

# Filling the gap: medium and large mammals from a Cerrado remnant in Central Brazil

## Llenando el vacío: mamíferos medianos y grandes de un remanente del Cerrado en el centro de Brasil

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Biodiversity in the Cerrado biome is threatened by deforestation and the conversion of native vegetation by agricultural and urban areas. Unfortunately, in some areas such as the state of Tocantins, there is a sampling gap of mammalian fauna, resulting in a lack of knowledge. The present study contributes to reducing this gap by providing information about medium and large-sized mammals from the Rio Formoso region, Tocantins. In January 2019, we carried out a field survey in 7 sampling points in the municipality of Dueré, southern Tocantins. We installed 4 camera traps which remained active for a period of 7 days. Additionally, diurnal and nocturnal active censuses were carried out. The relative completeness of the inventory was assessed through the species' cumulative curves. We recorded 21 species of medium and large-sized mammals over 7 days of sampling in a region under the influence of agricultural activities, including endangered species such as jaguars, giant armadillos, giant otters and marsh deer. The presence of species of large and medium mammals that play important ecosystem roles highlights that Cerrado remnants still maintain good environmental conditions even with anthropic actions occupying the landscape. These results highlight the importance of field studies at the regional level and provide information about an underexplored region.

**Key words:** Agricultural; Cerrado; inventory; large-sized mammals; Tocantins.

La diversidad del bioma Cerrado está amenazada por la deforestación y el reemplazo de la vegetación nativa por áreas agrícolas y urbanas. Desafortunadamente, áreas como parte del estado de Tocantins, permanecen como un vacío de muestreo para la fauna de mamíferos, que resulta en una falta de conocimiento. El presente estudio contribuye con información sobre mamíferos medianos y grandes de la región de Río Formoso, Tocantins. En enero de 2019, realizamos un levantamiento de campo en 7 puntos de muestreo en el municipio de Dueré, sur de Tocantins. Instalamos 4 cámaras trampa las cuales permanecieron activas por un periodo de 7 días. Adicionalmente, se realizaron censos activos diurnos y nocturnos. La relativa completitud del inventario se evaluó a través de las curvas acumulativas de las especies. Registramos 21 especies de mamíferos medianos y grandes durante 7 días de muestreo en una región bajo la influencia de actividades agrícolas, incluidas especies en peligro de extinción como jaguares, armadillos gigantes, nutrias gigantes y ciervos de los pantanos. La presencia de especies de mamíferos grandes y medianos, que tienen un papel importante en el ecosistema evidencia que el entorno local del Cerrado mantiene cierto equilibrio aún con las acciones antrópicas en el paisaje. Estos resultados muestran la importancia de los estudios de campo a nivel regional y brindan información sobre una región poco explorada.

**Palabras clave:** Agrícola; Cerrado; inventario; mamíferos de gran tamaño; mastozoología.

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The Cerrado biome occupies parts of Paraguay, Bolivia, and approximately 24 % of Brazil, encompassing a high phyto-physiognomic diversity, that features grassland, savanna and forest vegetation (Buttler *et al.* 2012). The environmental heterogeneity observed throughout its distribution allows for the occurrence of at least 251 species of mammals in this biome, 22 of which are endemic (Gutiérrez and Marinho-Filho 2017). This diversity is under threat due to the high rates of deforestation (Ferreira *et al.* 2017), resulting from the openings of agricultural areas and urbanization,

converting the natural landscapes into mosaics with fragments of natural vegetation limited by agricultural activities and urban landscapes (Brady *et al.* 2011).

Although some studies have already been carried out in several areas of the Cerrado, the mammal fauna remains poorly known and poorly documented in many regions of this biome (Oliveira *et al.* 2019). Some of these regions do not even have a list of species, which is necessary to carry out field surveys (Cabral *et al.* 2017). In addition to the list of species occurring in a location, faunal inventories can

provide useful information to assess the level of disturbance in an area, given that changes in the species composition of an environment over time can provide clues about the influence of anthropogenic activities on it (Silva and Passamani 2009). Interestingly, even though it appears as the most common contribution in event abstracts, most inventories of mammal fauna are not subsequently published in papers (Brito et al. 2009). In general, these studies usually occur in preserved areas, such as conservation units (Carmignotto and Aires 2011).

Among the regions still lacking information about the mammal fauna is the Cerrado in the state of Tocantins. This state has an area of 277,423 km<sup>2</sup>, with approximately 72 % of native vegetation preserved and composing one of the largest remnants of the biome in the country (Ministério do Meio Ambiente 2014). Currently, a new agricultural frontier has been established in the Cerrado of the states of Maranhão, Tocantins, Piauí and Bahia (named as MATOPIBA; Pereira et al. 2018). In these places, native vegetation is being rapidly replaced by agricultural crops. Some inventories of medium and large mammals in Tocantins were carried out outside of conservation units showing richness between 42 (Mercês et al. 2020) and 47 species (Santiago et al. 2019). Although these previous studies have sampled some areas across Tocantins, the state has a very large territory most

of which remains unexplored. Furthermore, the fieldwork for these surveys took place in 2011 and did not assess the presence of mammals in agricultural areas. In this sense, our study differs from previous surveys and contributes to a better understanding of the mammalian fauna in this state by exploring an unsampled region under the influence of agricultural activities in the municipality of Dueré.

In January 2019, a field survey was carried out for the inventory of medium and large size mammals at São Bento Farm and surrounding areas, in the municipality of Dueré, in the southern region of the state of Tocantins (11° 15' 31.69" S, 49° 44' 16.48" W; Figure 1). The vegetation contains savannas, forests, sporadically flooded grasslands, and *veredas* (palm swamps, *Mauritia flexuosa*; Resende et al. 2013). The climate is tropical humid (Aw), according to the Köppen classification (Alvares et al. 2013). The predominant land-use in this area is cattle ranching, but grains such as soy and rice are also present.

The inventory was carried out in 7 sampling points. In points 1 and 2, we installed 4 camera traps with movement and heat sensors (Bushnell model 119436) regulated to be active 24 hr and to capture images when triggered. Cameras remained active for a period of 7 days, totaling a sampling effort of 675 hr. Additionally, diurnal and nocturnal active censuses were carried out covering trails and

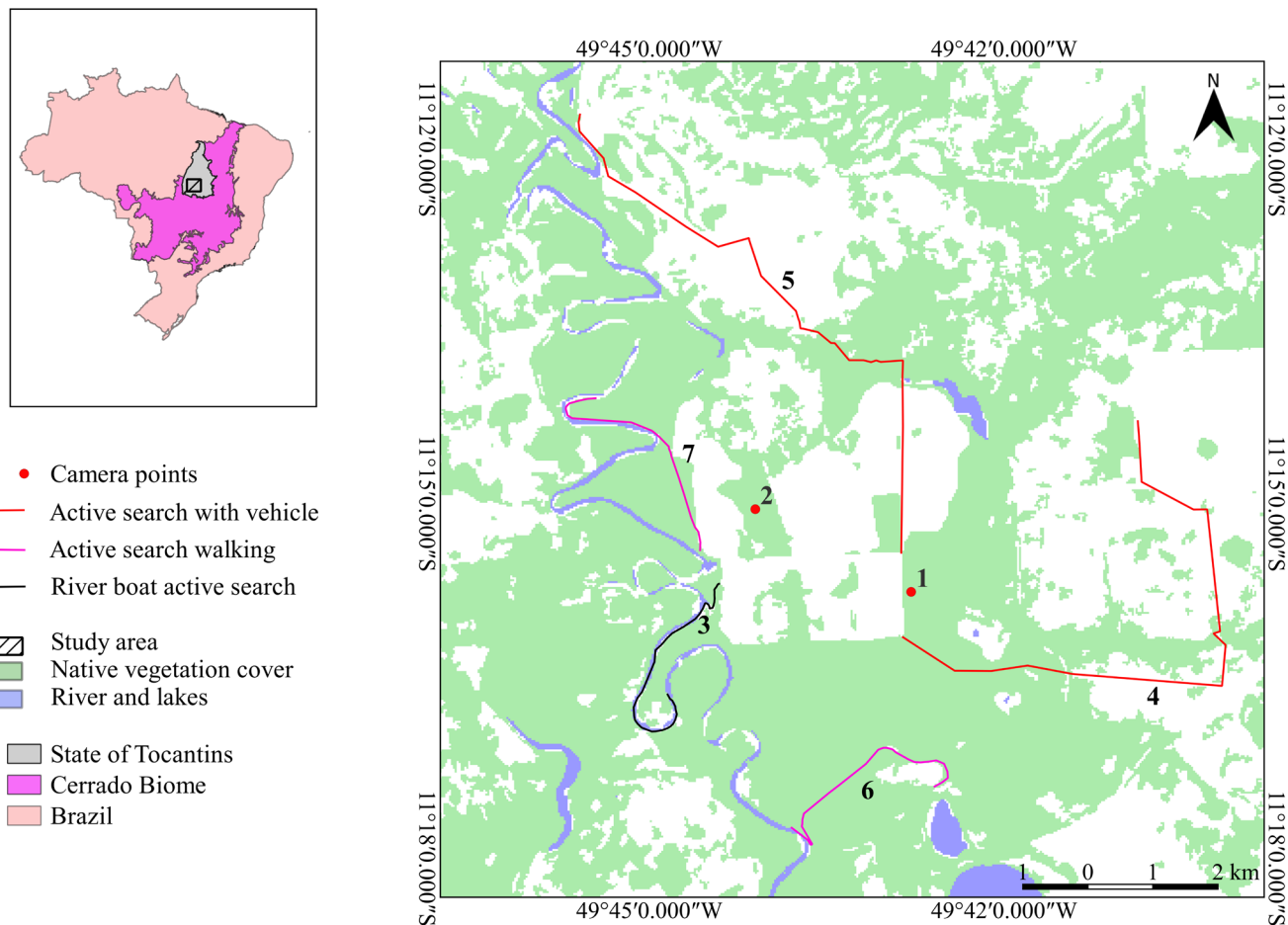


Figure 1. Sampling sites (1-7) and field methods employed at the study area, Farm São Bento, in Dueré, Tocantins, Brazil.

unpaved roads in search of sightings of animals or vestiges, such as tracks or feces, totaling a sample effort of 64 km. The points covered comprised heterogeneous areas, including areas close to crops, flooded grasslands, ponds, riparian forests, legal reserves, and one point in the river, covered using a boat. Point 3 was covered 4 km upstream, and points 4 and 5 were covered with a vehicle, covering 10 km each, on rural roads. In points 6 and 7, we used trails inside agricultural properties, covered by walking, covering 4 km each. The points were sampled sequentially over the field days, and the nocturnal censuses with the aid of a lantern. The relative completeness of the inventory was assessed through the inspection of the topology of cumulative curves using the species number estimator (Jackknife 1) in the EstimateS software (version 9.1, R. K. Colwell, <https://www.robertkcolwell.org/pages/estimates>).

Twenty-one species of medium and large mammals were recorded, divided into 9 orders and 14 families (Table 1). Among the species recorded, 6 are considered vulnerable and 1 endangered, according to the [IUCN classification \(2022\)](#). The marsh deer (*Blastocerus dichotomus*) was recorded only in wet rice crop areas.

Among the species registered, 26.5 % are classified as VU (Vulnerable), and the giant otter species (*Pteronura brasiliensis*) is classified as EN (Endangered). In one of the sites, the active search was carried out with a boat, hav-

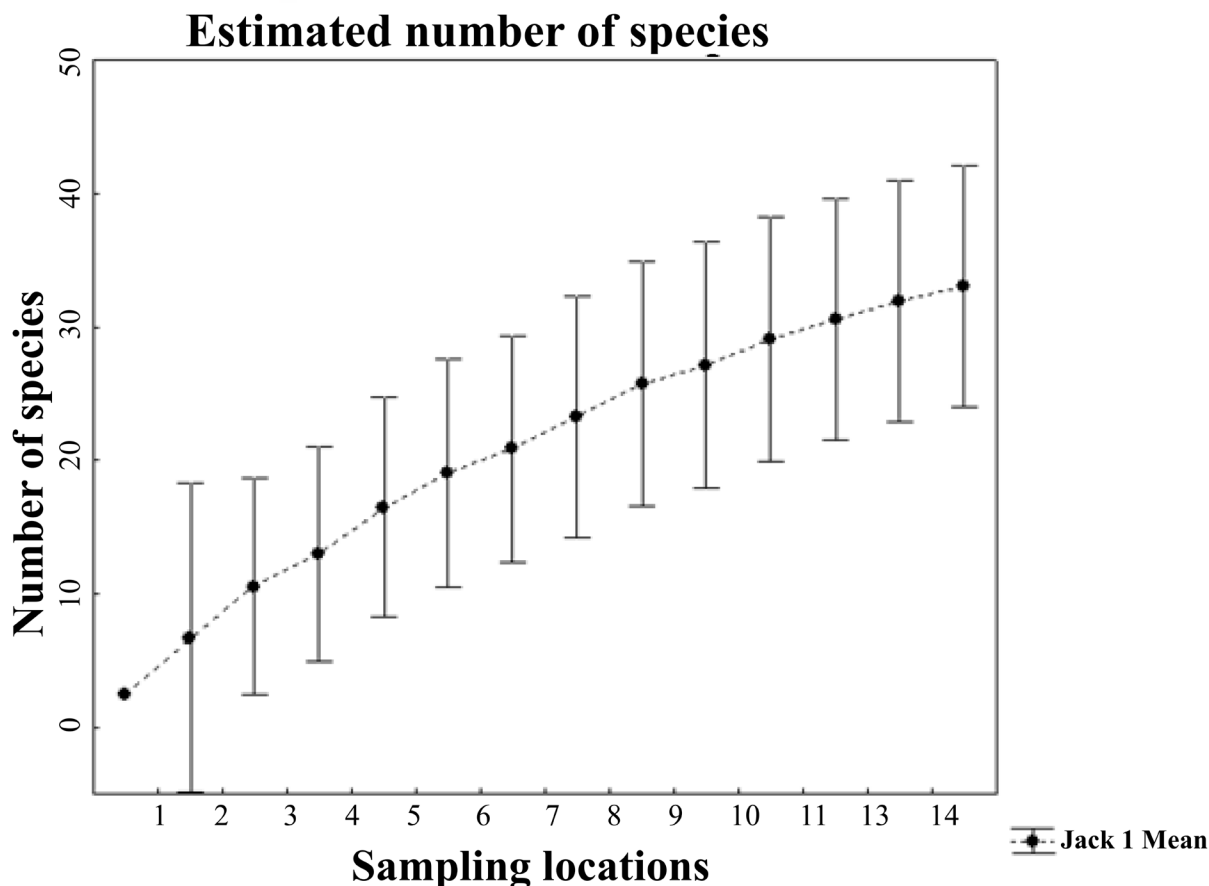
ing registered some species that presented total or partial foraging in aquatic habitats, such as the grey river dolphin (*Inia araguaiaensis*), giant otter (*P. brasiliensis*) and capybara (*Hydrochoerus hydrochaeris*). The topology of the estimated species' accumulation curves constructed based on our captures does not show an asymptotic tendency, suggesting that the area still has the potential to harbor a higher species richness (Figure 2).

Most species ( $n = 12$ ) were registered exclusively by active search, followed by camera trap captures (Figure 3A-J). Two other species, *Mazama gouazoubira* and *Leopardus pardalis*, were recorded in both survey methods (active search and cameras), emphasizing the importance of diversifying inventory methods ([Lyra-Jorge et al. 2008](#)).

Although the sampling effort period had been relatively short when compared to other studies, this number of species is high when compared to that reported by [Cabral et al. \(2017\)](#) in a private conservation unit in the municipality of Cavalcante, in the state of Goiás, which recorded 16 species; or when compared to the 19 species found by [Laurindo et al. \(2019\)](#) in Cerrado fragments under pasture influence, in the state of Minas Gerais. [Nogueira et al. \(2011\)](#) also recorded 41 species in mammalian inventories inside of protected areas in Tocantins. A study by [Santiago et al. \(2019\)](#), covering several sample sites distributed throughout the state, reported the occurrence of 47 species.

**Table 1.** Checklist of mammalian species recorded in the municipality of Dueré, Tocantins, Brazil. Conservation status according to the IUCN Red List (2022). IUCN abbreviations: LC = least concern, NT = near threatened, VU = vulnerable, DD = data deficient, EN = endangered, NE = not evaluated.

Order	Family	Scientific name	Common name	IUCN
Artiodactyla	Cervidae	<i>Mazama gouazoubira</i>	Gray Brocket	LC
		<i>Blastocerus dichotomus</i>	Marsh Deer	VU
	Tayassuidae	<i>Pecari tajacu</i>	Collared Peccary	LC
		<i>Tayassu pecari</i>	White-lipped Peccary	VU
Carnivora	Felidae	<i>Panthera onca</i>	Jaguar	VU
		<i>Leopardus pardalis</i>	Ocelot	LC
	Mustelidae	<i>Pteronura brasiliensis</i>	Giant Otter	EN
	Procyonidae	<i>Procyon cancrivorus</i>	Crab-eating Raccoon	LC
		<i>Nasua nasua</i>	South American Coati	LC
Cetacea	Iniidae	<i>Inia araguaiaensis</i>	Grey river dolphin	NE
Cingulata	Dasypodidae	<i>Dasypus novemcinctus</i>	Nine-banded Armadillo	LC
		<i>Priodontes maximus</i>	Giant Armadillo	VU
		<i>Euphractus sexcinctus</i>	Yellow Armadillo	LC
Didelphimorphia	Didelphidae	<i>Didelphis albiventris</i>	White-eared Opossum	LC
		<i>Philander opossum</i>	Gray Four-eyed Opossum	LC
Perissodactyla	Tapiridae	<i>Tapirus terrestris</i>	Brazilian Tapir	VU
Pilosa	Myrmecophagidae	<i>Myrmecophaga tridactyla</i>	Giant Anteater	VU
Primates	Atelidae	<i>Alouatta caraya</i>	Black-and-gold Howler Monkey	NT
	Cebidae	<i>Sapajus libidinosus</i>	Bearded Capuchin	LC
Rodentia	Caviidae	<i>Hydrochoerus hydrochaeris</i>	Capybara	LC
	Dasypodidae	<i>Dasyprocta azarae</i>	Agouti	DD



**Figure 2.** Estimated species accumulation curve (Jackknife1) medium and large mammals in Farm São Bento, in Dueré, Brazil.

Studies carried out in different areas of the Cerrado biome recorded medium and large mammal species ranging from 10 to 39 species (Cabral *et al.* 2017). However, this variation may be a consequence of the different methods (active and passive methods) and sampling effort employed, as well as the different phytophysognomies assessed in these areas (Bocchiglieri *et al.* 2010). Some species can search for food in anthropic areas to complement their diet with livestock and domestic animals or agricultural crops. As a response to the economic losses caused by these habits, the local population hunts these species, increasing the number of wild animals injured and dead (Cavalcanti and Gese 2010). In the present study, we registered large carnivores, such as *Panthera onca*, in environments inserted in pasture areas. We also recorded large herbivores, such as *B. dichotomus* and *H. hydrochaeris*, in grain crop areas.

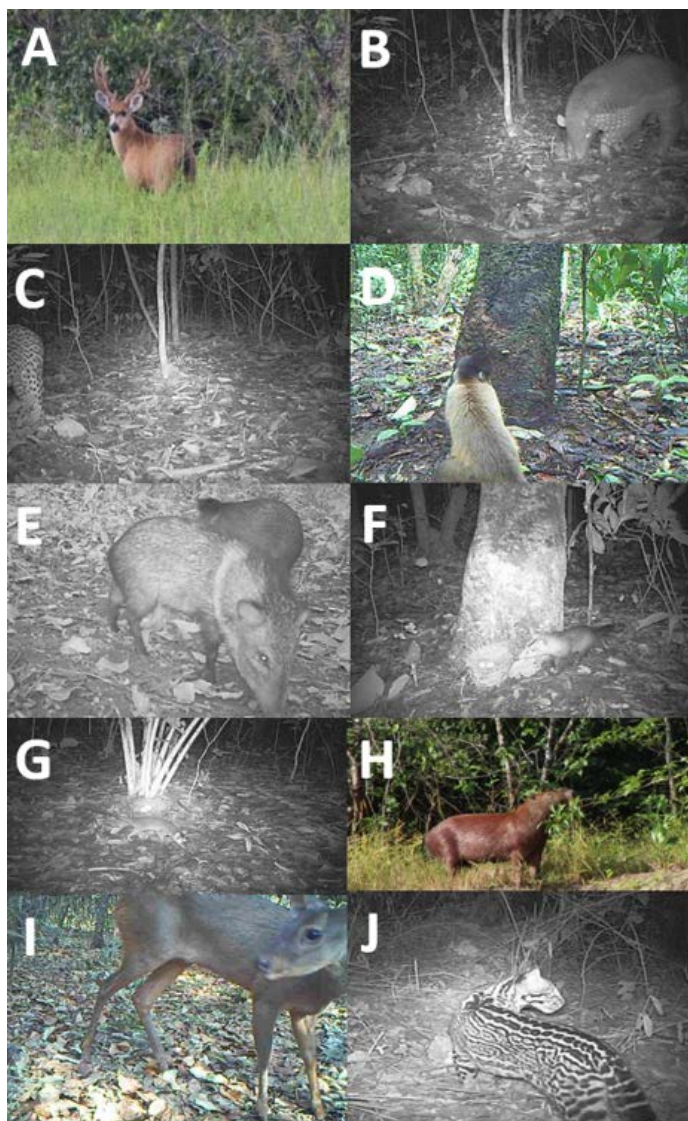
It is interesting to note that, in 7 days of sampling, the present study reached 75 % of the number of species observed by Silveira *et al.* (2003), in which 28 species of medium and large mammals were recorded in the Emas National Park, after 44 days of sampling. When compared

with data from other surveys of medium and large mammals outside conservation units in Tocantins, our data, collected in a single region, also represent 56.7 % of the richness recorded by Santiago *et al.* 2019, which recorded 37 species at several sample points present throughout the state in a decade of sampling.

Furthermore, it is likely that the number of species in the studied region will increase with a greater sampling effort, as suggested by the diversity estimates and the species accumulation curve that did not reach an asymptote in this period. Because large mammals need larger areas to forage and diversified environments to explore a wide variety of resources (Brady *et al.* 2011), the study area proved to be relatively rich for this group, even with anthropogenic interventions present. Thus, the animals of this region may be undergoing foraging adaptations or may be at greater risk to inhabit these anthropic environments (Shamoon *et al.* 2018).

We observed *B. dichotomus* only in rice crop fields, recording several individuals in this type of environment, which may suggest this species is using these flooded fields because they resemble swampy areas and provide food





**Figure 3.** Some medium and large mammals recorded in the municipality of Dueré, state of Tocantins, Brazil. A) *Blastocerus dichotomus*, B) *Priodontes maximus*, C) *Panthera onca*, D) *Sapajus libidinosus*, E) *Pecari tajacu*, F) *Didelphis albiventris*, G) *Philander opossum*, H) *Hydrochoerus hydrochaeris*, I) *Mazama gouazoubira*, J) *Leopardus pardalis*.

resources. Actually, the matrix effect can benefit some species (Borges-Matos et al. 2016). We observed that 7 of the species recorded are classified within some threaten category (IUCN 2022), drawing attention to the need for conservation measures. Some of these species face conflicts with the local population and agricultural activities, such as *P. brasiliensis* (Rosas-Ribeiro et al. 2011) and *Panthera onca* (Zimmermann et al. 2005). However, the presence of these top-chain predators (Ripple et al. 2014), together with game species, such as *Priodontes maximus* (Desbiez and Kluyber 2013) and large seed dispersers such as *Tapirus terrestris* (O’Farrill et al. 2013) and *Tayassu pecari* (Keuroghlian and Eaton 2008), play important roles in the ecosystem balance, reinforcing the importance of the studied area. Further studies and field efforts in the region are necessary for a deeper analysis of its mammalian diversity, as well as its potential relevance for the biodiversity of Tocantins and the Cerrado biome.

## Acknowledgements

We are grateful to the Instituto Federal de Ciências e Tecnologia Goiano, Campus Rio Verde (IF Goiano) by providing equipments and laboratory facilities. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. BF (extension) and JVV (Scientific Initiation Program) were recipient of scholarships of IF Goiano. A. Ribeiro de Moraes thanks Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for their research productivity fellows and Fundação Grupo Boticário de Proteção à Natureza for financial support. Two anonymous reviewers helped us to improve this note.

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Associated editor: Tamara M. Rioja Paradela.

Submitted: November 11, 2022; Reviewed: April 3, 2023.

Accepted: May 12, 2023; Published on line: June 16, 2023.