



Occurrence of *Pheidole tijucana* Borgmeier, 1927 (Hymenoptera, Formicidae) in the state of São Paulo, Brazil

DÉBORA CRISTINA DE OLIVEIRA GONÇALVES¹, LÍVIA PIRES DO PRADO², FABRÍCIO SEVERO MAGALHÃES¹, MARLINA RIBEIRO ABONIZIO-SANTOS¹, MARIA SANTINA DE CASTRO MORINI^{1*}

¹ Laboratório de Mirmecologia do Alto Tietê, Núcleo de Ciências Ambientais, Núcleo de Ciências Ambientais, Universidade Mogi das Cruzes, Mogi das Cruzes, SP, Brazil • DCOG: debora_cog@outlook.com <https://orcid.org/0000-0002-3739-9786> • FSM: fabricio-severo.fa@gmail.com <https://orcid.org/0000-0002-7173-658X> • MRAS: marlinaribeiro@live.com <https://orcid.org/0000-0002-6637-7236> • MSCM: mrcmorini@gmail.com <https://orcid.org/0000-0002-1823-6703>

² Laboratório de Hymenoptera, Museu de Zoologia da Universidade de São Paulo, São Paulo, SP, Brazil • livia.pires7@gmail.com <https://orcid.org/0000-0003-1819-8767>

* Corresponding author

Abstract. *Pheidole* Westwood, 1839 is a hyperdiverse ant genus that is widely distributed in a variety of terrestrial ecosystems, especially in the tropics. The identification of *Pheidole* species is challenging, thus contributing to the description of several questionable morphospecies in the literature and making the geographic distribution of most species uncertain. In this work, we present the first records of *Pheidole tijucana* Borgmeier, 1927 from the state of São Paulo, Brazil. The specimens were recorded at Parque Ibirapuera Conservação, an urban green area located in the southern part of the city of São Paulo. The sampling was performed in 2015, 2016, and 2017 using pitfall traps. In total, 224 specimens (one major worker and 223 minor workers) of *P. tijucana* were recorded. Our new data help fill a distribution gap and highlights the importance of reporting species that are a challenge to identify.

Keywords. Atlantic Forest, biodiversity, Myrmicinae, urban green area, urban park

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Introduction

Pheidole Westwood, 1839 (Myrmicinae) is a hyperdiverse ant genus with more than 1,000 valid species and subspecies, which are widely distributed around the world. In the Americas, *Pheidole* is the richest genus of Myrmicinae (Kempf 1972; Wilson 1976), having been recorded in the most varied environmental conditions and habitats (Economato 2015), in disturbed (Ješovnik and Bujan 2021), preserved (Jahan 2022), and regenerating areas (Aguilar 2022). Around 700 species are found in the Neotropical Region, 200 of which occur in Brazil and 60 of which occur in the state of São Paulo (Janicki et al. 2016).

Pheidole species display morphological and behav-

ioral traits that enabled a great adaptive success (i.e., the division of labor in two morphologically distinct castes; loss of a functional sting; the complete absence of ovaries in the worker castes) (Hölldobler and Wilson 1990; Wilson 2003). Nesting and foraging occur mainly in deeper soil layers, or above or between the interstices of the leaf litter (Delabie et al. 2000; Casadei-Ferreira 2021). In the leaf litter, *Pheidole* may occupy fruits, seeds, and wood in varying degrees of decomposition (Castaño-Menzes et al. 2015; Casadei-Ferreira 2021), and the latter includes twigs (Fernandes et al. 2019). Barroso et al. (2020) and Almeida et al. (2021) suggested that the occupation of twigs by species of *Pheidole* could be due to a process of selection.

Pheidole tijucana Borgmeier, 1927 belongs to the

fallax group (Wilson 2003), although its biology remains unknown. The species was described in 1927 by Borgmeier, based on 15 major workers and 12 minor workers collected by him in Tijuca, a neighborhood in the city of Rio de Janeiro (Rio de Janeiro state, Brazil). Many decades later, this species was again recorded, this time from the state of Bahia (Santos et al. 2017), in remnants of the Atlantic Forest at different regeneration stages; Santos et al. used pitfall traps and Winkler extractors to collect the specimens. Although São Paulo is one of the Brazilian states best-sampled for its ant fauna, no other records of *P. tijuana* have been recorded since, even in the recent updates on the Atlantic Forest species (Feitosa et al. 2021; Silva et al. 2022). Given the scarcity of information on *P. tijuana*, we report the first records of this species from the state of São Paulo.

Methods

The specimens were collected in an urban green area, Parque Ibirapuera Conservação, which is in the city of São Paulo. The park is within the Brazilian Atlantic Forest domain (Ribeiro et al. 2009); it has an area of 1,584 m² and is composed of mixed woodland with *Eucalyptus* and other exotic species, as well as native species. There are flower beds, lawns, and theme gardens on site, with a total of 532 species of vascular plants, including trees, shrubs, and herbaceous plants. The climate is humid subtropical, characterized by a notoriously dry winter and a rainy summer; temperatures

vary between 12 °C during the winter and 28 °C during the summer (annual average temperature 20.3 °C).

Our expeditions to collect specimens were carried out in the summers and winters of 2015, 2016, and 2017 in four areas of the park (Fig. 1). Ants were collected with pitfall traps containing 500 mL of preserving liquid (70% ethanol and 10% formaldehyde); the traps were buried at ground level. In total, 100 pitfall traps were used, with each area having 25 traps. Each trap was placed 3 m away from the next closest trap. The traps remained on site for eight days.

The genus was identified using the key by Baccaro et al. (2015). The species identification used the keys by Wilson (2003). The specimens collected were also compared to the type specimens of *P. tijuana*, which are deposited at Coleção de Hymenoptera of the Museu de Zoologia da Universidade de São Paulo (MZSP). The vouchers were also deposited at MZSP (individually as MZSP67490, MZSP67491, MZSP67492, and MZSP95643) and at the Laboratório de Mirmecologia do Alto Tietê da Universidade de Mogi das Cruzes (LAMAT) (Souza-Campana et al. 2020).

Results

Pheidole tijuana Borgmeier, 1927

Figures 2, 3

New records. BRAZIL – SÃO PAULO • São Paulo, Parque Ibirapuera Conservação; 23°35'38"N, 046°39'52"W;

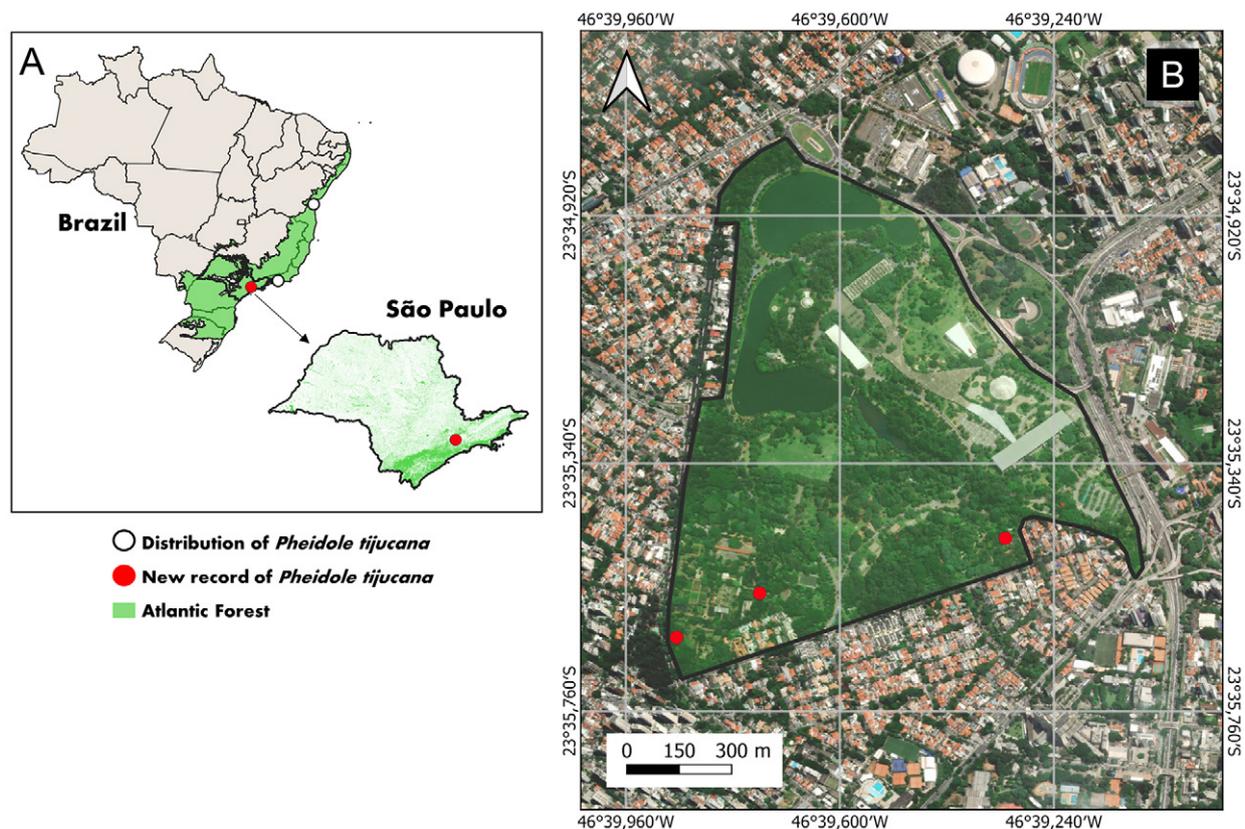


Figure 1. Geographic location of the areas of occurrence of *Pheidole tijuana* in the Brazilian Atlantic Forest. **A.** Study site, São Paulo, Brazil. **B.** Parque Ibirapuera Conservação, in the city of São Paulo.

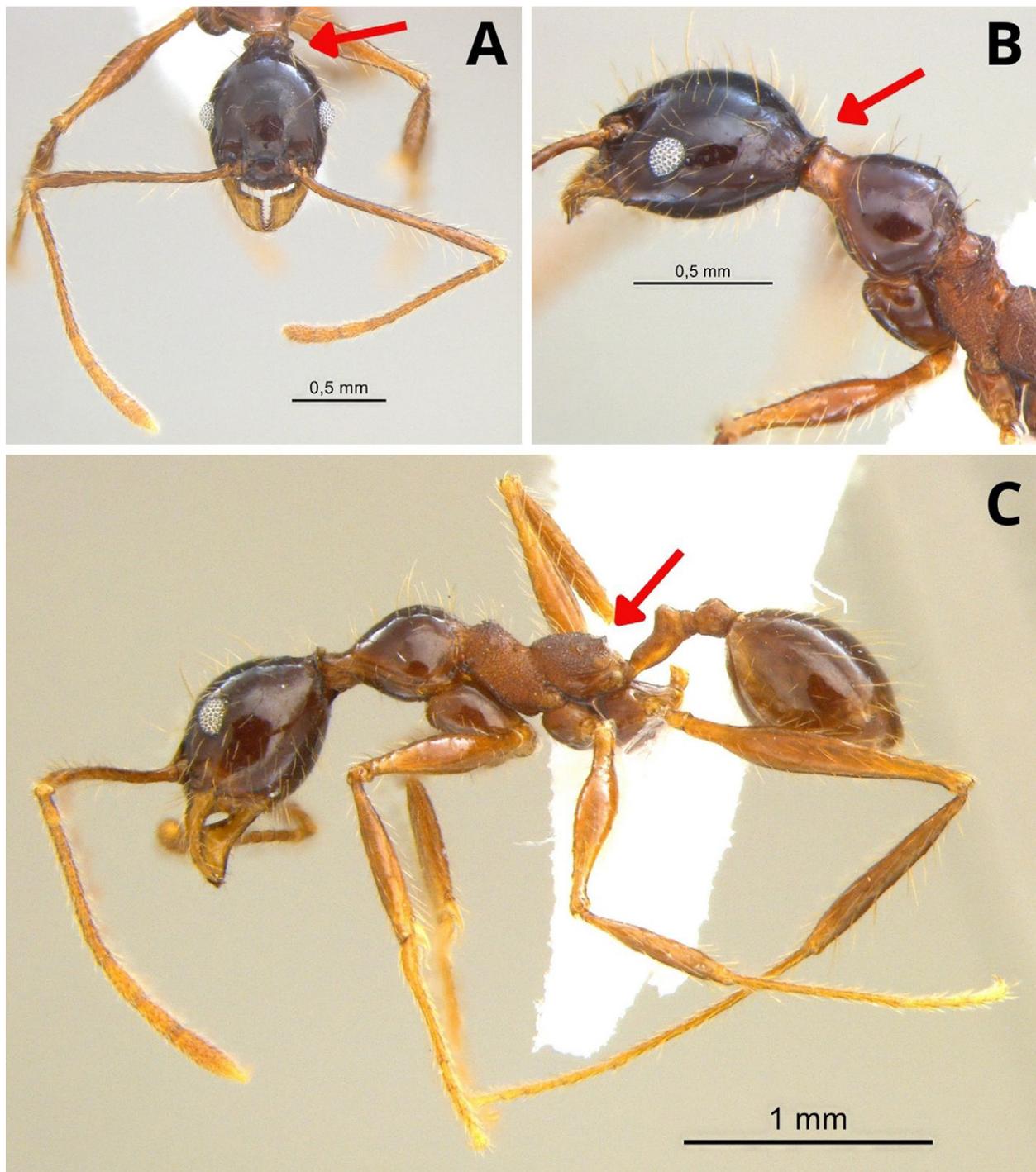


Figure 2. Minor worker of *Pheidole tijucana*. **A.** Head in frontal view. **B.** Latero-dorsal view. **C.** Lateral view.

761 alt.; 29.V.2015; R. Bertani col. leg.; pitfall; 56♀, MZSP; 1 major worker, MZSP95643 • same data, except 23°35'33"N, 046°39'44"W; 757 alt.; 22.V.2015; R Bertani col. leg.; pitfall; 4♀, LAMAT • same data, except 23°35'38"N, 046°39'52"W; 761 alt.; 29.I.2016; R. Bertani col. leg.; pitfall; 108 minor workers, LAMAT; 1♀, MZSP67490; 1 minor worker, MZSP67491; 1 minor worker, MZSP67492 • same data, except 23°35'33"N, 046°39'44"W; 757 alt.; 29.I.2016; R Bertani col. leg.; pitfall; 13 minor workers, LAMAT • same data, except 23°35'28"N, 046°39'19"W; 765 alt.; 29.I.2016; R Bertani col. leg.; pitfall; 1 minor workers, LAMAT • same data, except 23°35'38"N, 046°39'52"W; 761 alt.; 14.IX.2016;

R. Bertani col. leg.; pitfall; 16 minor workers, LAMAT • same data, except 23°35'38"N, 046°39'52"W; 761 alt.; 14.II.2017; R Bertani col. leg.; pitfall; 19 minor workers, LAMAT • same data, except 23°35'33"N, 046°39'44"W; 757 alt.; 14.II.2017; R Bertani col. leg.; pitfall; 1 minor worker, LAMAT • same data, except 23°35'28"N, 046°39'19"W; 765 alt.; 14.II.2017, R Bertani col. leg.; pitfall; 2 minor worker, LAMAT.

Total number of specimens: 223 minor workers and 1 major worker.

Identification. As reported by Wilson (2003), the minor worker of *P. tijucana* can be identified according to

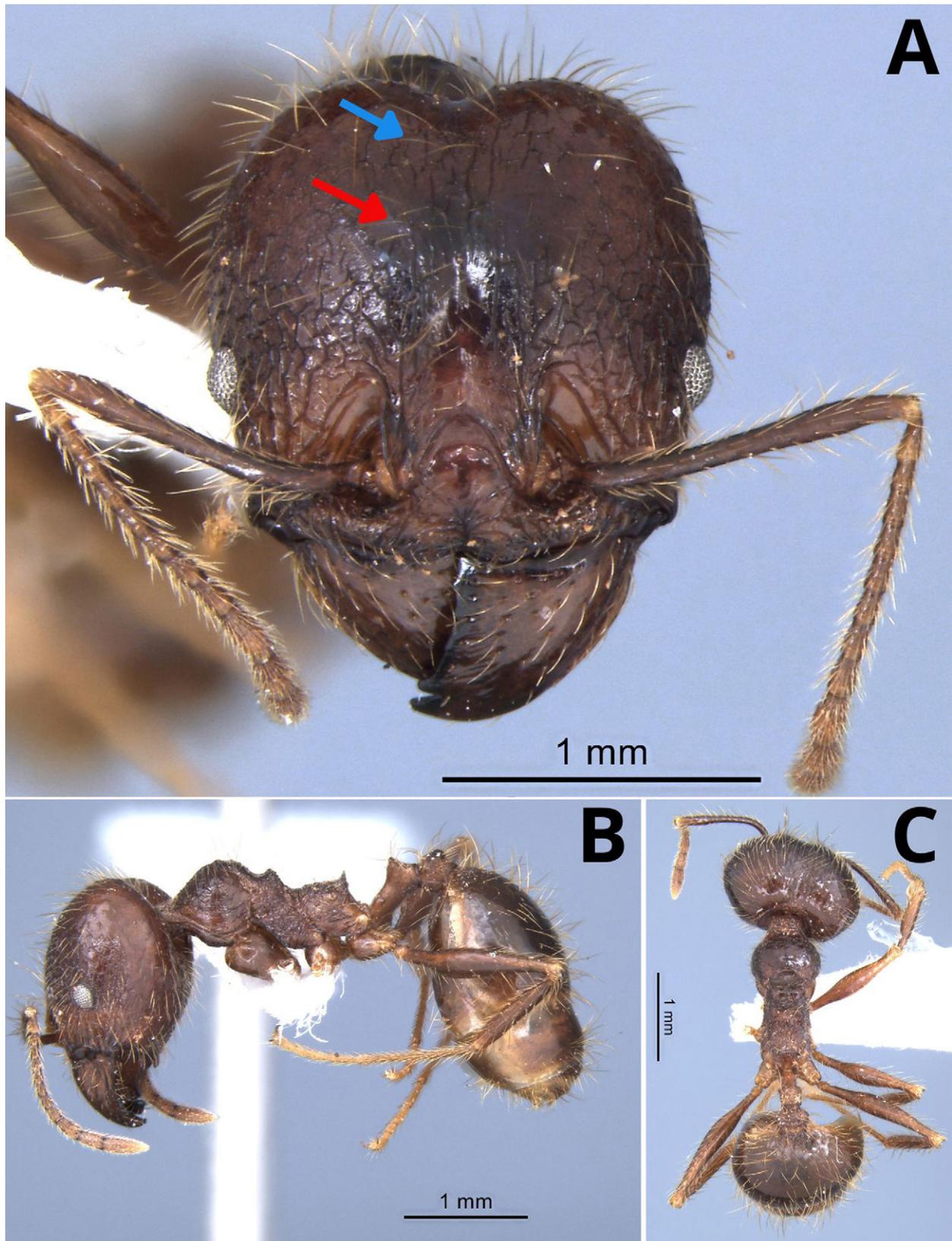


Figure 3. Major worker of *Pheidole tijucana*. **A.** Head in frontal view. **B.** Lateral view. **C.** Dorsal view.

the morphological characteristics of the fallax species group; also, it is distinct from all other species in this group because of the following characteristics: occiput constricted to the neck with a broad nuchal collar (Fig. 2A, B), propodeal spines reduced to denticles (Fig. 2C), and light brown, except for the head, which is a darker,

reddish shade (Fig. 2). The major worker (Fig. 3A–C), as reported by Wilson (2003), is morphologically similar to *Pheidole lucretii* Wilson 2003. However, the two species are distinguished mainly by the sculpture on the surface of the head. In *P. tijucana* most of the occiput vertex and frontal lobes are smooth and shiny (Fig.

3A, red arrow), with a presence of short longitudinal carinulae around midline at the occiput (Fig. 3A, blue arrow), whereas in *P. lucreti* the same region of the head is superficially rugoreticulate.

Discussion

Pheidole tijucana was found in an urban green area inserted in the Brazilian Atlantic Forest domain. Our results, as for all previous records of this species (Borgmeier 1927; Santos et al. 2017), suggest that it inhabits dense tropical rainforests. The Atlantic Forest consists of a mosaic of vegetation with distinct forests. One of them is the dense rainforest, which is characterized by very high humidity, high temperatures (average of 25 °C), and high precipitation well distributed throughout the year (0–60 dry days); vegetation is composed of phanerophytes, lianas, and epiphytes (IBGE 2012). This phytophysiognomy presents a wide diversity of ants (Feitosa et al. 2021; Silva et al. 2022), given that in 1 m² of leaf litter it is possible to find up to 35 species (Silva and Brandão 2010).

Since the description of *P. tijucana*, many surveys of leaf litter have been carried out in the Brazilian Atlantic Forest (i.e., Delabie et al. 2007; Pacheco et al. 2009; Suguituru et al. 2011, 2013; Silva et al. 2022), including in wood structures that are colonized by species of *Pheidole* (Souza et al. 2012; Fernandes et al. 2019, 2020). Moreover, several surveys have also been made in urban areas of Brazil (Bueno et al. 2017), and *P. tijucana* has not been recorded in any of them. The scarcity of records for *P. tijucana* may indicate that the species is not abundant and has a more limited distribution. However, the low taxonomic resolution of hyperdiverse genera such as *Pheidole* should be taken into consideration (Kempff 1961; Silva et al. 2022). Colonies of the *Pheidole* species typically have hundreds to thousands of workers (minor and major), but here we sampled only one major worker in our sampling, which may reflect the collection method used. In general, minor workers are usually responsible for foraging, while major workers remain mainly inside the nest (e.g., Wetterer, 2007). Thus, it is possible that the species was simply not identified in the above-mentioned checklists, and that its distribution and abundance are actually higher than what is now thought.

The lack of knowledge on the distribution and biology of insect species is alarming, mainly in face of the decline in the populations of these invertebrates (Sánchez-Bayo and Wyckhuys 2019; Wagner 2020). Unfortunately, our comprehension of tropical biodiversity is still severely limited by significant deficiencies in our knowledge of the taxonomy and distribution of species (Hortal et al. 2015). Hence, the occurrence record of *P. tijucana* in the state of São Paulo, in an urban area of a huge metropolis is quite surprising, and it opens new possibilities for the study of its biology.

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Author Contributions

Conceptualization: DCOG, LPP, MSCM. Data curation: DCOG, FSM, MRAS. Formal analysis: DCOG, LPP. Investigation: DCOG, FSM, MRAS, MSCM, LPP. Methodology: LPP. Project administration: DCOG. Supervision: MSCM. Writing – original draft: DCOG. Writing – review and editing: DCOG, FSM, MRAS, MSCM, LPP.

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Data Resources

The data underpinning the analysis reported in this paper are deposited in the Global Biodiversity Information Facility and are available at <https://doi.org/10.15468/rv7tdk>.