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Scientific Note

First report of the invasive species and potential pest *Zaprionus tuberculatus* Malloch, 1932 (Diptera, Drosophilidae) in Pará, Brazil

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Abstract. This paper reports the first occurrence of the potential pest *Zaprionus tuberculatus* Malloch, 1932 (Diptera, Drosophilidae) in the municipality of Belém, Pará, Brazil, specifically in the Amazon region at the vicinity of the Museu Paraense Emílio Goeldi. This report is crucial for collecting data on the geographic distribution and population growth of this invasive species, which will aid in the development of strategies for pest management programs. Furthermore, new points records for the invasive species in Brasília are presented for the first time, extending the spread of *Z. tuberculatus* across Brazil.

Keywords: Amazon, Drosophilid, non-native insects, pest management.

Globalization and climate change are driving the spread of non-native insects, which may be harmful to humans, agriculture and the environment (Geisca 2013). The Drosophilidae family has a long history of invasions due to factors such as their biology (high fecundity, mating behavior, short generation time, polyphagy), their ability to adapt to changing environments (Rota-Stabelli et al. 2013), the global fruit trade (Commar et al. 2012) and possibly climate change (Kremmer et al. 2017). Three invasive pests have already been reported in Brazilian environments: *Drosophila suzukii* (Matsumura, 1921) (Deprá et al. 2014), the African fig fly *Zaprionus indianus* Gupta, 1970 (De Toni et al. 2001), and more recently *Zaprionus tuberculatus* Malloch, 1932 (Cavalcanti et al. 2022).

Described by Malloch (1932), *Z. tuberculatus*, a species native to the Afrotropical region, was first observed breeding on figs in its native habitat (Yassin et al. 2008). In Brazil, *Z. tuberculatus* was reported for the first time in 2020, in urban parks and preserved fragments of the Cerrado biome, located in Brasília (Federal Capital of Brazil) (Cavalcanti et al. 2022). Subsequently, cases were reported in five other states: São Paulo (Mateus & Machado 2022; Montes & Vilela 2022), Rio de Janeiro (Faria & Bitner-Mathé 2023), Rio Grande do Sul (Jobim et al. 2023), Santa Catarina (Dos Santos et al. 2023), Minas Gerais (Moreira et al. 2023), and Paraíba (Ribeiro et al. 2024).

During a recent visit to study the Drosophilidae collection at the Museu Paraense Emílio Goeldi (MPEG), the first author collected a series of *Z. tuberculatus* specimens near MPEG's Research Campus, marking the first record of this invasive species in the Amazon biome. The results include a new report on the species, a distribution map of all examined records (including specimens listed in TaxoDros database), and additional records of *Z. tuberculatus* in Brasília, DF, Brazil based on observations published on the iNaturalist platform (iNaturalist 2024).

The presence of the invasive pest *Z. tuberculatus* in the municipality of Belém, Pará, Brazil, is reported for the first time at the Amazon biome, specifically around the Museu Paraense Emílio Goeldi (-1.452365, -48.476832). Three adult female of *Z. tuberculatus* (Fig. 1) were collected flying around decaying *Carica papaya* L. (Caricaceae) fruits. The collection took place throughout May 2024 and the specimens were stored in vials containing 70% alcohol (voucher number MZ053543).

Female adults were identified based on external morphology following the original description presented by Malloch (1932). Morphological descriptive terminology follows Cumming & Wood (2017). For photography, specimens were mounted on entomological pins after a drying process, which involved three steps: i) the specimens were then dried on paper towels, with their wings and positions arranged for mounting; ii) they were then bathed in amyl acetate (ISO) for about 20 seconds (Ando et al. 1998); iii) the specimens were pinned and before they hardened completely, their wings were adjusted again. Finally, the pinned specimens were deposited in the Diptera Collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP).

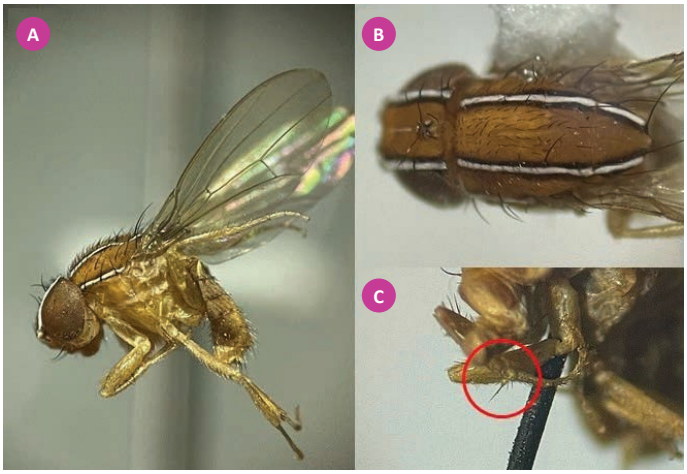

Figure 1. Female specimen of *Zaprionus tuberculatus* Malloch, 1932. A) Habitus, lateral view; B) Head and thorax, dorsal view; C) Fore left leg with a red circlet highlighting the spur on a prominent tubercle on the medioventral surface of the anterior femur, a characteristic that differentiates it from other species of this genus. Scale bars = 0.5 mm.

The specimen was photographed using an Olympus CL 6000 stereomicroscope at 4x and 10x magnifications. Photographs of different focal planes of the same structure were stacked and combined using Helicon Focus software. The details of the examined specimens are listed as follows: the name of the country written in capital letters, followed by the state in verselet letters and acronym of state (in brackets); the name of the city underlined, any additional

Museum locality and coordinates (in brackets); the date of collection, the methods of collection and the name of the collector; the number of females followed by the voucher museum number(s) of the specimen(s) (in brackets).

A distribution map was created in QGIS Las Palmas ver. 2.18.10 software (QGIS Development Team 2016) displaying all previously known records of *Z. tuberculatus* in Brazil, including the new Amazonian record presented in this study. To construct the map, we used specimen data from labels in the TaxoDros database (Bächli 2024) (Tab. 1), supplemented by iNaturalist (2024). We limited ourselves to including only landmarks on iNaturalist that had photographs where we could accurately identify the species.

Thus, individuals recorded in iNaturalist are treated as specimens from collections, with each observation number (i.e., the platform's link, e.g., www.inaturalist.org/observations) serving as the specimen record number. These records, which are still unknown to science, are not available in TaxoDros (Fig. 2).

Examined Material. BRAZIL: Pará [PA], Belém, [Museu Paraense Emílio Goeldi, coordinates -1.452365, -48.476832] 03.V.2024Method: active collection, Mendes M.F. col. three females. Voucher number MZ053543.

Records from iNaturalist. BRAZIL: Distrito Federal: Brasília, DF [Av. Central - Condomínio Privê, Rua 4, Módulo 8, Lote 1B - Ceilândia, Brasília, Brasil] -15.78387, -48.13910, 30.XI.2022, J. Martins col. (www.inaturalist.org/observations/143355621); BRAZIL: Distrito Federal: Brasília, DF [Área de Proteção Ambiental do Planalto Central, Brasília, Brasil] - 15.77590, -47.79711, 29.XI.2022, Rafael RS.1 col (www.inaturalist.org/observations/143422759).

Corroborating Viana et al. (2024), *Z. tuberculatus* is a generalist species that warrants attention due to its high potential to exploit resources, making it an invasive species of concern. Evidence of this includes the rapid spread and distribution of the species across Brazilian biomes since its first report (Cavalcanti et al. 2022; Montes & Vilela 2022; Dos Santos et al. 2023; Faria & Bitner-Mathé, 2023; Jobim et al. 2023; Moreira et al. 2023; Ribeiro et al. 2024).

This report is important for gathering data on the geographic distribution and population growth of the species, which will aid in the development of pest management strategies.

Table 1. Distributions of *Zaprionus tuberculatus* Malloch, 1932 to Brazilian environments (references), including the occurrence in the municipality of Belém, Pará (PA) State, Brazil.

Distribution	Reference	Manuscript
DF	Cavalcanti et al. 2022	Geographic expansion of an invasive fly: first record of *Zaprionus tuberculatus* (Diptera: Drosophilidae) in the Americas.
MG	Moreira et al. 2023	First record of *Zaprionus tuberculatus* Malloch, 1932 (Diptera: Drosophilidae) in Minas Gerais, Brazil.
SC	Dos Santos et al. 2023	Primeiro registro de *Zaprionus tuberculatus* (Diptera: Drosophilidae) no estado de Santa Catarina, Brasil.
RS	Jobim et al. 2023	Expansion of the area of occurrence of *Zaprionus tuberculatus* (Diptera: Drosophilidae) in the Americas and registration of new host plants.
RJ	Faria & Bitner-Mathé 2023	Occurrence of *Zaprionus tuberculatus* on Southeastern Brazil coastal plain, in Rio de Janeiro.
SP	Cavalcanti et al. 2022	Geographic expansion of an invasive fly: first record of *Zaprionus tuberculatus* (Diptera: Drosophilidae) in the Americas.
	Mateus & Machado 2022	Survey of Drosophilidae fauna in an interior Atlantic Forest fragment in Southeastern Brazil reveals the occurrence of the invasive *Zaprionus tuberculatus.*
	Montes & Vilela 2022	*Zaprionus tuberculatus* was collected in the metropolitan region of São Paulo, state of São Paulo, Brazil.
PB	Ribeiro et al. 2024	First record of *Zaprionus tuberculatus* (Malloch, 1932) (Diptera: Drosophilidae) in Paraíba state, Brazil.
PA*	Present study	First report of the invasive species and potential pest *Zaprionus tuberculatus* Malloch, 1932 (Diptera, Drosophilidae) in Pará, Brazil.

*Species newly recorded from the state of Pará.

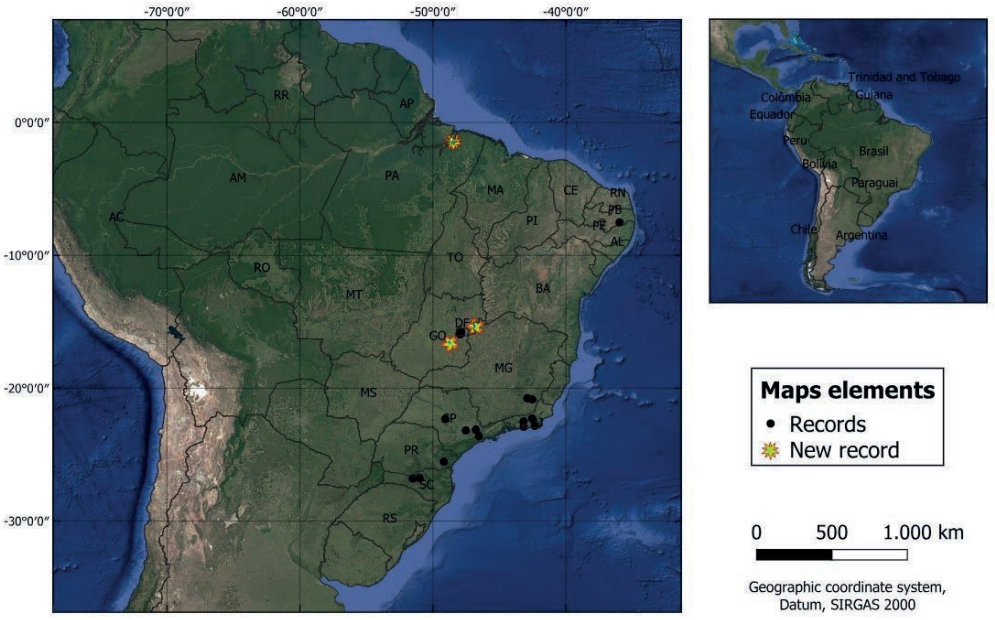

Figure 2. Distribution map of *Zaprionus tuberculatus* Malloch, 1932 in South America, with records of occurrences marked in Brazil. The map highlights both previously known and a new record.

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Authors' Contributions

MFM: Conceptualization, validation and writing - review and editing; CJEL: Conceptualization; supervision; funding acquisition; writing - review and editing.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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