

Exotic and predatory: a spider (Araneae: Salticidae) that preys on native stingless bees (Hymenoptera: Meliponini) in Brazil

Exótica y depredadora: una araña (Araneae: Salticidae) que se alimenta de abejas nativas sin aguijón (Hymenoptera: Meliponini) en Brasil

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Abstract. Pollination is a fundamental ecosystem service for the natural balance. Bees are the main biological agents for carrying out this service. It is known that the excessive simplification process of the landscape through anthropic action hinders the establishment of more sensitive species and favors generalist, exotic and invasive species. Thus, urbanization is a process that threatens native species. Thus, it is essential to understand the impact of this relationship, since it can foster tools that make cities more pleasant environments for pollinators. The aim of this study was to record the predation of a eusocial stingless bee species by an invasive exotic spider. Understanding this relationship is important from an environmental and economic point of view, since the preyed species is a potential pollinator of agricultural crops, and its rational breeding is widespread in Brazil.

Key words: Apidae; Arachnida; *Menemerus*; *Nannotrigona*; predation.

Resumen. La polinización es un servicio ecosistémico fundamental para el equilibrio natural. Las abejas son el principal agente biológico para la realización de este servicio. Se sabe que el excesivo proceso de simplificación del paisaje mediante la acción antrópica dificulta el establecimiento de especies más sensibles y favorece a las generalistas, exóticas e invasoras. Así, la urbanización es un proceso que amenaza a las especies nativas. Por tanto, es fundamental comprender el impacto de esta relación, ya que puede fomentar herramientas que hagan de las ciudades entornos más agradables para los polinizadores. El objetivo de este trabajo fue registrar la depredación de una especie de abeja eusocial sin aguijón por parte de una araña exótica invasora. Comprender esta relación es importante desde el punto de vista ambiental y económico, ya que la especie presa es un potencial polinizador de cultivos agrícolas y su cría racional está muy extendida en Brasil.

Palabras clave: Apidae; Arachnida; *Menemerus*; *Nannotrigona*; predación.

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Pollination is undoubtedly a fundamental ecosystem service for the maintenance and balance of both natural and managed ecosystems, with bees acting as the main biotic agent that performs this service (Klein *et al.* 2007; Kremen *et al.* 2007; Aizen *et al.* 2009; Potts *et al.* 2010, 2016; Bulhoes *et al.* 2021). However, due to anthropic actions, populations of this important group of insects have been reported as being in sharp decline on a global scale (Fortel *et al.* 2014; Potts *et al.* 2010, 2016; Bulhoes *et al.* 2021). Habitat fragmentation, including fragmentation generated by urbanization, is considered to be one of the anthropogenic impacts that is contributing to this decline (Fortel *et al.* 2014; Bulhoes *et al.* 2021).

Urbanization causes the excessive simplification of the natural landscape, resulting in a predominance of impermeable spaces and buildings. As such, this type of landscape makes it difficult and/or unfeasible to establish more sensitive native species and may sometimes favor the presence and prevalence of generalist species, as well as the establishment of exotic species. This is especially true for species that present predatory potential, due to the increase in the synanthropic fauna that act as food items, causing these species to become invasive (Fuller *et al.* 1999; McKinney 2006; Shochat *et al.* 2010). The interspecific interactions between native and exotic species (*e.g.*, competition, herbivory, parasitism, disease transmission and predation) can result in numerous negative consequences for native species (Fuller *et al.* 1999; Espínola and Júlio-Junior 2007), including, local extinctions (Davies 2009), mainly in urban environments where populations are already small and fragmented.

The groups involved have the following specific richness, where the Salticidae family has 670 described species (Pupin and Brescovit 2023), while the Meliponini tribe currently has 259 described species (Nogueira 2023). Thus, the advance of urbanization can, unequivocally, be considered as a potential threat to the conservation of native species, especially for bee species (Hymenoptera: Anthophila). This biological group, including both adults and offspring, depends of vegetation to collect food and to build their nests.

As such, it is extremely important to identify the impacts that exotic fauna has on native fauna, since this information can serve as a basis for the elaboration of public policies that aim to make cities more friendly with pollinating insects. Thus, the present paper aims to report the first record of predation of a eusocial stingless bee, native to Brazil (Apidae: Meliponini), by an invasive exotic spider species (Araneae: Salticidae).

The registration took place on July 1, 2023, in a highly anthropized public area in the Pituba neighborhood, in the municipality of Salvador, Bahia, Brazil (UTM X-558.237/Y-8.562.558) (Fig. 1). A nest of eusocial stingless bees (Meliponini tribe) belonging to the genus *Nannotrigona* Cockerell, housed in the cavity of a PVC pipe (Polyvinylchloride), installed on a wall, was identified (Fig. 2A). During this event, we observed a spider Salticidae near the PVC pipe, moving towards the nest, where sentinel bees were found (Figs. 2B, 2C). The spider approached the upper part of the tubular entrance to the nest, but soon positioned itself in the lower part, where it lay in wait to capture the sentinel workers guarding the entrance to the nest (Figs. 2D, 2E). Following the successful predation event, 17 bees were collected and identified by RLR and FFO as belonging to the species *Nannotrigona* (*Nannotrigona*) *testaceicornis* (Lepelletier, 1836) and deposited in the Entomological Collection of the Zoology Sector of the Museu de História Natural da Bahia (MHNBA-Zoo/UFBA), under voucher numbers MHNBA-Hymeno 15504 to 15520. The Salticidae was later identified as a female of the species *Menemerus bivittatus* (Dufour, 1831), by ADB through high-resolution microphotographs.

Nannotrigona (*Nannotrigona*) *testaceicornis* (Lepelletier, 1836), popularly known as Iraí, is a Meliponini species native to Brazil, also occurring in Argentina and Paraguay (Rasmussen and Gonzalez 2017). According to Rasmussen and Gonzalez (2017), workers of this species are morphologically characterized by the following set of characters: mesoscutum and scutellum densely and grossly pitted; antennal scape with short, erect bristles, no more

than 0.3 times the diameter of the scape; ocellular area, with scattered and larger punctuations than on the frons (Fig. 3D in Rasmussen and Gonzalez 2017); clypeus with minute and coarse punctuations (Fig. 3E in Rasmussen and Gonzalez 2017); light reddish-brown antennal flagellum (Fig. 7I in Rasmussen and Gonzalez 2017).

This species has generalist characteristics regarding nesting site preference, as it is able to use natural structures, such as tree hollows, or pre-existing cavities present in buildings, such as crevices in masonry structures, to construct their nests. Consequently, it has been allocated the status of pollinator of both native and exotic plants, in both agricultural in urban areas (Klein *et al.* 2007; Vasques *et al.* 2023).

Menemerus bivittatus (Dufour, 1831) is a species of jumping spider from the Salticidae family and is native to Africa (Wesołowska 1999). It presents a cosmopolitan distribution (Wesołowska 1999; Pupin and Brescovit 2023) and is always associated with highly disturbed environments, often found in man-made structures (anthropized environments) (Wesołowska 1999; Edwards 2000; Pupin and Brescovit 2023). In the Americas, where it is considered an exotic invasive species, this species occurs from the southern United States to southern South America (Edwards 2000; Pupin and Brescovit 2023).



Figure 1. Location map of the natural nest of *Nannotrigona (Nannotrigona) testceicornis* (Lepeletier, 1836), in the neighborhood of Pituba, Salvador, Bahia, Brazil. / Mapa de ubicación del nido natural de *Nannotrigona (Nannotrigona) testceicornis* (Lepeletier, 1836), en el barrio de Pituba, Salvador, Bahia, Brasil.

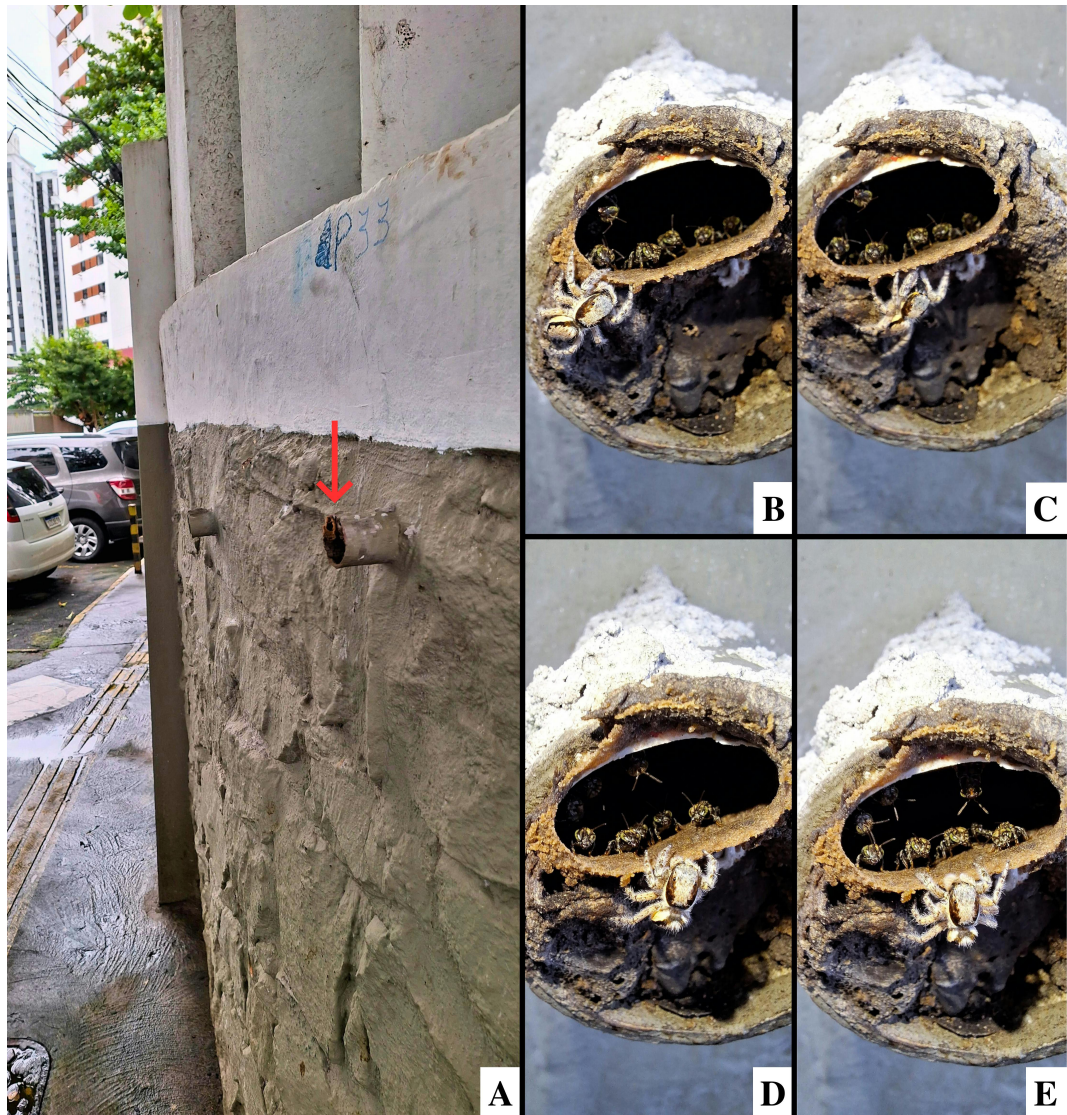


Figure 2. A. Nest in PVC pipe. B, C, D, E. *Menemerus bivittatus* (Dufour, 1831) on the move to prey on the sentinels of *Nannotrigona* (*Nannotrigona*) *testceicornis* (Lepeletier, 1836). / A. Nido en tubo de PVC. B, C, D, E. *Menemerus bivittatus* (Dufour, 1831) en movimiento para aprovecharse de los centinelas de *Nannotrigona* (*Nannotrigona*) *testceicornis* (Lepeletier, 1836).

According to Edwards (2000), when alive, the females of this species are morphologically characterized by the following set of characters: gray coloration dorsally; carapace bordered by a thin white band laterally; gray semifoliate abdomen, bordered by wide black bands on each side that meet posteriorly; orange clypeus (Fig. 2 in Edwards 2000). When in alcohol, reddish-brown bristles can be seen in the gray areas, particularly on the abdomen.

The prey-predator trophic relationship between spiders and bees is well documented in the scientific literature, especially for spiders that employ the sit-and-wait strategy (*e.g.*, family Thomisidae), capturing bees while they forage on flowers (Dukas and Morse 2003; Novo *et al.* 2009; Rocha-Filho and Rinaldi 2011), or are captured through webs (Craig 1994; Rao 2010; Ximenes and Gawryszewski 2019). However, Salticidae are predatory insects that actively seek their food and do not build webs (Edwards 2000). There is already one report in the

literature of Meliponini bee predation by *M. bivittatus* [*Hypotrigona gribodoi* (Magretti 1884)] in Gambia (Africa), a region where this species of spider is native (Penney and Gabriel 2009). Additionally, *M. bivittatus* individuals have been commonly observed wandering near nest entrances of other stingless bees in Africa (Penney and Gabriel 2009), but direct predation of Meliponini by this species outside its natural range has never been reported except only on flies (Insecta: Diptera) (Edwards 2000; Penney and Gabriel 2009). Therefore, the present research provides an unprecedented record of *M. bivittatus* preying on a specimen of *N. (N.) testaceicornis*, serving as an additional report on the dangers of invasive fauna pressuring the conservation of native bee fauna, especially in urban areas. Furthermore, our observations corroborate the premises of Penney and Gabriel (2009), who state that *M. bivittatus* individuals actively seek out Meliponini bees in their nests for predation. Finally, we present evidence of the direct impact of invasive alien species on native biodiversity residing in cities.

The species *N. (N.) testaceicornis* is widely used in Meliponiculture, and when managed correctly can provide enormous benefits, both for the beekeepers through the production of honey, pollen, and propolis, and for ecosystems due to its function as a pollinator of native and cultivated plants. Furthermore, due to its “good” ability to adapt to urbanization, it is considered an excellent pollinator of predominantly urban landscapes (Lima dos Santos *et al.* 2021). However, interspecific interactions with invasive exotic spider species can be disharmonious, given the expansive capacity of invasive species, such as *M. bivittatus*, and their inherent ability to colonize areas with high levels of anthropization.

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