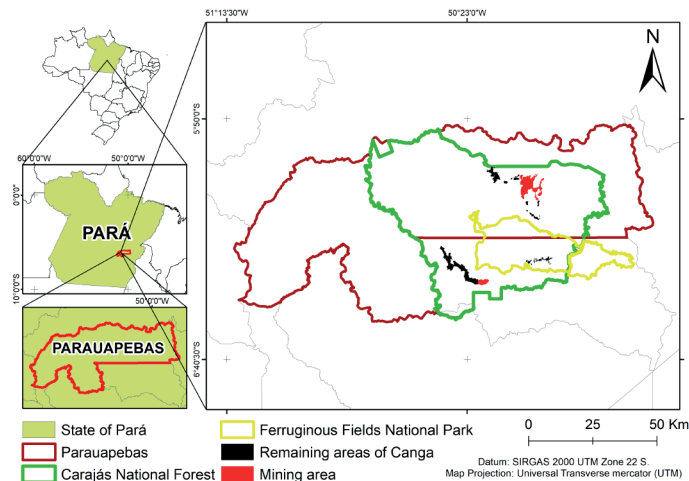


Figure 1. Location of the Carajás mineral province, formed by the Carajás National Forest and Ferruginous Field National Park, in a mountain complex known as ‘Serra dos Carajás’, which is no more than 860 meters above sea level. The region is mostly found in the municipality of Paraúapebas, in the state of Pará, in the Eastern Amazon region of Brazil. Detail of the flower and leaves, in their natural habitat in the ‘Serra dos Carajás’, emerging from the dotted circle the only remnants of the Canga area, in the world, in which *Ipomoea cavalcantei* occurs naturally.

The number of mites was not counted, however, it was found through observation of the fully expanded leaves of all *I. cavalcantei* plants in the nursery and garden, that these mites start in small numbers of individuals from the beginning of the dry season (April). The mite population, as well as the symptoms on the leaves, grows visibly as the months of low precipitation, relative humidity and high temperatures (maximums above 38 °C daily) progress. Visibly, the peak of symptoms and abundance of mites on leaves occurred between the months of August and September. In all observations, to confirm whether tetranychid mites were, in fact, associated with the symptoms, some leaves with similar symptoms were taken to the laboratory and examined under a stereomicroscope.

The leaves of the plant had light green spots, initially small and punctual. As the symptoms intensified, these spots coalesced, evolving into larger and yellowish spots. The edges of the leaves also wilted (Fig. 2). These symptoms are characteristic of mite attacks from the Tetranychidae family, which cause spots by removing cellular contents (Huffaker et al. 1969). Although symptoms of whiteflies, thrips and defoliating insects were observed, mites were considered the main causes of damage to plants, as they were in much greater numbers and on all expanded leaves of plants, in all observations. Pest attack symptoms were present on 98,6% of the leaves of seedlings grown in the UFRA greenhouse. The mites were identified as *Tetranychus ludeni* Zacher, 1913 (Fig. 2).

Tetranychid mites are among the most important crop pests worldwide. *Tetranychus* is a genus of tetranychid mites that gathers important pests of many agricultural crops species (Migeon et al. 2010; Flechtmann & Moraes 2017). *Tetranychus ludeni* is widely spread throughout Brazil, where it has been found in 12 states and the Federal District (Flechtmann & Moraes 2017). This is the second record of *T. ludeni* in the state of Pará. Until now, seven other tetranychid mites have already been recorded in the state of Pará: *Oligonychus mangiferus* (Rahman & Saprà, 1940), *Oligonychus pratensis* (Banks, 1912), *Tetranychus desertorum* Banks, 1900, *Tetranychus marianae*

McGregor, 1950, *Tetranychus mexicanus* (McGregor, 1950), *Tetranychus palmarum* Flechtmann & Noronha, 2011 and one unidentified species of *Tetranychus* (Flechtmann & Moraes 2017; Noronha et al. 2021).

Tetranychus ludeni is polyphagous, having been associated with plants from 23 botanical families in Brazil, mainly Asteraceae and Fabaceae plants (Flechtmann & Moraes 2017). Additionally, *T. ludeni* has been found in ten different species of Convolvulaceae, all of them belonging to the genus *Ipomoea* L. (Flechtmann & Moraes 2017). Therefore, *I. cavalcantei* is the 11th Convolvulaceae host species identified for *T. ludeni*.

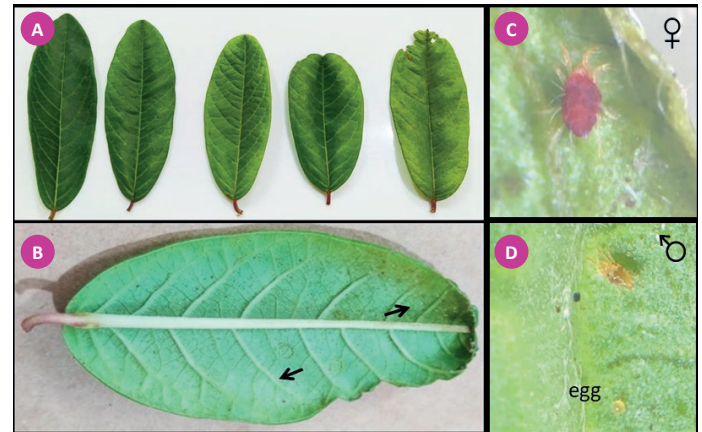


Figure 2. Symptoms of *Tetranychus ludeni* on the leaves of *Ipomoea cavalcantei* and details of female, male and egg of *Tetranychus ludeni* on leaves of this plant. (A) The first leaf on the left is a healthy specimen, while on the right side of this page are the evolution (from right to left) of the symptoms of the mite attack on the adaxial face of the leaves; (B) presence of mites, webs, exuvia and symptoms on the abaxial face (pointed by arrows); Details of a female (C), a male and an egg (D) of *T. ludeni* on leaf discs of *I. cavalcantei*.

Tetranychus ludeni has the potential to become an important pest in hot climate regions with an average temperature of around 30 °C. This is in comparison to *Tetranychus urticae* (Koch, 1936) (Tetranychidae), which is a cosmopolitan and polyphagous species and is one of the most well-known and important spider mites (Gotoh et al. 2015). In highly temperature (30 °C) *T. ludeni* accelerates its development and is highly flexible and adaptive to significant changes in average ambient temperatures over generations (Ristyadi et al. 2021). *Tetranychus ludeni* has been observed causing significant damage to *Ipomoea batatas* (L.) Lam. (Soares et al. 2012; Castro et al. 2019) and *Gossypium hirsutum* L. (Malvaceae) (Silva 2002; Moraes & Flechtmann 2008; Valadares et al. 2021). In the multi-diverse Brazilian Amazon, *T. ludeni* has only been found on *Tithonia diversifolia* (Hemsl.) A. Gray. (Asteraceae) in the state of Amazonas (unpublished data from the doctoral thesis by Vasconcelos, G. J. N., completed in 2011), on *Citrullus lanatus* (Thumb.) Matsum. & Nakai (Cucurbitaceae), in the state of Roraima (Mendonça et al. 2011) and on *Vigna unguiculata* (L.), in the state of Pará (Noronha et al. 2019). This work is the first record of phytophagous attacking *I. cavalcantei* plants.

This study highlights *T. ludeni* as a potential threat to the *ex situ* conservation efforts for protecting *I. cavalcantei* from extinction. The next step is to study the biological life cycle of *T. ludeni* on *I. cavalcantei* and confirm it as a pest. This information can help develop strategies for plant management and pest control in nurseries. Additionally, further studies should be conducted to explore the mite fauna associated with *I. cavalcantei* in its natural habitat and identify predatory mites that could potentially provide natural biological control of *T. ludeni*.

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Authors' Contributions

NCGX: Conceptualization, Investigation, Visualization, Data Curation, Writing - Original Draft, Review & Editing. MCS: Investigation, Visualization, Writing - Review & Editing. JDAL: Investigation, Visualization, Writing - Original Draft, Review & Editing. **ÁIAFS**: Visualization, Writing - Original Draft, Review & Editing. LT: Writing - Original Draft, Review & Editing. WBW and NJF: Validation, Writing - Original Draft, Review & Editing. WPC: Term, Conceptualization, Methodology, Investigation, Resources, Writing - Original Draft, Review & Editing, Visualization, Supervision, Project administration.

Conflict of Interest Statement

The authors declare that there is no conflict of interest.

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