

SHORT NOTES

Invasive *Zaprionus tuberculatus* (Diptera, Drosophilidae): Spreading across half of Brazil in just five years

Invasión de *Zaprionus tuberculatus* (Diptera, Drosophilidae): ocupación de la mitad del territorio brasileño en cinco años

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ABSTRACT

We verified the rapid geographic expansion of *Zaprionus tuberculatus* throughout Brazil by sampling in the Caatinga, Atlantic Forest, Pantanal, and Amazon biomes. Approximately 15 000 insects were collected, of which 254 were *Z. tuberculatus*. We present the first record of this species from the Pantanal, indicating its presence now in all Brazilian biomes. We expanded the known area of occupation of *Z. tuberculatus* in the Atlantic Forest and Caatinga. This species can be found in half of the Brazilian territory after only half a decade of invasion.

Keywords: biological invasion, brazilian biomes, Pantanal biome, South America.

RESUMEN

Verificamos la rápida expansión geográfica de *Zaprionus tuberculatus* en Brasil mediante muestreos en los biomas de Caatinga, Floresta Atlântica, Pantanal y Floresta Amazônica. Se recolectaron aproximadamente 15 000 insectos, de los cuales 254 fueron *Z. tuberculatus*. Presentamos el primer registro de esta especie en el Pantanal, indicando su presencia ahora en todos los biomas brasileños. Ampliamos el área conocida de ocupación de *Z. tuberculatus* en la Floresta Atlântica y en la Caatinga. Esta especie ya se puede encontrar en la mitad del territorio brasileño después de media década de invasión.

Palabras clave: América del Sur, biomas brasileños, bioma Pantanal, invasión biológica.

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INTRODUCTION

Biological invasions by insects have caused severe damage to agriculture (Niassy *et al.* 2020), human health (Cuthbert *et al.* 2023), and ecosystem equilibrium (Rabitsch *et al.* 2024). The globalization of trade, together with climate and environmental changes, has favored the introduction and establishment of invasive insects throughout the world (Venette and Hutchison 2021).

Zaprionus tuberculatus Malloch, 1932 is the most recent drosophilid to invade Brazil, with its first record in 2020 in the Cerrado (neotropical savanna) biome in Brasília (Cavalcanti *et al.* 2022). The species has since been recorded in the Atlantic Forests of the southern and southeastern regions of that country (Mateus and Machado 2022, Santos *et al.* 2023) as well as in the southern Pampa biome (Jobim *et al.* 2023). This species has also been reported in the Caatinga (semi-arid) domain (Ribeiro *et al.* 2024) and the Amazon region (SEGED 2024). Viana *et al.* (2024) observed the broad potential of *Z. tuberculatus* to infest different fruits during their larval stage and to coexist with other invasive drosophilid agricultural pests. Therefore, it is a worrisome invasive species in terms of potential ecosystem and economic disruptions.

Here we present the first record of *Z. tuberculatus* in the Pantanal biome, evidence of its geographic expansion into the Caatinga and the Atlantic Forest, and its occurrence points in Brazil.

MATERIAL AND METHODS

Drosophilids were captured using traps made from plastic bottles containing banana bait (Tidon and Sene 1988) in eight locations in the Caatinga, Atlantic Forest, Pantanal, and Amazon Forest biomes (Table 1). The traps were suspended 1.5 m from the ground, spaced a minimum of 30 m apart and remained exposed for three consecutive days. The captured drosophilids were stored in absolute ethanol.

Specimens of *Z. tuberculatus* were identified based on the diagnostic characteristics provided by Cavalcanti *et al.* (2022). Voucher specimens were deposited in the drosophilid collection of the Universidade Federal Rural de Pernambuco, Brazil. The current and previous distribution area of *Z. tuberculatus* was calculated from a polygon

obtained by connecting its occurrence points, calculated in QGIS, version 3.10.8. This species has been found in several municipalities in Brazil (Cavalcanti *et al.* 2022, Mateus and Machado 2022, Montes and Vilela 2022, Faria and Bitner-Mathé 2023, Jobim *et al.* 2023, Moreira *et al.* 2023, Santos *et al.* 2023, Ribeiro *et al.* 2024, SEGED 2024). Differences in the abundance of *Z. tuberculatus* in the Atlantic Forest and Caatinga biomes were evaluated via a Chi square test in BioEstat 5.0 (Ayres *et al.* 2007).

RESULTS AND DISCUSSION

We sampled 14 916 drosophilids, 254 (1.7 %) of which were *Z. tuberculatus*. The species was found in the Caatinga, Atlantic Forest, and Pantanal biomes; however, it was not observed in the Amazon Forest (Table 1). With the new records, the area occupied by *Z. tuberculatus* in Brazil totals 4 138 736 km², equivalent to 48.6 % of the country in less than five years after its first invasion record in the Americas. This result doubles the known area of occupation of the species in Brazil as compared to previous reports (2 073 628 km²) (Fig. 1)

The detection of *Z. tuberculatus* in two conservation areas in the Caatinga (Table 1) expands its distribution by approximately 150 km in this biome, both to the north and to the south (Fig. 1). No differences in the abundance of this species were observed between the investigated sites in the Caatinga ($X^2 = 0.325$, $p = 0.5687$). Although with low relative abundance in this biome (less than 3 %, Table 1), *Z. tuberculatus* is probably well adapted to the Caatinga, considering its rapid geographic expansion and occupation of fruits as larval breeding sites (Ribeiro *et al.* 2024).

Regarding the Atlantic Forest, the new records (Table 1) expand the distribution of *Z. tuberculatus* by more than 1600 km to the north (to Pernambuco State), as well as 350 km to the south (Rio Grande do Sul State, Fig. 1). Previously, this species occupied 266 548 km² in the Atlantic Forest. With the new localities, the area of occupation of *Z. tuberculatus* in this biome has increased almost three times (781 173 km²). These results demonstrate its adaptability to occupy areas with different climates and vegetation. As compared to *D. sukuzii* and *D. nasuta*, drosophilids that invaded the Atlantic Forest in the last decade (Andreazza *et al.* 2017, Martins *et al.* 2023), *Z. tuberculatus* has the widest detected geographic distribution in this biome.

Table 1. Locations investigated for the presence of *Zaprionus tuberculatus* in the Caatinga, Atlantic Forest, Pantanal, and Amazon biomes of Brazil. The climate, geographic coordinates, sampling dates, number of traps, total number of drosophilids captured (N), and the absolute and relative abundances of *Z. tuberculatus* are indicated for each location.

Biome	Climate*	Locality	Coordinates	Date	Trap	N	<i>Z. tuberculatus</i> (%)
Caatinga	Semiarid, annual rainfall= less than 500 mm. Driest months between July and December.	Pedra da Boca State Park (Araruna, Paraíba)	6°26'S/ 35°40'W	15/7/22	6	213	6 (2.82)
		Catimbau National Park (Buíque, Pernambuco)	8°34'S/ 37°14'W	17/6/22	6	4127	82 (1.99)
Atlantic Forest	Humid tropical, annual rainfall is close to 1000 mm. Driest months between August and January.	Rural area (Igarasu, Pernambuco)	7°49'S/ 30°00'W	5/10/23	6	1944	21 (1.08)
		Rural area (Chã de Alegria, Pernambuco)	8°00'S/ 35°13'W	29/4/24	4	920	12 (1.30)
	Humid temperate, annual rainfall = 2500 mm. Driest months between April and September.	Itatiaia National Park (Itatiaia, Rio de Janeiro)	22°26'S/ 44°36'W	10/3/21	6	2143	4 (0.19)
	Humid temperate, annual rainfall=1500 mm. No defined dry season.	Rural area (Porto Alegre, Rio Grande do Sul)	30°08'S/ 51°10'W	5/1/23	3	598	118 (19.73)
Pantanal	Hot humid, annual rainfall=1200 mm. Driest months between April and September.	Rural area (Cáceres, Mato Grosso)	16°04'S/ 57°41'W	28/4/23	6	3692	11 (0.30)
Amazon Forest	Hot equatorial. Annual rainfall= 3000 mm. No defined dry season.	Rural area (Manaus, Amazonas)	3°05'S/ 59°58'W	15/1/22	6	1279	0 (0)

*Climatempo (2024)

Significant differences were observed in the abundance of *Z. tuberculatus* between the investigated locations in the Atlantic Forest ($X^2 = 598.127$, $p < 0.0001$). Considering the wide latitudinal variation of this biome (from 5° to 30° south latitude), new samplings should be carried out in the investigated areas to understand the adaptive and seasonal preferences of *Z. tuberculatus*. Before the invasion of this species in Brazil, Coutinho-Silva *et al.* (2017) observed that Neotropical and invasive drosophilids have distinct seasonal preferences in the northern portion of the Atlantic Forest in the state of Pernambuco.

We reported the first records of *Z. tuberculatus* for the Pantanal (municipality of Cáceres), demonstrating the occurrence of this species in all Brazilian biomes (Fig. 1). The records closest to the municipality of Cáceres in the

Pantanal were approximately 1000 km away in the Cerrado and Atlantic Forest biomes (Fig. 1). The abundance of *Z. tuberculatus* in the Pantanal was less than 1 % (close to that of the invasive *D. nasuta* in that same biome) (Martins *et al.* 2023).

Only two individuals of *Z. tuberculatus* were previously collected in the Amazon Forest (municipality of Belém, SEGED 2024), and none were collected in this biome in the present study (municipality of Manaus, approximately 1300 km from Belém). The low abundance of *Z. tuberculatus* in the Amazon biome is therefore notable, and its absence in Manaus may indicate that the species had not yet reached the city before our sampling, or that its abundance is very low, requiring a larger number of samples for its detection.

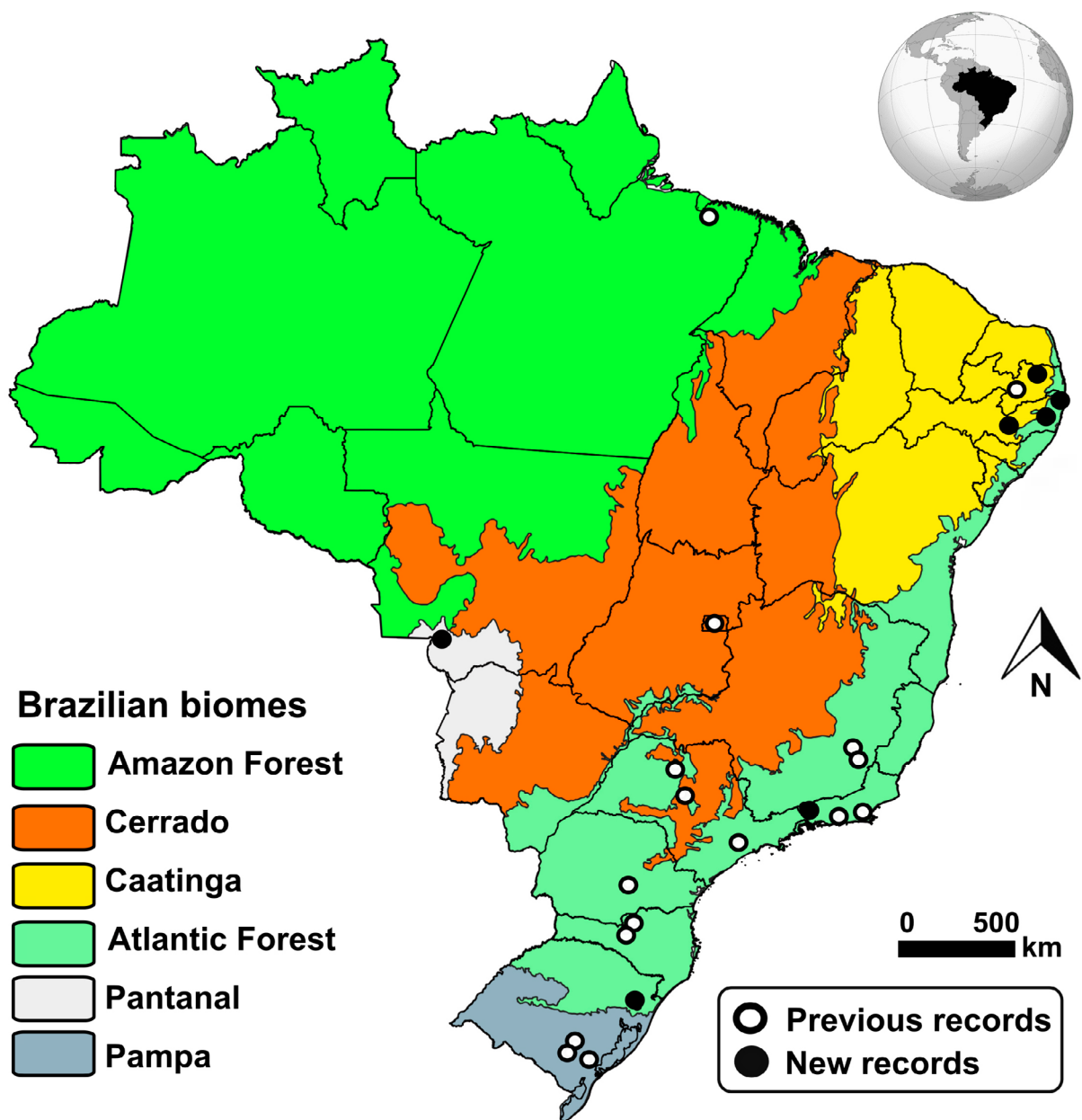


Figure 1. Map of biomes in Brazil with indication of municipalities where invading species *Zaprionus tuberculatus* has been recorded. White dots previous records; black dots new records.

In addition to the rapid and wide geographic distribution of *Z. tuberculatus* reported in this study, its adaptive potential in Brazil has likewise been demonstrated by its flexibility in using different hosts as larval breeding sites. Viana *et al.* (2024) observed the emergence of *Z. tuberculatus* from 24 plant hosts in the Brazilian Cerrado; in nine of these resources, the relative abundance of this species

exceeded 50 % as compared to other drosophilids. Given the socioeconomic importance of fruit production in Brazil (MAP 2024) and the risk of *Z. tuberculatus* becoming a harmful invasive species for horticulture, it will be essential to assess its ecosystem and economic impacts and monitor its potential to invade new territories.

AUTHOR CONTRIBUTIONS

Conception and design of the study: ACLG and MAM. Sampling and identification of drosophilids: ACLG, AESS, CRO, JRO, JIPFQ, KVLA, MFSS, PMSN, MFS, TCSLM and MAM. Writing—review and editing: ACLG and MAM. Funding acquisition: ACLG.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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